

New Jersey Strategic Management Plan for Invasive Species

The Recommendations of the New Jersey Invasive Species Council to Governor Jon S. Corzine

Pursuant to New Jersey Executive Order #97






Vision Statement:

"To reduce the impacts of invasive species on New Jersey's biodiversity, natural resources, agricultural resources and human health through prevention, control and restoration, and to prevent new invasive species from becoming established."

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The first draft of this plan was produced by the author, under contract with the New Jersey Invasive Species Council, in February 2007. Two subsequent drafts were prepared by the author based on direction provided by the Council. The final plan was approved by the Council in August 2009 following revisions by staff of the Department of Environmental Protection.

Cover Photos:

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This report may be cited as: New Jersey Invasive Species Council. 2009. New Jersey Strategic Management Plan for Invasive Species. Trenton, NJ. 110 pages.

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EXECUTIVE SUMMARY

This report and set of recommendations was produced pursuant to New Jersey Executive Order #97 which created the New Jersey Invasive Species Council with the charge of completing a comprehensive invasive species management plan for the State of New Jersey.

New Jersey has abundant biodiversity, natural resources and agricultural resources that are highly worth protecting for our citizens, both present and future. Seventy percent of our state consists of agricultural lands and natural habitats. A snapshot of our wealth includes 850,000 acres of agricultural lands, 2.1 million acres of forest cover, 52 globally rare and federally listed species and over 2,100 species of native plants (including 55 species of orchids, which is more than Hawaii). These natural resources provide ecosystem goods (e.g., agricultural commodities, timber, fish) and services (e.g., flood control, carbon sequestration), the combined value of which is estimated at $20 billion per year. Wildlife-related tourism is estimated to provide an additional $3 billion per year of gross economic activity. However, our natural and agricultural resources are being damaged by non-native, invasive species which are transforming our resources in undesirable ways. These animals, plants and pathogens are pervasive throughout the state, are steadily increasing in abundance and numbers of species, and already are imposing a significant cost to the public and private sectors. Further damage to our State's economy and ecology is inevitable if New Jersey does not take a proactive role toward managing invasive species.

The New Jersey Invasive Species Council (NJISC) has adopted the definition developed by the National Invasive Species Council, which defines an invasive species as "a species that is 1) non-native to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health." An invasive species can be a plant, animal or microbe. Thousands of non-native species have been introduced to our state. Although most non-native species do not become invasive or cause harm, the small percentage that do pose important threats to our environmental, economic and social welfare.

The economic impact of invasive species on New Jersey agriculture is estimated at $290 million per year, or 33 percent of New Jersey's total agricultural cash receipts. One prominent example of the economic impact is New Jersey's oyster industry, which has been nearly destroyed by two invasive pathogens. Other obvious negative impacts range from the loss of over 21,000 mature trees due to Asian longhorned beetle infestations in Union and Middlesex counties and increased mosquito bites due to the invasive Asian tiger mosquito, to extremely rare but severe events such as human mortality caused by West Nile Virus. In addition, invasive species have created profound impacts including modification of whole forest types and local extinction of rare species. Approximately 1,000 plant species, or about 30 percent of the State's flora, are non-native. The consensus of field scientists is that invasive plant species probably cover hundreds of thousands of acres in our state. Invasive species are considered the greatest threat to biodiversity after outright habitat destruction. In the United States, 40 percent of federally threatened and endangered species are at risk from invasive species.

Confronting this challenge will require newly dedicated resources and strong commitment from all stakeholders. We must work together to PREVENT new invasions and limit the continued

spread of invasive species that are already present. We must also CONTROL infestations that currently exist and work to RESTORE ecosystems to their natural condition.

The NJISC recommends that resources devoted to invasive species programs be commensurate with the threats posed to biodiversity and the damage they cause to our natural resources, agricultural resources and human health. New Jersey's effort must also be commensurate with that of neighboring states, to promote regionally effective programs and policies. There is little doubt that we have already lost much to invasive species. With a concerted effort, New Jersey can limit future losses and begin to reverse the damage.

The agricultural, conservation and scientific communities from governmental, nongovernmental, academic and business sectors have put much thought and action toward understanding and reducing the invasive species problem. This plan provides a blueprint for a cooperative effort among stakeholders to put into practice the actions needed to reduce and manage the invasive species problem.

Vision and Mission

The NJISC's vision statement is "To reduce the impacts of invasive species on New Jersey's biodiversity, natural resources, agricultural resources and human health through prevention, control and restoration, and to prevent new invasive species from becoming established." Its mission is to provide overarching coordination and guidance for invasive species activities throughout the state and to act as a liaison for regional and national cooperative efforts.

Recommendations of the New Jersey Invasive Species Council

Our success in addressing the threats posed by invasive species to New Jersey's ecological, agricultural and economic assets requires that the State of New Jersey establish leadership in solving the problems caused by invasive species. Ultimately, this will necessitate a dedication of resources well beyond the admirable but currently disparate and uncoordinated efforts undertaken to date. Lacking an entity with sole responsibility for overseeing and coordinating this initiative, New Jersey cannot expect to ensure the successful implementation of this plan. Creation of such an entity, referred to in this plan as the Office of Invasive Species, and the appropriation of resources necessary to support it, may be difficult to envision at a time of diminishing government resources. However, it must remain a goal integral to the mission of the NJISC as mandated under Executive Order #97. See Appendix 11 for a complete list of NJISC recommended goals, goal implementation leaders, and goal completion measurements.

Tier I Recommendations

The following tasks are considered by the NJISC to be of the highest priority and are identified for implementation within one to two years of management plan adoption. These high priority tasks are considered "budget neutral" and, therefore, may be accomplished with existing State staffing and resources. Sections of the text where more information can be found are indicated in parentheses following each recommendation.

- Establish a permanent NJISC, co-chaired by the Department of Environmental Protection (NJDEP) and the Department of Agriculture (NJDA), to continue in its capacity as advisory body to the Governor of New Jersey. The NJISC will emphasize partnerships among governmental agencies, non-governmental and private-sector organizations, and concerned citizens representing the full range of stakeholders affected by invasive species problems. The NJISC will meet at least quarterly, promote volunteer-based actions to reduce the impacts of invasive species and educate the public, and ensure that the requirements of the Environmental Law Institute's 'Silver Standard' for state action on invasive species are met. (Section 5)

- Supplement the NJISC with members representing key federal partners (USDA, DOI and EPA). (Section 5)

- Develop two-way communication mechanisms within New Jersey and between neighboring states and regional and national invasive species entities. (Section 5)

- Develop a dialogue with the Biological Risk Assessment Committee for Port Elizabeth. (Section 5)

- Create an informative website with NJ-specific information, important regional and national links, and description of the NJISC's composition and mission. (Section 2)

- Encourage passage of revisions to the USDA-APHIS Quarantine 37 rules to require pre-screening of plants for invasive potential prior to entry into the United States. (Section 3)

- Use a modified Massachusetts protocol to seek peer-review of the DEP's 2002 *Prioritized Listing of New Jersey's Nonindigenous Plant Species* to better promote education and outreach efforts and serve as a basis for potential regulatory programs. Incorporate into this effort development of a "Clean List" of nonindigenous species that lack invasive qualities and are safe for planting. (Section 3, Appendix 2)

- Utilize existing statutory authority to prohibit the sale of invasive or potentially invasive plant species, and enforce through NJDA's nursery certification program. (Section 3)

- Enforce Policy Directive 2004-04 prohibiting the intentional introduction of specified invasive plant species into DEP lands and waters, and require planting of native or "Clean Listed" non-native species only on all State-owned lands. (Section 3)

- Cooperate with the Division of Fish & Wildlife on continued implementation of comprehensive statewide deer management that establishes statewide deer hunting goals based on ecosystem health thresholds and increased hunting access on public and private lands. (Section 4)

- Seek re-appropriation of the Hunters Helping the Hungry (HHH) program, which enables hunters to donate venison to needy individuals throughout NJ, with a suggested restart amount of $250,000, to enhance incentives for increased deer hunting in NJ. (Section 4)

- Using NY PRISM's as a model, establish Cooperative Weed Management Areas (CWMAs) that apply early detection/rapid response (ED/RR) methods to limit damage by invasive species before they become widespread or impact biodiversity-rich sites, promote public education programs, and identify and seek federal funding to establish technical assistance and cost-share programs for stakeholders. (Section 4)

- Create a list of native plants for restoration projects on various habitat types and encourage the use of native ecotypes best suited to local conditions. (Section 4)

- Require the incorporation of invasive species issues and ED/RR principles into the development of Community Forestry plans by municipalities and into updates of existing plans. (Section 3)

- Encourage public/private partnerships in managing invasive species on State-owned lands through a creative agricultural lease program with farmers and the involvement of trained and certified volunteers. (Section 4)

Tier II Recommendations

The following tasks, listed under various headings and Recommendation Sets, outline a longer-term strategy to achieve the mission of the NJISC. They include the creation of new programs and initiatives that aim to prevent new invasions, control infestations and restore ecosystems. The resources required to accomplish these tasks do not currently exist and may be difficult to garner given the State's current fiscal constraints. The NJISC envisions a three to ten-year horizon from management plan adoption for full or partial implementation of these recommendations.

Structure for New Jersey's Invasive Species Program (Section 5)

- *Recommendation Set #1 - Create an efficient and effective invasive species program*

  - Create an Office of Invasive Species (OIS) to ensure successful implementation of the New Jersey Strategic Management Plan for Invasive Species.

  - Create a New Jersey Invasive Species Strike Team (NJ-ISST) to administer invasive species control efforts. The NJ-ISST will report to the OIS.

  - Provide existing State agencies and programs (NJDEP, NJDA, Rutgers – New Jersey Agricultural Experiment Station Cooperative Extension (RCE)) with additional staff positions and funding.

  - Consider incorporation of funding for stewardship into future Garden State Preservation Trust (GSPT) bond initiatives, and explore additional funding sources, recognizing that habitat lost through the proliferation of invasive species represents the loss of our State's capital assets.

- Ensure annual appropriation for research on biological control agents that mitigate the impacts of NJ's most harmful invasive species.

Stakeholder Conversations (Section 2)

- *Recommendation Set #2 - Coordinate a campaign to educate stakeholders and improve public awareness, reduce existing problems and minimize the risk of new invasions*

  - Create printed and web-based materials and signage for distribution to stakeholders.

  - Authorize creation of and fund invasive species teaching modules by RCE, Office of Continuing Education, curriculum modules for K-12 education, and expanded undergraduate and graduate-level education at New Jersey's institutions of higher learning.

  - Enhance the NJISC website to provide additional information, such as updates on ED/RR programs and invasive species distribution maps.

  - Encourage voluntary stakeholder endorsement and adherence to the St. Louis Declaration Voluntary Codes of Conduct.

  - Create a rewards and recognition program for voluntary nursery and other industry and community group efforts.

  - Provide outreach and incentives to reduce the reservoir of invasive plant species that continue to spread from planted landscapes.

Prevention (Section 3)

- *Recommendation Set #3 - Prevent further intentional introductions of invasive species*

  - Prohibit the interstate shipment of invasive species into NJ utilizing established NJDA quarantine and regulatory processes.

  - Establish new NJDA regulations for maintenance of invasive species in public gardens that would require reporting and prevention of spread into non-garden areas.

  - Expand evaluation of invasive potential to all non-native species introduced/utilized for agriculture, horticulture, medicinal uses, pet trade, etc.

  - Re-evaluate every five years the prioritized listing of NJ's nonindigenous plants, animals and pathogens, including the production of an annual report and database of new introductions through the existing Quarantine 37 process.

- *Recommendation Set #4 - Reduce unintentional introductions of invasive species*

- Seek to ensure that US Customs and Border Protection agricultural inspection programs throughout New Jersey are fully staffed, as well as that of the USDA-APHIS-PPQ Plant Inspection Station in Linden.

- Minimize the spread of invasive species through recreational activities, such as installing interpretive signage at trailheads and boat launches, and other educational approaches that encourage appropriate behaviors.

- Minimize the spread of invasive species through forestry activities by providing outreach.

- Determine appropriate prevention strategies to protect marine systems following communications with the New Jersey Marine Science Consortium and other relevant stakeholders.

- *Recommendation Set #5 - Develop and implement a comprehensive Early Detection/Rapid Response (ED/RR) Program*

  - Create an ED/RR program within the OIS to prioritize potentially invasive species and limit damage before they become widespread or established within high priority sites that contain significant resources.

  - Initiate a site-based approach on six sites with high biodiversity values and low infestation levels, to include all physiographic provinces and coastal dune habitat.

  - Initiate a species-based approach on five high priority invasive species that are present but not yet widespread in NJ.

Control and Restoration (Section 4)

- *Recommendation Set #6 - Develop and implement a comprehensive program to reduce animal populations that facilitate invasive plant infestations or directly harm native animals*

  - Continue and enhance plans to reduce resident Canada geese, snow geese and mute swans.

  - Provide greater outreach to pet owners to encourage participation in existing domestic cat spay/neuter programs and reduce feral cat populations.

- *Recommendation Set #7 - Establish mechanisms to select the highest priority sites and species to focus control efforts across the State*

  - Perform field surveys to update the status of rare plant species and ecological communities.

- Determine the distribution of non-native species through the systematic mining of existing data and development of a mapping protocol to rapidly assess infestation levels.

- Use existing and newly collected data to create a prioritized list of public lands and waters for future control activities.

- *Recommendation Set #8 - Implement control and restoration programs that efficiently protect priority sites and reduce impacts from the most detrimental invasive species*

  - Initiate a pilot project on one heavily infested site of reasonable size (e.g., > 500 acres) to demonstrate various innovative control and restoration strategies and techniques.

  - Create a comprehensive database of invasive plant phenology and treatment options to aid control efforts on public and private lands and waters.

  - Encourage completion of comprehensive management plans by public and private land managers prior to initiating invasive species control efforts.

  - Examine and select protocols to measure restoration success by geographic region.

- *Recommendation Set #9 - Formulate partnerships that facilitate fundraising and cooperative invasive species control efforts*

  - Maximize landowner participation in existing state and federal cost-share stewardship programs, such as the USDA-NRCS Conservation Reserve Enhancement Program (CREP) and Wildlife Habitat Incentives Program (WHIP).

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SECTION 1: INTRODUCTION

This introduction provides basic background on the reasons to be concerned about invasive species, the scope of the problem and efforts to date to reduce the threat of invasive species. For a thorough review of New Jersey's invasive plant species, readers should also refer to Snyder and Kaufman (2004). For those unfamiliar with the multiple agency, program and technical abbreviations please refer to Appendix 1, which is a glossary of acronyms used in this plan.

Section 1.A: Why should we care about invasive species?

The first step, even before defining invasive species, is to acknowledge that New Jersey harbors significant biodiversity, natural resources and agricultural resources that are worth protecting (Table 1). Seventy percent of our state consists of agricultural lands and natural habitats (Lathrop and Hasse 2008). A snapshot of our wealth includes 850,000 acres of agricultural lands, 2.1 million acres of forest cover, 52 globally rare and federally listed species and over 2,100 species of native plants (including 55 species of orchids, which is more than Hawaii). These natural resources provide ecosystem goods (e.g., clean water, agricultural commodities, timber, fish) and ecosystem services (e.g., flood control, carbon sequestration). The combined value of New Jersey's ecosystem goods and services is estimated at $20 billion per year (NJDEP 2007). In addition, wildlife-related tourism is estimated to provide an additional $3 billion per year of gross economic activity. The invasive species problem is a tremendous burden on these resources and reduces the value of these goods and services.

Invasive species impacts include effects on human health, economic losses and harm to our natural environment. Most directly, invasive species cause severe economic costs to our agricultural industry and have nearly eliminated the oyster industry in New Jersey. The gypsy moth and Asian longhorned beetle threaten our street trees and forestry industry along with the overall health of our forests. Some invasive species, such as the Asian tiger mosquito, are direct human nuisances. In rare but extremely serious instances, invasive species may lead to death in humans as evidenced by the recent West Nile Virus outbreak. Further damage to our State's economy and ecology is inevitable if New Jersey does not take a proactive role toward managing invasive species.

Valuing these resources (morally, aesthetically and economically) must be the primary motivation toward reducing negative impacts created by invasive species. The bottom line is that we benefit in many ways from these resources but continue to cause them harm through the introduction and spread of invasive species. Stewardship, as the mitigation of disproportionate human impacts on natural systems, is required to remedy this problem.

Defining the problem is simple…

For Invasive Plants: A relatively small number of nonindigenous species take up large amounts of space that would be occupied by a diversity of native species, leading to negative impacts on native plants and animals.

For Invasive Animals: Invasive animals, insect pests and pathogens cause significant damage through the degradation of whole native systems or through competition and predation of native species.

Section 1.B: What are invasive species and how big is the problem?

Invasive species are a form of "biological pollution" (McNight 1993). Unlike most chemical pollutants that may eventually breakdown in the environment, contamination from invasive species grows and spreads as time passes. For the general public, this change has been largely unnoticed because it requires expertise to identify most plants and animals - some have dubbed this phenomenon the "Silent Invasion" (NWRA 2002).

The term 'invasive' characterizes species imported to an area outside their natural range through human activities that ultimately produce large populations having detrimental impacts on natural or agricultural systems (see Text Box 1). An invasive species can be a plant, animal or microbe. It is important to note that the majority of non-native species introduced to New Jersey have not become invasive, but the small percentage that become invasive can produce severe ecological and economic impacts (See Tables 2 - 4).

Mature tree being overwhelmed by Japanese wisteria (yellow arrow indicates broken tree top).
Nearly all of the green leaves in this photo belong to the invasive vine. Photograph by Michael Van Clef.

Table 1. New Jersey's Natural and Agricultural Assets

Asset	*Key Attributes*	*Notes*
Flora	- 310,000 acres within Natural Heritage Priority Sites (as of 2007) - 2,143 native plant species - 52 globally rare species/varieties - 8 federally listed or candidate species	Some of our rare flora includes the world's largest population of Torrey's mountain mint, a globally-rare orchid called small whorled pogonia, swamp pink, Hirst's panic grass and the only population of American chaffseed located north of North Carolina.
Fauna	- 2,542,079 acres within highest priority landscape areas - 466 native vertebrate animal species (not including fish) - 81 globally rare species (excluding marine fish and marine invertebrates) - 20 federally listed species	New Jersey's imperiled animals include significant portions of the federally endangered short-nosed sturgeon, bog turtle, and federally threatened piping plover populations. Delaware Bay beaches and marshes provide a critical migratory stopover and refueling stop for major portions of the western hemisphere shorebird populations, especially for the "rufa" subspecies of the red knot.
Undeveloped Lands	- As of 2001, 55% of the state remained in natural cover (e.g., forests, wetlands)	Development consumed 15,000 acres per year from 1984 to 2001 (Lathrop and Hasse 2008) and constitutes the only threat to biodiversity that is greater than invasive species. In 2001, approximately 30% of land in New Jersey was developed.
Preserved Open Space	- 1,212,036 Total Acres Protected 10% owned by Federal government 63% owned by State government 17% owned by County and Municipal government 6% owned by Non-profits 4% as Pinelands Development Credits	Many groups are vested in the continued protection of open space. (Data provided by Judeth Yeany, NJDEP-Green Acres –January 2009).
State Parks, Forests, and Wildlife Management Areas	- 56 state parks, forests and recreation areas with 15 million visitors per year - 121 state wildlife management areas totaling 309,000 acres with over 335,000 hunting and fishing licenses sold annually	State park and forest lands produce $812 million in economic benefits with only $228 million in costs (Reyes and Mates 2004). The Outdoor Recreation Alliance estimates the total economic ripple effect of outdoor recreation to be $4.1 billion annually in New Jersey.
Agricultural Resources	- 850,000 agricultural acres across 9,600 farms - 174,852 farmland acres permanently preserved across 1,470 farms (NJDA 2006, Judeth Yeany, personal communication) - $867 million in cash receipts annually	The State Agricultural Development Committee (SADC) and private landowners are vested in the continued protection of agricultural resources. The SADC, in coordination with County Agriculture Development Boards, municipal governments and nonprofit organizations and landowners, work to preserve the land base by purchasing development easements and permanently deed restricting farmland. Major agricultural sectors include nursery/greenhouse/sod, vegetables, equine, field crops, dairy and poultry/eggs. Fish and seafood commodities account for an additional $146 million annually in cash receipts.
Forestry Resources	- 2 million acres of forest land - Forest-based employment of nearly 30,000	Approximately 100,000 acres are managed under Forest Stewardship Plans that specifically consider conservation and forest health.
Water Resources	- NJ residents utilize nearly 2.1 billion gallons of water per day (USGS 2007)	Clean and plentiful water supplies are dependent upon healthy ecosystems to filter and store water. Approximately 2/3 of our water use is from surface water and 1/3 comes from ground water resources.

Text Box 1: Defining an Invasive Species

The term invasive characterizes species imported to an area outside their natural range through human activities that ultimately produce large populations having detrimental impacts on natural or agricultural systems. There are a variety of terms that require attention before formally defining an invasive species:

Species origin categories (Snyder and Kaufman 2004)

- *indigenous/native* - species that occur naturally within a specified geographic area (i.e., occur in an area without human assistance or influence)
- *non-indigenous/non-native/alien/exotic* - species that have been introduced outside their natural range as a result of human assistance or influence

Species status categories from imported to invasive

- *imported* - species transported from its indigenous range to a new area where they do not successfully reproduce/spread into areas untended by humans (e.g., horticultural plants that do not spread from gardens)
- *introduced* - species able to produce offspring that spread into natural or semi-natural habitats after being imported (e.g., plants that spread from gardens to untended areas, but do not produce seeds in untended areas)
- *established/naturalized* - species able to produce offspring that spread into natural or semi-natural habitats from untended individuals (e.g., garden plants that spread to untended areas and then continue to spread further without assistance by humans)
- *invasive* - species able to produce offspring that have significant impacts on indigenous species in natural or semi-natural areas (e.g., garden plants that spread into natural areas, continue to reproduce unassisted by humans and ultimately cover large areas to the exclusion of other species in natural or semi-natural habitats)

Formal Definition for Invasive Species Adopted by the New Jersey Invasive Species Council

Federal Executive Order 13112 – February 3, 1999, Adopted by the National Invasive Species Council (NISC 2001): A species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health

Table 2 summarizes the number of non-native and invasive species documented in New Jersey. A small sample of our most notorious invasive plants include purple loosestrife, mile-a-minute, multiflora rose, Japanese barberry, Japanese stiltgrass, garlic mustard, Asiatic bittersweet, tree-of-heaven, autumn olive, Japanese honeysuckle and Eurasian water-milfoil. Forest pests and pathogens such as chestnut blight, Dutch elm disease and hemlock wooly adelgid have caused permanent damage to our forests. Other species that have also caused serious damage include gypsy moth, dogwood anthracnose, beech bark disease, butternut canker, a group of non-native earthworms and a host of agricultural weeds and pests. Larger invasive animal species include the European starling, house mouse, brown and black rat, pigeon, mute swan and feral cat. Invasive species of marine habitats include Asian shore crab, MSX oyster disease and Dermo, European green crab and common periwinkle.

Once introduced, invasive species continue to spread through human activities and natural processes (e.g., birds, wind, water flow, etc.). Scientists believe an important factor that creates invasive species is their 'release' from natural predators and diseases that kept them in check in their original native habitats. This allows their populations to grow and persist at very high rates and densities in their new environments.

Table 2. Estimated Numbers of New Jersey's Non-native and Invasive Species

Taxa	*Number of Non-Native Species*	*Number of Invasive Species*	*Notes*
Plants	974	72	A prioritized list of non-native plants is located in Appendix 2 which includes all 964 plant species with ranks provided by Natural Heritage Program botanist David Snyder and 10 additional species that have been recently collected in New Jersey natural areas. The Snyder rankings suggest 72 invasive or potentially invasive species. These species will be utilized by the Council as a placeholder list for outreach purposes until a formal review process is completed. See text Section 3.
Pests and Pathogens	46	31	Includes pests (i.e., insects) and pathogens (e.g., bacteria, viruses) primarily associated with forest trees and agricultural commodities. These numbers should not be considered complete for agricultural systems in NJ, but does highlight the most threatening species. See Appendix 5.
Marine Species	38	13	Includes fish, invertebrate animals, pathogens and algae. The status and impacts of many of these species is unknown and so cannot be classified as invasive. Species were classified as invasive if their impacts were considered 'high' or 'medium.' See Appendix 6.
Land and Freshwater Animals	67	20	Includes non-marine species only and does not include insect pests and pathogens (see above). The total number is much underestimated due to a lack of available data on non-native insects. See Appendix 4.
TOTALS	**1,125**	**136**	The total number would be much higher if all non-native microbes were included, but this data is not available (and is mostly unknown).
Breakdown of 'Land and Freshwater Animals' by Type			
Mammals	9	5	See Appendix 4.
Birds	9	7	See Appendix 4.
Reptiles and Amphibians	2	0	See Appendix 4.
Freshwater Fish	29	0	The status and impacts of many of these species is unknown and so cannot be classified as invasive. See Appendix 4.
Invertebrate Animals	18	8	Includes insects, mussels, snails, earthworms, etc. The list includes some non-native species, such as earthworms, which are not normally considered pests or pathogens, but which have had a profound ecological effect. The status and impacts of many of these species is not completely understood, and so they cannot be classified as invasive. See Appendix 4.

Invasive species are an enormous global problem (Table 3), which received attention as early as the 1800's by Charles Darwin and began to receive more detailed scrutiny as early as the 1950s (Elton 1958). Ecologists have been studying invasive species for some time, but the quantity of scholarly research significantly increased through the 1980s and continues to the present day. The consensus is that invasive species are the greatest threat to biodiversity after outright habitat destruction (Wilcove et al. 1998). Harmful impacts include displacement of native species, contributing to species extinctions and altering plant community structure, composition and function. Invasive species also significantly impact agricultural productivity by reducing yields or increasing production costs through control efforts (OTA 1993, Pimentel et al. 2005).

Recent research has indicated that the threat posed by invasive species is exacerbated by global climate change. In addition to placing greater stress on native species, global warming increases the likelihood that species of plants and animals previously known only from more southern regions will extend their range into New Jersey. Higher levels of carbon dioxide have also been shown to promote the growth of invasive species, increasing their potential impact on the landscape (Weltzin et al. 2003). Addressing the problems posed by invasive species will be closely linked to the challenges we face in the future from climate change.

Table 3. Quick Facts - Scope of the Invasive Species Problem in the United States (Sources include OTA 1993, Pimentel et al. 2005)

*Description**	*Additional Notes*
U.S. - 50,000 non-native species *introduced*	See below for a breakdown by species groups.
U.S. - 20,000 non-native microbes *established*	Includes bacteria, fungi, viruses (a.k.a. pathogens).
U.S. - 5,000 non-native plants *established*	This represents 8% of the total number of species introduced. Established non-native plants represents 23% of the total plant species in the U.S. (17,000 native species).
U.S. - 5,000 non-native arthropods *established*	2,500 species in the continental U.S. and 2,500 in Hawaii. 20% of arthropods in the continental U.S. are considered major or minor pests and 24% are considered beneficial.
U.S. - 500 non-native invasive plants (a.k.a. weeds) of agricultural systems	There are an additional 185 native weeds of agricultural systems in the U.S.
U.S. - 360 non-native insects *established* in forests	30% of these have become *invasive* species.
U.S. - 138 non-native fish *established*	Notorious *invasive* species include grass carp and common carp.
U.S. - 97 non-native birds *established*	Notorious *invasive* species include house sparrow, pigeon, European starling and mute swan.
U.S. - 88 non-native mollusks *established*	Notorious *invasive* species include European zebra mussel, quagga mussel and Asian clam.
U.S. - 53 non-native amphibians and reptiles *established*	Primarily a problem in warmer climates than NJ (e.g., Florida and Hawaii).
U.S. - 20 non-native mammals *established*	Includes domesticated pets and livestock as well as pests, including rats and mice.
U.S. - 11 non-native earthworms *established*	The impacts from earthworms in northern parts of the U.S. are unmeasured, but are likely severe. There are no native earthworms in New Jersey.
Florida - 25,000 non-native plants *imported*	4% of these have become *established* (900 species).
California - 3,000 non-native plants *introduced*	30% of these have become *established* (1,000 species) and 3% of all introduced plants have become *invasive* species (100 species).
Great Smokey Mountains National Park - 400 non-native plants *established*	3% of these are *invasive* species (10 species).
U.S. - 1.7 million acres become newly infested every year	NJ encompasses approximately 5 million acres.
U.S. - 40% of federally threatened and endangered species are at risk from invasive species	This is the result of impacts caused by competition and predation.
Hawaii - Impacts of all invasive species	800 native species at risk and 200 native species believed to be extinct; 35% of Hawaii's flora is non-native.
California - Impacts of yellow star thistle	Dominates 20 million acres and eliminated economic productivity of former grassland habitat.
Utah and Idaho - Impacts of European cheatgrass	Dominates 12 million acres of former shrub-steppe habitat; Increased average fire frequency from every 90 years to every 4 years, eliminated shrubs and reduced or eliminated animals dependent upon shrubs and other lost native species.

U.S. - Impacts of feral and domestic cats	30 million feral and 62 million pet/domesticated cats consume nearly 500 million birds annually.
*See Text Box #1 for definitions of imported, introduced, established, and invasive	

An evaluation of the comparative negative impacts of New Jersey's numerous environmental problems concluded that invasive species ranked among the top four risks to the State (Rosen 2003). Governments within the U.S. and around the world have realized the extent of the problem and have begun to take action (see Text Box 2).

Text Box 2. Actions of International, Federal and Other State Governments

There are four main components to successful legislative actions at the national level: 1) phytosanitary and zoosanitary rules, 2) restrictions on deliberate importation of plants and animals, 3) eradication of new pests through Early Detection/ Rapid Response (ED/RR), and 4) control of well established pests (generally involving a cost-share approach). Although no single country has addressed all of these points, several countries have made significant strides to prevent entry of new invasive species. For a review, ELI (2004b) describes legal actions taken by various governments around the world to mitigate invasive species.

Australia has seen some of the world's worst invasive species problems. Notorious animal pests include mice, rabbits and cane toads. In addition, 30,000 non-native plant species have been introduced (2,700 or 9% have become *established*, and 300 or 1% have become *invasive*). In 1997, Australia introduced a comprehensive Weed Risk Assessment (WRA) protocol. Their WRA involves a decision-tree approach whereby species may be denied entry based upon characteristics that would lend themselves to becoming invasive. Australia has adopted a clean list approach that denies entry to all species that have not been determined to be non-invasive. In practice, if a species is not on the clean list, then their WRA protocol is applied to determine whether entry will be permitted. Since 1997, Australia has evaluated 1,400 species through their WRA. Approximately 50% of species are approved for entry, 20% of species are denied entry, and the remaining species are recommended for additional analyses to determine invasive potential. New Zealand, which like Australia has severe invasive species problems, has passed a Hazardous Substances and New Organisms Act and similarly applies a pre-screening protocol and clean list approach. Other countries with notable prevention efforts include Chile, South Africa, and Japan.

In the U.S., the National Invasive Species Council was formed in 1999 to coordinate the federal response. The U.S. Department of Agriculture (USDA) has introduced significant new revisions to its Quarantine 37 Regulations that would restrict importation of potentially invasive plants based upon a risk assessment protocol. Other significant changes to these regulations include consolidation of multiple regulations for clarity, consistency and transparency, re-evaluation of currently prohibited species and development of programs to reduce the risk of unintentional species introductions. These rules have recently received public comment, which will be used to evaluate the proposed changes.

In addition, nearly every state in the U.S. now has invasive species councils or advisory groups that have developed statewide invasive species plans for at least a subset of invasive species. Significant legislation banning the sale of invasive species has been enacted in nearby states including Massachusetts, Connecticut and New Hampshire. In addition, many states allocate significant funding to mitigate the impacts of invasive species. The Government Accounting Office (GAO 2000) reported FY2000 funding for invasive species at the federal level and in seven states. The federal government spent $632 million. Florida, California, Hawaii, Idaho, New York, Michigan and Maryland spent $128, $87, $8, $4, $3, $2 and $2 million, respectively. In New York, $3.25 million was appropriated in FY2007, which was funded through their Environmental Protection Fund and a Real Estate Transfer Tax.

Invasive species impacts can be seen throughout New Jersey. One of the most significant impacts is the loss of American chestnut trees through infection by chestnut blight, an invasive pathogen. Forests once classified as "oak-chestnut forest" no longer exist across North America. An invasive insect, the hemlock wooly adelgid, has infested nearly 90% of all hemlock trees in New Jersey and has eliminated whole stands in the northern part of the state (Rosen 2003).

Despite efforts to combat the adelgid through the release of biological control insects, the ultimate result may be the total loss of 26,000 acres of this unique forest type in New Jersey, with impacts on trout fisheries and rare bird populations. Invasive plants also cause very severe impacts. Many forests that normally contain a variety of native shrubs and woodland wildflowers under a canopy of tall trees are instead infested with near monocultures of garlic mustard, Japanese stiltgrass or Japanese barberry. Shrublands and old fields that would ultimately become healthy forests are often infested with multiflora rose or autumn olive, and young trees attempting to break through these thickets get smothered with invasive vines such as Asiatic bittersweet or Japanese honeysuckle.

Importantly, the obvious challenges that invasive species create for plants and ecological communities have less obvious but equally threatening impacts on our native animals that depend on healthy and diverse plant communities. Overall, invasive species have rapidly changed interactions within the natural world that evolved over millennia. Unfortunately, the severity of the problem will increase because new species that may become invasive are being introduced every year. Snyder and Kaufman (2004) estimate that nearly 50 new plant species have been introduced to New Jersey over the last 25 years. Emerging threats from Asian longhorned beetle, sudden oak death, emerald ash borer and other pests and pathogens are also of grave concern. These are only a few examples, but the impacts of invasive species are being felt in all natural systems.

> "We must make no mistake: we are seeing one of the great historical convulsions in the world's fauna and flora."
>
> – Charles Elton, The Ecology of Invasions by Animals and Plants, 1958

The harm to biodiversity outlined above is only one part of the problem. Harm to our natural resources and direct economic costs are considerable (Table 4). For example, healthy forests are the most important source of copious amounts of clean drinking water on which we all depend. In addition, direct costs result from the need to control invasive species to support human activities. Examples include control for agricultural and forestry operations, road maintenance, gypsy moth spraying and Asian longhorned beetle tree removal and replacement costs. Pimentel et al. (2005) estimate that invasive species have a total cost of $120 billion per year in the United States.

Invasive species have severe economic impacts on agriculture in New Jersey. It is estimated that New Jersey loses over $290 million from direct crop loss/damage and costs of control of invasive species including numerous agricultural weeds, insects, pathogens and rats.[1] This loss from invasive species represents a staggering 33% of New Jersey's total agricultural cash receipts.

An additional example of economic impacts may be seen in New Jersey's Delaware Bay from the introduction of MSX oyster disease and Dermo (Partnership for the Delaware Estuary 2007). The Delaware Bay oyster industry nearly collapsed upon the introduction of MSX in 1957. MSX stands for "multinucleated sphere X," which was later determined to be a protozoan

[1] This value was estimated using data from Table 4 multiplied by the proportion of total US agricultural cash receipts represented by the NJ agricultural industry, which is approximately 0.4% (USDA-NRS 2007).

parasite named *Haplosporidium nelsoni* (VIMS 2009a). MSX is known to occur in Asia and Europe, but does not cause significant oyster mortality outside of North America (VIMS 2009a). The mechanism of outbreaks and spread is unknown (now found north to Nova Scotia), but is dependent upon temperature and salinity.

In 1985, there was another severe outbreak of MSX followed in 1990 by a severe outbreak of Dermo. Dermo is a fungus originally classified as *Dermocystidium marinum* but later reclassified as *Perkinsus marinus* (VIMS 2009b). This species was first documented in the Gulf of Mexico in the 1940s, but has since expanded its range north to Maine. Increased winter temperatures and other climate factors along with human-assisted spread through contaminated oysters is expected to exacerbate the range of Dermo. These invasive species outbreaks have nearly destroyed the oyster industry in New Jersey and there remains only one packinghouse with 50 employees. Modern harvest numbers remain less than 15% of their size compared to peak production in the 1950s.

Asian longhorned beetle (Photograph courtesy of Wikipedia - http://en.wikipedia.org/wiki/Asian_longhorn_beetle)

Table 4. Quick Facts - Costs Associated with Invasive Species in the United States (Sources include OTA 1993, Pimentel et al. 2005 and references therein)

Description	*Losses and Damages*	*Cost of Control*	*Notes*
Non-native weeds on agriculture	$24 billion per year	$3 billion per year for herbicide applications	Native agricultural weeds produce $9 billion in losses and damages and cost $1 billion per year in herbicide applications
Non-native plant pathogens on agriculture	$21 billion per year	$720 million per year for fungicide applications	
Non-native rats on agriculture	$19 billion per year	--	Rats also act as vectors of disease and consume eggs of native birds
Non-native insects on agriculture	$13 billion per year	$500 million per year for pesticide applications	
Mad Cow Disease	$5 billion (includes control costs)	See Losses and Damages	
Non-native plant pathogens on forestry	$2.1 billion per year	--	
Non-native forest pest insects	$2.1 billion per year	$11 million per year for one species (European gypsy moth)	
European zebra mussel and Asian clam	$2 billion per year (includes control costs)	See Losses and Damages	Damage caused by clogging water intake pipes; alteration of lake ecosystems
Formosan termite	$1 billion per year	--	
Feral hogs	$800 million per year (agricultural damage)	--	NJ has a single emerging population of feral hog located in Gloucester County
European starlings	$800 million per year (agricultural damage)	--	
Japanese beetles	--	$450 million per year	Damage to turf grass, ornamental plants, and nursery stock
Control of aquatic weeds in lakes and reservoirs	--	$100 million per year	
Dutch elm disease	--	$100 million per year	Cost of tree removals
Purple loosestrife	$45 million per year (includes control costs)	See Losses and Damages	Species occurs in 48 states. Costs include forage losses.
Impacts of European green crab (New England)	$44 million per year	--	Destroy commercial shellfish beds and consume native oysters and crabs
Emerald ash borer and Asian longhorned beetle	$40 million for FY2007	--	This amount is less than half of that requested by conservation and forestry groups.
Michigan (Ann Arbor) - emerald ash borer	Residential water bills increased by 15% from lost shade	$4 million	Removal of 8,000 damaged street trees
Florida - Australian melaleuca tree	--	$3-$6 million per year	
Hawaii - Feral hogs	--	$450,000 per year	
Texas – Red imported fire ant	$300 million per year	$200 million per year	Damage to livestock and wildlife; pose human health risk
New Jersey - purple loosestrife	--	$100,000 per year	Production of biocontrol agent (Snyder and Kaufman 2004)

Direct human health issues, although usually rare, are of great concern. Typically, the spread of human-related illnesses are considered by epidemiologists and are studied separately from invasive pathogens that lead to death of non-human hosts (e.g., wild animals or plants). A very recent and tragic example of an invasive pathogen introduced to New Jersey was the West Nile

Virus (WNV), which caused the death of nearly 1,000 individuals and countless thousands of wild birds across the country since 1999 (CDC 2007). In New Jersey, 84 people have been diagnosed with WNV including five fatalities (NJDHSS 2007). Coincidentally, one of the carriers of the virus is the invasive Asian tiger mosquito, and invasive species of birds (European starlings, pigeons and house sparrows – CDC 2007) serve as reservoirs of the virus, especially in urban areas where these invasive birds are most common. Although many native species of mosquitoes and birds are involved with the transmission of this invasive pathogen, it is reasonable to assume that the abundant invasive mosquitoes and birds exacerbated the problem. This complex example is illustrative of the intersection of traditional epidemiology with the study of invasive species. Although the human health aspects of WNV appear to be subsiding, especially in New Jersey, there is a continuing threat of invasive species that may cause direct harm to public health.

For example, avian influenza is a potentially serious threat to human health and wildlife. Although not yet present in North America, this invasive species has infected over 250 humans and killed over 150 worldwide since 2003 (WHO 2007). It has been speculated that migratory birds may carry the virus across continents, but this has not been proven (USDA-NISIC 2007, USFWS-DMBM 2007 and references therein). Overall impacts on waterfowl are unrecorded, but it is known that several thousand migratory bar-headed geese were killed by the virus in Northern China in April 2005.

Section 1.C: How will we meet the challenge?

Section 1.C.1: Past and Present Efforts in New Jersey

The problem of invasive species is now widely recognized by the New Jersey Department of Environmental Protection (NJDEP) and the New Jersey Department of Agriculture (NJDA). The NJDEP identified invasive species as a serious threat to our fauna and flora (NJDEP 2006, Snyder and Kaufman 2004). The NJ Comparative Risk Project (Rosen 2003) analyzed the relative risks posed by numerous environmental problems. Invasive species were considered one of the top threats to ecological systems. The NJDEP has taken action to reduce the impacts of invasive plants by issuing Policy Directive 2004-02 (NJDEP 2002a). This directive prohibits the intentional release of 148 plant species on lands and waters administered by NJDEP. The Division of Parks & Forestry participates in the Gypsy Moth Suppression Program with NJDA (see below).

The NJDEP Division of Fish & Wildlife has promulgated rules prohibiting the possession and release of non-native wildlife established as "potentially dangerous" due to their ability to cause agricultural or environmental damage or pose a threat to human safety (N.J.S.A. 23:4-63.3 and N.J.A.C. 7:25 subchapters 4 and 10). The Division, along with NJDA and USDA, has been proactive by testing for Chronic Wasting Disease (CWD) in white-tailed deer since 1998 (NJDEP 2007c). In 2002, NJDEP banned the importation of elk and deer from outside New Jersey to prevent the spread of CWD into wild and captive animals. Although this disease was documented in New York, all testing prior to publication of this document has been negative in New Jersey. In addition, the Division and NJDA have been attempting control of New Jersey's only population of the invasive feral hog in Gloucester County. Feral hogs are known to carry diseases transmittable to livestock and humans and cause significant ecological harm.

The NJDA, along with state and federal partners, plays a significant role in the prevention and control of threats to agriculture and forestry. (Authorities of federal and state agencies are summarized in Appendices 7 and 8, respectively.) Significant state authorities related to invasive species include insect and plant disease control, nursery stock and vegetable plant shipping regulations, phytosanitary inspection and certification (260,000 requests per year) and specific regulations for tomatoes, peppers and roses. The NJDA carries out surveillance programs for a variety of foreign plant pests and diseases in cooperation with the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (USDA-APHIS) sponsored Cooperative Agricultural Pest Survey. NJDA also contributes to eradication, suppression and biological control programs for invasive pests in cooperation with USDA-APHIS, USDA Forest Service and USDA Agriculture Research Service (ARS). The NJDA's agricultural seed certification and control program regularly inspects shipments of seeds and prohibits five species and restricts allowable quantities of ten additional species in seed shipments for agricultural purposes (NJDA 2007d). Some examples of their work related to invasive species include the Asian longhorned beetle eradication program, gypsy moth suppression program and early detection/rapid response to sudden oak death and giant hogweed. One of the most notable prevention efforts in New Jersey involves work of the NJDA and its partners on Asian longhorned beetle (see Text Box 3). NJDA was also quick to respond to the unintentional introduction of the pathogen that causes sudden oak death (SOD) when it appeared in Cape May (introduced via contaminated nursery stock from California). Surveys were conducted for SOD and no infections have been found in wild plants. They also quickly treated an occurrence of giant hogweed (*Heracleum mantegazzianum*) in Mendham Township (annual follow up visits will be required to confirm eradication). NJDA continues to work with all Departments of the state on avian influenza emergency planning and annual testing of poultry and waterfowl.

Text Box 3. NJ Action! - Asian Longhorned Beetle

Carl Schulze of the New Jersey Department of Agriculture, Division of Plant Industry, has been leading control efforts on a potentially damaging insect that has arrived in our state. The Asian longhorned beetle (ALB) kills trees (especially maple) and could ultimately cause severe damage to entire forests. It was introduced to the United States through untreated wooden pallets/crates (referred to as wood packaging materials or WPM) carrying goods from Asia. Since 2002, infestations of the beetle have been detected in Jersey City, Hoboken, Linden, Carteret and Rahway.

The response to the beetle is a classic example of successful early detection/rapid response. The formation of partnerships and cooperation between governmental agencies and an effective public education campaign has led to rapid removal of infested trees and installation of replacement trees. Partnerships between state agencies (NJDA, NJDEP) and the federal government (APHIS-PPQ) have been instrumental. A public education campaign, including news releases and readily available information on the NJDA website, provided guides to identification of the beetle and its telltale damage. This education campaign has resulted in hundreds of calls annually to report potential infestations. NJDA also effectively communicated with partners and the public with regular progress updates through their website and responses to questions and concerns from those in impacted communities. The alacrity of the treatment response and public education campaign has also ensured the cooperation of county and municipal governments that have facilitated tree removals and replanting efforts.

Although it is possible that new infestations will be found, especially near previously impacted areas, the protocols in place should ensure successful treatment. In addition, recent international requirements to treat WPM at their point of origin should reduce the risk of new introductions from Asia (see Section 3.B). The natural tendency of the beetle for short-range movements, an effective educational campaign to assure a vigilant public, staff expertise of NJDA and its partners, continuation of federal funding and eventual full implementation of international WPM treatment requirements mean that the threat posed to our forests from ALB have a very good chance of being eliminated without causing significant damage.

New Jersey land managers representing federal, state, county, municipal and private entities have put considerable effort into controlling infestations of invasive species. Text boxes located throughout this plan highlight significant on-the-ground efforts by various governmental agencies and private groups. Many of these case studies represent the pioneers of invasive species control in New Jersey and their work serves as models.

The federal government has a number of authorities related to invasive species (Appendix 7) including numerous regulations administered by a variety of agencies and programs. These authorities relate to importation/movement, quarantine and seizure, control/management/ restoration, development of databases, research, strategies for international control, treaty and trade negotiations, ballast water management and public education. The formation of the National Invasive Species Council, under Federal Executive Order 13112, was intended to coordinate these diverse authorities to create a more cohesive policy response at the federal level.

USDA-APHIS establishes the nation's policies and protocols for the importation of plants and plant products and identifies international plant pest threats. The U.S. Department of Homeland Security (DHS) Customs and Border Protection (CBP) has the primary responsibility to inspect incoming passenger baggage, air and sea cargo and international mail. The CBP's priority mission is preventing terrorists and terrorist weapons from entering the United States, while also facilitating the flow of legitimate trade and travel, enforcing the laws that provide for an abundant, high-quality and varied food supply, and strengthening the marketability of U.S. agriculture in domestic and international commerce.

The USDA-APHIS Plant Protection and Quarantine (PPQ) program administers and operates four plant inspections stations on the east coast (Miami, Orlando, John F. Kennedy Airport and Linden, New Jersey). The plant inspection stations examine plants imported for planting and provide technical identification services for the DHS CBP inspectors. The New Jersey station has a six-person staff with expertise in botany, entomology and plant pathology. Despite this effort, federal inspection stations are understaffed to adequately inspect the massive quantity of goods shipped into our country as evidenced by the very small fraction of goods that can be inspected relative to the total flow. This situation assures a constant flow of unintentional introductions that may ultimately become new invasive species. Additional information on federal and international efforts can be found in Sections 3.B and 3.C.

The St. Louis Declaration Voluntary Codes of Conduct (Appendix 9) represents a potential avenue to address invasive species in New Jersey. An historic meeting between ecologists and horticulturalists in December 2001 produced these guidelines to mitigate the spread of invasive species through self-governance and self-regulation. In 2003, the New Jersey Nursery and Landscape Association endorsed these Codes and asked its members to stop production of fifteen invasive species. Many garden clubs across the state have also endorsed the Codes. Adoption and adherence to these Codes by the full complement of government agencies, nursery professionals, gardening public, landscape architects and public gardens could produce significant positive results. Recently, the nursery industry has taken positive steps in California through the PlantRight program, which encourages adherence to the Codes (http://www.plantright.org). Overall, 43 groups across the country have signed onto the voluntary Codes.

Although much work has been initiated in New Jersey and around the world, the overall effort to date has been primarily reactive and disproportionate to the seriousness of the threat. The continued 'cost of failure' to properly address the problem is immense. Serious efforts must be undertaken to further understand the pathways that introduce new invasive species, develop predictive models to screen new species introductions, determine the susceptibilities of ecological and agricultural systems to invasion, and develop appropriate responses to new and existing invasive species. Increased vigor through additional funding, cooperation and coordination are required to effectively reduce the global invasive species problem.

Section 1.C.2: Future Efforts for New Jersey

This document was produced pursuant to New Jersey Executive Order #97 (Appendix 12), which created the New Jersey Invasive Species Council (NJISC) with the charge of completing a comprehensive invasive species management plan that incorporates the following: a) recommend measures necessary to cooperate with federal agencies and other states complying with Executive Order 13112 and the National Invasive Species Plan; b) identify research needs to better assess the sources, degree, distribution and threat posed by invasive species, and methods for preventing the introduction and control of invasive species; c) review ongoing invasive species control efforts being carried out by the Departments, and recommend new or revised measures to limit the introduction and effectuate the control of invasive species; d) produce educational materials for public distribution regarding threats posed by invasive species, outlining measures to prevent the introduction of invasive species and to control invasive

species, and encourage the use of local native genotypes propagated in New Jersey in landscaping and planting (including drought tolerant native plants); e) develop partnerships with federal, state and local government agencies and private organizations, including the horticultural industry, necessary to implement the policies and recommendations of the NJISC; f) identify funding sources for research, monitoring, control, and outreach programs; g) plan, design, and implement two invasive species eradication and native plant restoration pilot projects (see Text Boxes 3 & 4); and h) identify legislative or regulatory actions necessary to implement or further the policies and recommendations of the NJISC. All of these elements are captured in this plan and its recommendations.

Text Box 4. NJ Action! - Cape May Meadows Ecosystem Restoration

Elizabeth Brandreth of the Philadelphia District, U.S. Army Corps of Engineers has headed the extremely ambitious Lower Cape May Meadows-Cape May Point Environmental Restoration Project, which includes lands owned by the state (Cape May Point State Park) and The Nature Conservancy (Cape May Migratory Bird Refuge). The breaching of dunes by salt water from the ocean and restriction of freshwater flow toward the ocean combined to alter a diverse coastal freshwater marsh into an infestation of the invasive Phragmites. This project is a complete ecological restoration that addresses: 1) root causes of the infestation, 2) control of invasive species, and 3) restoration through planting of native species. Most importantly the project has a 5-year adaptive management strategy built into its budget to ensure success through monitoring of results and applying corrective measures if necessary.

This massive project involved replenishing beach, rebuilding dunes, restoring freshwater hydrology, creation of three freshwater ponds, herbicide treatments and mowing to significantly reduce Phragmites on over 100 acres. The total project cost is $32 million. The majority of these costs include beach replenishment, which will be periodically performed over the 50-year project term. The cost of Phragmites control and restoration are relatively minor portions of the total project cost.

The project began in 2003 by replenishing eroded beach sands, repairing dunes and clearing blocked dikes that carry freshwater through the marsh. Herbicidal treatments of Phragmites in the fall began in 2004. Mowing of treated Phragmites followed herbicide applications to allow light to penetrate to the ground and stimulate regeneration by native species in the seed bank. Seeds of native plants, from areas that were not completely infested by Phragmites, were collected and grown by the Pinelands Nursery. These plants were used to hasten the rate of recovery at selected locations within the restoration. Follow-up treatments of Phragmites and mowing continued through 2007.

The monitoring of natural native plant colonization of the site and success of plantings was initiated in 2007. Methods include quantitative measurements in monitoring plots and photographic documentation of changes over time. Adaptive management strategies will be based upon monitoring results and may include additional hydrology improvements and/or plantings if necessary.

Efforts to wisely combat invasive species will fall into four basic strategies that form the remaining sections of this plan. Sections include stakeholder conversations, prevention, control and restoration, and structure of New Jersey's invasive species program. Future success will depend upon consistent funding from state and federal sources, input of all stakeholders, and coordination with neighboring states and regional groups. The goal over the next 10 years is for New Jersey to meet the Environmental Law Institute's "Silver Standard" for state action on

invasive species (ELI 2002) through the implementation of recommendations from the NJISC. ELI standards can be found in Appendices 10.

The remaining text and appendices of this plan are intended to provide additional background and rationale for specific recommendations of the NJISC. The plan is designed for use by a wide range of stakeholders (e.g., public land managers initiating an invasive species control and restoration program, policy makers looking for examples of damage caused by invasive species, gardeners interested in lists of non-invasive species, conservation groups seeking lists of organizations interested in invasive species issues and control, etc.).

The recommendations of the NJISC are presented in a condensed format in the Executive Summary. Individual recommendations are grouped into various Recommendation Sets to facilitate interpretation of broad activities. A detailed description of each recommendation including comments, relative implementation priority, lead organizations and successful completion measurements can be found at the end of each section of the plan. Appendix 11 serves as a complete listing of all Council recommendations. Recommendations are categorized as "Tier 1" with anticipated completion within one to two years of plan adoption and "Tier 2" with anticipated completion within five to 10 years of plan adoption. However, preventing, controlling and restoring damage from invasive species must continue through the foreseeable future.

It should be noted that the text also contains informal suggestions that should not be considered specific recommendations of the NJISC and are intended solely to provide guidance to stakeholders for their own programs. For ease of reference, official recommendations of the NJISC are repeated at the end of each section.

The native blue lobelia. Photograph by Michael Van Clef.

Text Box 5. NJ Action! - Federal Lands: Great Swamp National Wildlife Refuge

Craig Bitler, preserve manager of the National Park Service's Great Swamp National Wildlife Refuge, has been successfully controlling a variety of invasive species for over 10 years. The Refuge has a number of New Jersey's worst invaders including purple loosestrife, Japanese barberry, Phragmites, Japanese knotweed, multiflora rose, autumn olive, Japanese stiltgrass and garlic mustard. Importantly, their deer management program has allowed wetland forests to flourish with a lush understory of native shrubs, which appears to provide resistance to invasive species in many areas of the Refuge.

The first attempts at controlling purple loosestrife involved hand-pulling and then spraying individuals with herbicide. Spraying kept it from spreading, but releases of biocontrol agents were required to virtually eliminate the infestation over 150 acres. Craig was a pioneer in biocontrol releases and actually reared his own biocontrol beetles from an initial allotment provided by Bernd Blossey of Cornell University.

There has been a massive effort to reduce Japanese barberry at the Refuge. Since 2001, approximately 40,000 individuals have been killed through herbicide applications. Craig estimates that 90,000 plants remain, but efforts have slowed in the past two years to address Phragmites, which is considered a more serious problem for conservation targets at the Refuge (i.e., migratory waterfowl).

In only two years, 46 patches of Phragmites have been sprayed and the remaining patches were treated in 2007. Craig plans to visit former patches on a three-year cycle and spray any individuals that may have survived initial control efforts. Japanese knotweed control is being implemented after a survey revealed 20 patches on the Refuge. Control has been achieved at each patch after multiple applications of herbicide.

Japanese stiltgrass has been rapidly spreading at the Refuge. Currently, volunteers are hand-pulling plants and staff has been applying herbicide. However, the infestation is so large that complete control is not anticipated without development of a biocontrol agent. Control of garlic mustard has not been attempted, however, the Refuge has been the subject of study by researchers from Cornell University, who are developing a biocontrol agent. The Refuge has been placed on a list to be one of the first sites for release once research is completed.

Three species of early successional uplands have also been the subject of Craig's control efforts. The Refuge had acquired a former plant nursery containing thousands of Bradford pear trees, which proceeded to spread onto the Refuge. Over 3,000 trees were cut down with chainsaws. In an ironic twist, white-tailed deer finished off the job by eating root sprouts of the cut trees, which led to their death within three years. Both multiflora rose and autumn olive have been controlled in specific locations through cutting stems and applying a 50% solution of glyphosate herbicide.

Overall, invasive species control at the Great Swamp National Wildlife Refuge is one of the most significant efforts in New Jersey.

SECTION 2: STAKEHOLDER CONVERSATIONS

Section 2.A: Introduction

The NJISC understands that acknowledging the concern for our natural and agricultural heritage and the threats posed to them by invasive species will be essential in its effort to address this issue. The common joke regarding the difference between ignorance and apathy ("don't know, don't care") cannot apply to invasive species if they are to be addressed as a serious environmental problem. Importantly, those directly engaged with conservation can have neither ignorance nor apathy toward other stakeholder groups. Real progress can only be achieved with two-way dialogue that leads to positive change for all stakeholders. This section will outline stakeholder groups that must be engaged to address their concerns. Messengers and methods to engage stakeholders are also discussed.

It is important to note that education and public awareness that ultimately leads to stakeholder groups saying "do know, do care" will take time to realize if only the currently small number of concerned messengers are involved. It is imperative that leaders within each stakeholder group echo and amplify the message to their own colleagues and to the general public.

Finally, the success of improved dialogue must be measured by the results toward reducing the threat of invasive species to the satisfaction of all stakeholders. Recipients of the invasive species message have to be provided with a sense of urgency to address their newly found knowledge. A successful statewide outreach program can only be measured in outcomes, such as monitoring the extent of threat, enhancements to the composition, structure, function and health of natural and agricultural systems, increased funding for invasive species programs, reductions in importation of potentially invasive species, passage and implementation of new legislation and regulations, voluntary agreements, improved volunteer recruitment leading to additional acreage of land cleared of invasive species, and reduction in sales of invasive species that are less than or equal to increased sales of native or non-invasive species.

Section 2.B: Stakeholder Groups

The engagement of many stakeholders is required to address the full scope of the invasive species problem. These include elected and appointed officials, key government agencies and commissions, environmental commissions, county and municipal land managers, certified nurseries, plant dealers and wholesale seedsmen, landscape architects, garden clubs, home gardeners and aquarists, public gardens, certified tree experts, arborists and foresters, conservation groups, outdoor enthusiasts and school children (Table 5). Appendix 13 provides lists or sources of lists for representative stakeholder groups. Although many individuals within stakeholder groups are aware and sensitive to the problem of invasive species, the majority of stakeholders will require increased education, awareness and 'champions' to spur action within their constituencies. The remainder of this section provides a brief introduction to the many stakeholder groups and methods to facilitate the formation of targeted messages that may address this problem.

To give is better than to receive…
A short list of New Jersey natives that have become invasive species elsewhere: multiple species of asters and goldenrods, wild black cherry, muskrats, gray squirrels, mink, duckweed, pokeweed, red fox, ragweed and fleabane.

Table 5. Representative Stakeholder Groups

Category	*Number of Individuals or Groups*	*Notes*
Elected and Appointed Officials	796	State: Governor, 40 state senators, 80 general assembly members, ca. 100 county freeholders and 560 municipal mayors Federal: 2 senators and 13 congressional representatives
Key State Government Agencies and Commissions	9	Department of Environmental Protection, Department of Agriculture, Department of Transportation, New Jersey Economic Development Authority, Department of Health and Senior Services, Pinelands Commission, Highlands Council, New Jersey Meadowlands Commission and Port Authority of New York and New Jersey
Environmental Commissions	373	Includes municipal and county commissions (ANJEC 2007)
County and Municipal Governments	587	21 counties and 566 municipalities. Many counties and municipalities own land with invasive species issues.
Certified Nurseries	990	(NJDA 2007b)
Certified Plant Dealers	1,510	(NJDA 2007b) This list includes landscapers that provide plants to their customers.
Registered Wholesale Seedsmen	113	(NJDA 2007c)
Garden Clubs	134	The majority of clubs are affiliated with one of the following: The Garden Club of America or the National Garden Clubs, Inc. (state chapter is the Garden Club of New Jersey)
Home Gardeners	Many thousands of individuals	Includes traditional gardeners and water gardeners/pond owners
Aquarists	Many thousands of individuals	The home aquarium can be a source of invasive plants and fish if they are released into the environment
Public Gardens	85	Includes arboreta, botanic gardens and public places with associated gardens as part of their attractions
Certified Tree Experts, Arborists and Foresters	593	Combined listings of certified professionals related to forestry and landscape trees
Conservation Groups	Approximately 150	Includes land trusts, watershed associations, environmental education groups, open space advocates, etc. There are 38 Land Trust Alliance members in NJ.
Outdoor Enthusiasts	Many thousands of individuals	Numerous outdoor recreation groups with varied interests including nature observation, hiking, mountain biking, horseback riding, hunting, fishing, boating, photography and exercise and leisure. This includes hunting and fishing groups (e.g., Trout Unlimited, Pheasants Forever, etc.). The total number of outdoor enthusiasts could easily be in the millions.
Children (K-12)	1.4 million	NJDOE (2009)

Section 2.B.1: Elected and Appointed Officials

This target group has potentially the greatest influence on reducing the impacts of invasive species through the creation of legislation at the national and state levels. However, elected officials are besieged with daily pleas to address many other serious problems. Messages provided to legislators must precisely articulate the seriousness of the threat and suggest realistic avenues to mitigate those threats. One of their most significant contributions would be to appropriate funding that is commensurate with the threat posed by invasive species.

Section 2.B.2: Key State Government Agencies

Several key state agencies are already members of the NJISC. These include the Department of Agriculture (NJDA), Department of Environmental Protection (NJDEP), Department of Transportation (NJDOT), and the NJ Economic Development Authority (NJEDA). Within NJDEP, the Division of Fish & Wildlife and Division of Parks & Forestry are key players in diminishing the impacts of invasive species because they manage hundreds of thousands of acres across the state. Other key stakeholders with significant mandates and authorities include the Department of Health and Senior Services, New Jersey Pinelands Commission, New Jersey Highlands Council, New Jersey Meadowlands Commission and Port Authority of New York and New Jersey. All of these agencies must be engaged to produce a robust and coordinated response to invasive species.

Section 2.B.3: Environmental Commissions and County/Municipal Governments

County and municipal governments are critical to reducing the impacts of invasive species. These bodies own and administer parks and conservation lands directly impacted by invasive species. In addition, counties and municipalities own numerous public gardens that serve to educate the public. Environmental commissions together with elected and appointed officials make local decisions that involve concerned citizens and civic groups that require engagement.

Section 2.B.4: Certified Nurseries/Dealers and Registered Wholesale Seedsmen

This group has the strongest financial link to production of invasive or potentially invasive species and will require education and outreach that is sensitive to this reality. The USDA estimated that the New Jersey horticulture, sod and Christmas tree industry had $330 million in gross receipts in 1995 (USDA-NASS 2005). Approximately 40% of gross receipts were derived from growers, 20% from dealers and 40% from landscaping. New Jersey nursery growers represented 2.5% of national receipts in 1995 (Brooker et al. 2000). In 2006, cash receipts were $364 million for the combined horticulture, sod and Christmas tree industry (NJDA 2006).

Every grower faces a plethora of financial and technical issues with the production of any plant species. In many cases, the attributes that make a species invasive make them the easiest species to grow and sell (e.g., tolerant to a wide range of growing conditions, grow rapidly, produce large amounts of seeds, deer resistant, etc.). Horticulturalists will be required to innovate and adapt to provide nursery stock that meets practical requirements without exacerbating the invasive species problem.

Section 2.B.5: Landscape Architects, Garden Clubs and the Gardening Public

Gardeners and landscape architects are consumers of invasive species and can provide a demand-side influence to reduce the continued use and subsequent spread of invasive species. Landscape architects are often faulted for specifying invasive species in their plans even though the development and sale of invasive plant species is perfectly legal. There are now multiple resources that provide lists of native alternatives to invasive species, but their production is still relatively limited. However, there are many non-invasive, non-native species that may be used in gardens.

Garden clubs and Master Gardeners throughout New Jersey are becoming increasingly effective agents that provide public outreach and demonstration projects. For example, the Short Hills

Garden Club has initiated the "Restore the Floor" campaign to improve forest health at the Hartshorn Arboretum in Millburn Township. The Mercer County Master Gardeners cleared invasive species and planted a native meadow in Hopewell Township, and the Essex Fells Garden Club has been removing invasive species and planting native species at the Essex Fells Glen.

However, there remain a number of issues or misconceptions that must be addressed through education. Several of these can be summarized using hypothetical statements from gardeners along with appropriate responses that can be provided by those performing outreach to reduce the impacts of invasive species:

Statement: "I like [insert invasive species name] because it attracts butterflies."
Response: "There are many non-invasive species that also attract butterflies."

Statement: "My specimen of [insert invasive species name] doesn't spread outside my yard – I live the middle of a suburb/city."
Response: "Birds and other animals have the potential to carry seeds a great distance. In addition, seeds may end up in your yard waste that is carried away to new and distant areas. Seeds may also be carried with mud in the tread of your tires or boots. Do you ever trade plants with friends that live near natural areas?"

Statement: "I like [insert invasive species name] because it grows really well no matter how much I abuse it – I have one in the shady wet spot near my deck and another one on the south side of my house in direct sunlight, they both do great and make lots of flowers and fruit. I have been transplanting their seedlings to make a hedge to block the view of my neighbors!"
Response: "You have just defined an invasive species. Here is a list of non-invasive species that you can try, including some that will help you avoid your neighbor."

Statement: "The only thing that deer don't eat in my yard is [insert invasive species name]."
Response: "This is also happening in many of our forests. We sorely need a coordinated statewide effort to reduce the deer population through increased hunting access and establishment of annual population harvest goals with consideration for ecosystem health. Until that happens, here is a list of deer-resistant non-invasive species. Unfortunately, this list represents a small fraction of the total number of species you could plant if deer were not overabundant. Also, do you allow deer hunting on your property or have you approached your town council regarding acquisition of a Community Based Deer Management Permit?"

Section 2.B.6: Public Gardens

Arboreta and botanic gardens have historically been considered sources of invasive plants. The importation, propagation and display of non-native species have been their core mission. It is important to note that the great majority of their accessions have not become invasive and some gardens now have staff with botanical expertise in native plants.

Gardens are ideally situated to play a prominent role in outreach to the general public because they attract people already interested in plants. Some gardens' efforts are particularly prominent. For example, the Brooklyn Botanic Garden has published two excellent books on invasive

species and native alternatives for the landscape (Randall and Marinelli 1996, Burrell 2006) and the Morris Arboretum has contributed to various conservation efforts including invasive species and deer overabundance.

Section 2.B.7: Certified Tree Experts, Arborists and Foresters

The application of forestry throughout the eastern United States and in New Jersey has been altered due to the combination of deer overabundance and invasive species (Rawinski 2008, Rhoades 2009). In the past, thinned or even clear cut forests could quickly re-colonize with native species. Currently, local foresters have observed that re-colonization by native species is severely reduced or eliminated through deer browse in many portions of New Jersey (T. Doty, R. Farr and J. Wagar, personal communications). For example, deer browse can severely restrict Atlantic white cedar regeneration in the Pine Barrens (Kuser and Zimmerman 1995, Mylecraine and Zimmermann 2000, Zimmerman and Mylecraine 2005, Pinelands Forestry Advisory Committee 2006). Areas newly exposed to sunlight through tree harvesting become susceptible to infestation by less palatable invasive species that resist deer browse (Eschtruth and Battles 2008). This situation may require that foresters employ new and costly techniques such as deer exclusion fencing, invasive species control and tree planting to ensure tree regeneration. However, strategies for deer management in specific forest regeneration areas and less costly modifications to forestry techniques are reported (Campbell et al. 2004, Krueger 2006).

Forestry in the Pine Barrens region represents a special case. In the Pine Barrens, invasive species are much less abundant and the application of ecologically based forestry techniques may be considered a critical component to the health of the system that can be used strategically to mimic wildfires that are largely suppressed in the region. Overall, alliances between foresters, biologists and botanists, all vested in healthy forests, could help resolve the challenges posed by invasive species and overabundant white-tailed deer. See Section 4 for additional discussions.

Section 2.B.8: Conservation Groups

The conservation groups most engaged with the invasive species issue are land trusts and watershed associations that own and manage land. Conservationists have been aware of the invasive species issue and have been providing models of management and outreach. However, proper stewardship of land owned by conservation groups may be limited by funding in many cases. These groups have a strong desire to control invasive species, but are financially constrained. In general, donors are less receptive to funding stewardship compared to land protection, and problems caused by invasive species tend to be largely unchecked on many properties owned by conservation groups.

Section 2.B.9: Outdoor Enthusiasts

Outdoor enthusiasts consist of a very large and diverse segment of the public. Interests include birding, photography, botanizing, bicycling, hunting, fishing, boating and a variety of other activities. Collectively, this group represents a ready supply of potential volunteers for invasive species detection and control because they have an appreciation for nature and many are willing to help protect it. Unfortunately, trails and equipment used by outdoor enthusiasts are often portals for invasive species moving into pristine areas. There is a need to provide education, primarily at entry points of natural areas and lakes, to reduce sources of new infestations.

Section 2.B.10: Children (K-12)

When considering any large problem, it is often the hope that the next generation will 'get it right.' In some cases, educating our children about invasive species could have immediate impacts as they share their newly found information with their parents! The environmental education community is trained to present messages to children and most of these professionals are aware of invasive species. The incorporation of invasive species concepts into school education programs should be accelerated and expanded whenever possible. The core of this message should be an appreciation for nature that allows students to build a commitment to protect biodiversity.

Section 2.C: Messengers and Methods

The NJISC should take a leadership role in a campaign to improve public education and awareness. The 'drum beat' for this message should focus on biodiversity, natural resources and agricultural resources that we are trying to protect. Invasive species are a menacing threat, but have no consequence without specific examples of what they threaten. The message for most target groups will be similar – invasive species are 'biological pollution' that contaminate our natural and agricultural resources. Information provided in Section 1 can be used to provide examples of what New Jersey has at stake and the threats posed by invasive species. Specific messages for each stakeholder group should focus on their level of responsibility to address invasive species. The NJISC recommends a coordinated campaign to educate stakeholders and improve public awareness through the creation of a website and widely distributed printed materials. The website would act as a clearinghouse of New Jersey-based information on invasive species. The overarching goal is to integrate invasive species education into a variety of venues. To assist with this campaign and encourage action, the NJISC recommends recruiting stakeholders to endorse and adhere to the St. Louis Declaration Voluntary Codes of Conduct (Appendix 9).

Land trusts, watershed associations and the Native Plant Society of New Jersey have been actively providing education on invasive species to garden clubs, environmental commissions, landowners and the general public. These events generally involve presentations discussing impacts and non-invasive alternatives for gardeners. However, both the number of groups providing and receiving information on invasive species can be expanded. The very large number of stakeholders and their contact information can be found in Appendix 13 - each stakeholder should be provided with outreach materials, including the St. Louis Declaration Voluntary Codes of Conduct (Appendix 9), and be asked for a firm commitment to adhere to the Codes. The ultimate goal is for members of stakeholder groups to become new messengers.

Rutgers Cooperative Extension (RCE) is very well situated to provide education to a wide variety of stakeholders. The long-established Master Gardener Program, recently established Environmental Stewards Program and RCE staff are equipped to create quality media productions. The Master Gardener Program is designed to increase horticultural skills, environmental awareness and stewardship utilizing research-based education. Established in 1984, the program provides 60 hours of classroom training before an individual can become certified as a Master Gardener. In recent years, invasive species training has become part of the established curriculum. Importantly, each trained Master Gardener is required to provide 60

hours of volunteer service. From 1984-2005, Master Gardeners have logged a staggering 952,211 volunteer hours. In 2008, there were over 1,900 active Master Gardener volunteers statewide. This program and its participants can be an excellent vehicle to train gardeners about the risks of invasive species and encourage non-invasive alternatives.

RCE's Environmental Stewards Program, established in 2005, is operated in cooperation with Duke Farms. Participants are provided with extensive training and required to contribute solutions to a wide variety of environmental problems. This program was specifically designed to provide stewardship of conserved lands, best management practices and environmental public advocacy. Modeled after the Master Gardener Program, Environmental Stewards are also required to participate in 60 hours of classroom training and contribute 60 hours of volunteer service to become certified. Several recent graduates have volunteered with land trusts to mitigate impacts of invasive species. The key component of both programs is the establishment of a communication network through interaction of lecturers and participants. This coordination amplifies the effects of the training and produces an informal group of additional messengers. The application of these programs along with other RCE resources toward the development of an effective early detection/rapid response program in New Jersey will be discussed in Section 3.D.5.

In addition, RCE faculty and staff have produced award winning television and video productions. They produce a television series entitled "If Plants Could Talk," which appears on WNJN. RCE has also produced high-quality instructional videos including titles such as "Asian Longhorned Beetle," "Emerald Ash Borer," "Hemlock Wooly Adelgid" and "West Nile Virus." Their website, http://ifplantscouldtalk.rutgers.edu/, provides fact sheets, slide shows and videos on a variety of topics including invasive species. These easily accessed multi-media products provide excellent outreach opportunities and establish RCE as a leader toward increasing stakeholder education on invasive species.

The NJISC recommends that RCE: 1) assist with production of an invasive species teaching module for its Master Gardener and Environmental Stewards Programs along with other continuing education programs for a variety of stakeholders; 2) provide outreach and incentives to reduce the reservoir of invasive species that continue to spread from planted landscapes; and 3) create a rewards and recognition program for voluntary nursery efforts to reduce production of invasive and potentially invasive plant species.

Section 2.C.1: Sources of Information

There are dozens of websites providing information about invasive species (see Appendix 14). All of these websites provide original content as well as links to additional information. Two particularly good introductions to invasive species include the "What the heck is an invasive plant?" fact sheet (http://www.nps.gov/plants/alien/pubs/whatis.pdf) and "Silent Invasion" prepared by the National Wildlife Refuge Association (http://www.refugenet.org/new-pdf-files/Silent%20Invasion%20pdf.pdf). One of the more comprehensive sites covering nearly every invasive species issue is the National Invasive Species Information Center (http://www.invasivespeciesinfo.gov/), which contains legal, technical and educational information.

The federal government has produced two innovative outreach programs that should be used expansively in New Jersey. In 2002, the U.S. Fish & Wildlife Service (USFWS) introduced the "Stop Aquatic Hitchhikers!" program (http://www.protectyourwaters.net/). This long-term outreach campaign is aimed at recreational boaters in an effort to reduce the transport of aquatic invasive species between lakes. Another recent program, "Habitattitude," was formed by the Aquatic Nuisance Species Task Force Partnership (represents 10 federal government agencies, Pet Industry Joint Advisory Council, NOAA National Sea Grant College Program) to address aquarists, pond owners and water gardeners. Their goal is to reduce the purposeful release of unwanted aquarium fish and plants into natural water bodies (http://www.habitattitude.net/).

The production of educational DVD's has been used to raise public awareness of invasive species. In New Jersey, RCE has produced multiple instructional videos (see above). The USDA-APHIS and US Forest Service (USFS) produced a video entitled "Emerald Ash Borer: The Green Menace" to raise public awareness of this now widening problem. Educational and management resources are also available on CD-ROM (see National Invasive Species Information Center and its links). Titles include: "Exotic Aquatics on the Move (EATM)" (contains 27 classroom activities); "Exotics to Go! Presentations and Publications to Prevent the Spread of Aquatic Nuisance Species;" "PIS, Aquatic Plant Information System;" "PMIS, Noxious and Nuisance Plant Management Information Systems;" "1000 Weeds of North America;" "Invasive Plants of the Eastern United States: Identification and Control;" "The UC Interactive Tutorial for Biological Control of Insects and Mites;" "Forest Pests of North America: Integrated Pest Management Photo CD Series;" and "Sudden Oak Death – How Concerned Should You Be?" Instructional videos may cost $50,000 to $100,000 to produce, but have the ability to reach a very wide audience and can be used in the absence of professional lecturers.

Lesson plans to enhance invasive species education (K-12) can be found at various websites including the National Invasive Species Information Center (http://www.invasivespeciesinfo.gov/). Curricula and other materials include: "ESCAPE (Exotic Species Curriculum for Agricultural Problem-Solving Education);" "Nab the Aquatic Invader;" "TEACH the Great Lakes;" "What's Wrong with this Picture;" "The Natural Inquirer;" "Return of the Natives - Restoration Curriculum;" "Aliens in Your Neighborhood;" and "A Kids Journey to Understanding Weeds." The Center for Invasive Plant Management (http://www.weedcenter.org) provides a long list of educational resources including links to grants for environmental education. Web links for these programs are included in Appendix 14.

Section 2.D: NJISC Recommendations for Stakeholder Conversations
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
1	Tier 1	2.C: Messengers and Methods	Coordinate a campaign to educate stakeholders and improve public awareness - Step 1: Create website	Create a website with NJ-specific information and links to other invasive species websites; Include basic overview of NJ's valuable natural and agricultural resources and threats posed by invasive species; Include NJISC information including members, statement of vision, mission and guiding principles. Links will include existing nationwide outreach efforts including "Stop Aquatic Hitchhikers" and "Habitattitude".	NJISC, RCE	Website established, 10,000 hits per year
2	Tier 2	2.C: Messengers and Methods	Coordinate a campaign to educate stakeholders and improve public awareness - Step 2: Create printed materials and signage	Create educational flyers, brochures, and signage that provide a basic overview of the invasive species problem including several examples of non-invasive alternatives for gardens. Distribute to visitor centers/trail heads at State-owned lands, horticultural retailers, landscape architects, landscape architecture programs, municipalities/ environmental commissions, conservation organizations, schools, Association of New Jersey Environmental Commissions, Soil Conservation Districts, Rutgers Cooperative Extension, etc. The website address will appear on the printed materials and signage.	NJISC, NJDA, NJDEP	Materials created, 100,000 items distributed
3	Tier 2	2.C: Messengers and Methods	Encourage endorsement and adherence to the St. Louis Declaration Voluntary Codes of Conduct	Codes were created through active engagement of stakeholders through participation in industry-lead conferences and other public meetings. There is a code for various bodies including government, nursery professionals, gardening public, landscape architects and botanic gardens/arboreta.	NJISC, OIS, RCE	Outreach conducted, 25 new groups from each category endorsing and adhering to Codes

Section 2.D: NJISC Recommendations for Stakeholder Conversations
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
4	Tier 2	2.C: Messengers and Methods	Coordinate a campaign to educate stakeholders and improve public awareness - Step 3: Enhance website	Website additions including NJ specific information and photos of invasive species, species lists with state distribution, potential new invaders with reporting link to ED/RR program, teaching modules and expert lists with points of contact. Develop an interactive page where citizens report observations of invasive species occurrences.	NJISC, OIS	Improvements created, 20% increase in website hits per year
5	Tier 2	2.C: Messengers and Methods	Create a rewards and recognition program for voluntary nursery industry efforts to reduce the production of invasive and potentially invasive plants	Rewarded efforts would include stopping propagation of invasive species before regulatory requirements take effect or producing only clean listed species.	NJISC, OIS, RCE	Award program created, annual awards distributed
6	Tier 2	2.C: Messengers and Methods	Create invasive species teaching modules	Create invasive species teaching modules for Rutgers Cooperative Extension, Rutgers NJAES, Office of Continuing Education, curriculum modules for K-12 education, and expanded undergraduate and graduate-level education at New Jersey's institutions of higher learning. Modules may include identification and control of current invasive species and identification of emerging invasive species for the Master Gardener and Environmental Steward Programs and could also be used to provide continuing education requirements for NJ-certified pesticide applicators and operators, foresters, commercial farm operators and landscape professionals.	NJISC, RCE	Five modules created, 5,000 people completing modules per year
7	Tier 2	2.C: Messengers and Methods	Provide outreach and incentives to reduce the reservoir of invasive species that continue to spread from planted landscapes	Encourage plant distributors to supply non-invasive plant materials to replace invasive species currently planted in gardens. This could take the form of a design competition with rewards for the most attractive landscapes that do not contain invasive species.	NJISC, OIS, RCE	Outreach conducted, 10 participating nurseries, annual design competition established

SECTION 3: PREVENTION

Section 3.A: Introduction

Our invasive species problems are severe and the first step is to stop making the problem worse. Prevention of new introductions is the highest priority. The old adage of "an ounce of prevention is worth a pound of cure" applies very well to invasive species. The cost of cleaning up existing infestations is exponentially greater than the much smaller amounts of resources required for prevention. The word 'prevention' regarding invasive species falls into three categories: 1) preventing the entry of new introductions that are currently absent from New Jersey; 2) eradicating or containing invasive species that have just begun to infest our state; and 3) protecting pristine areas from new infestations of already widespread invasive species. Currently, the majority of existing efforts in New Jersey involve attempts to clean up infestations that have become too large to solve on a statewide scale. Although efforts to control existing invasive species are critical at the local scale, we will assure ourselves a never ending supply of messes to clean up if we do not prevent the entry of new invasive species and check the continued spread of existing invasive species.

Invasive species are a global problem requiring coordination between governments to preserve the uniqueness of local natural systems and agricultural productivity. Leadership from international organizations and the federal government are required to slow the spread of new species introductions because global trade policies and procedures are not decided at the state level. The U.S. has initiated some significant efforts to stem the tide of new species introductions, which are discussed in this section of the plan. However, most efforts will require continued improvement and expansion. International efforts are tracked by the Global Invasive Species Programme (GISP), which facilitates communication and supports implementation of international legal agreements. Past and present prevention efforts in New Jersey are summarized in Section 1.C.1.

Section 3.A.1: Prevention Opportunities

Opportunities for preventative policies and procedures occur at three levels: pre-border (at the species' country of origin), border (ports of global commerce) and post-border (within New Jersey). Ultimately, it is hoped that potentially invasive species would be identified or quarantined and refused entry within New Jersey. Existing efforts involving preventative measures for intentional and unintentional introductions of invasive species are described later in this section. Stopping invasive species at the pre-border and border levels requires action of international and federal bodies that can be encouraged by New Jersey's congressional delegation. Post-border policies are primarily a State responsibility.

It should be noted that numerous invasive species have arrived to New Jersey after first establishing in other states in the U.S. Examples include mile-a-minute (Pennsylvania), swallowworts (New York) and sudden oak death (California). To reduce the risk of interstate transport of invasive species, New Jersey will be required to: 1) perform research to identify pathways that allow new invasive species to arrive in New Jersey; 2) develop programs and policies to reduce these risks; and 3) coordinate with invasive species councils and state officials

in neighboring states to identify imminent risks and to act together to reduce the impacts from emerging problems.

Section 3.A.2: Rate of New Introductions

The rate of new species introductions continues to increase as a function of global trade and the rapidity of transport of people around the world. New Jersey is particularly susceptible because of our major ports located in Elizabeth and Camden. These ports receive enormous numbers of shipment containers annually. Shipments arriving through air at Newark International Airport, John F. Kennedy International Airport and Philadelphia International Airport also constitute a significant pathway for non-native species to reach New Jersey. The Port Authority of New York and New Jersey reported receipt of nearly 3 million transport containers in 2005 (PANYNJ 2007). This represented a 60% increase since 1991. The potential for new species introductions is staggering. Industries associated with the introduction of species include horticultural, aquarium and pet trades and the medicinal and aromatic plant trade which includes over 3,000 plant species traded internationally.

Section 3.A.3: Percentage of Introductions that become Invasive Species

Overall, the percentage of introduced species that may become invasive is variable, but may range from less than 1% to over 75% (Williamson 1996). Although dependent upon numerous ecological factors, the success of introduced species can be highly dependent upon the number of individuals that are introduced by humans – this is often referred to as 'propagule pressure.' There are a number of ecological reasons for this, but it boils down to a question of probability. A larger number of individuals have a much higher chance of establishing a thriving population than a small number of individuals. This concept has been utilized with the purposeful releases on non-native plants and animals (including biocontrol agents released to mitigate impacts of invasive species - see Section 4.D). The practical implication is that any species that may be considered potentially invasive should not be released into the environment in large numbers. In New Jersey, notable examples include lining streets and sidewalks with invasive trees (e.g., Callery pear) or planting Boston ivy and African lovegrass along hundreds of miles of our major highways.

Additionally, some species are present for many decades before they become invasive species. They may go virtually unnoticed growing in very small numbers until 'something happens' and they begin to spread with great speed. Ecologists refer to this phenomenon as 'lag time' in reference to the biology and mathematics of growing populations. Snyder and Kaufman (2004) report several invasive species with relatively short lag times, including Japanese stiltgrass, Japanese honeysuckle and Eurasian watermilfoil, that spread rapidly over 20-30 years from their first recorded observations in New Jersey. However, other very damaging invasive species took more than 70 years to spread across the state (e.g., Japanese barberry, Norway maple, lesser celandine and garlic mustard). Snyder and Kaufman (2004) quote the cautionary words of Williams and Meffe (1998): "The thousands of established non-indigenous species in the United States that are not known to have caused ecological and economic damage to date should not be viewed as benign biota but as potential time bombs." The issue of lag time necessitates the re-evaluation of all non-native species in the state on a periodic basis, coupled with implementation of a robust program of Early Detection/Rapid Response (ED/RR) for species deemed to be potentially invasive.

Section 3.A.4: Intentional and Unintentional Introductions

The introduction of non-native species may be either intentional or unintentional. The general rule is that most plants and larger animals have been intentionally introduced for ornament, medicinal purposes or other commercial activities (Pimentel et al. 2005). In the past, many plant species were also unintentionally introduced to New Jersey as seeds in the soil ballast of ships. In modern times, ship ballast consists of water from its port of origin, which has been a major unintentional source of non-native marine species. Pests and pathogens generally arrive unintentionally through packaging materials. However, one of New Jersey's most notorious forest pests, the European gypsy moth, escaped into the environment after being purposely introduced as a potential source of silk. (Coincidentally, this business idea did not work out but we are still stuck with the invasive species). A short list of other invasive species and their modes of introduction include: Japanese stiltgrass (unintentional - packing material for delicate china); sudden oak death (unintentional - shipment of contaminated nursery stock); European starling (intentional - part of an effort to establish all animals mentioned in plays written by William Shakespeare); Asian longhorned beetle (unintentional - untreated wood packing material - WPM); Japanese barberry (intentional - ornamental purposes); and garlic mustard (intentional - food and medicinal uses).

Climate change over the coming decades will result in new species introductions to New Jersey from southern states (Weltzin et al. 2003). One example could be kudzu, which already has small populations in New Jersey but could become more problematic and infest large areas as it does in the southern states. Scientific research suggests that increases in carbon dioxide favor vines, which could make our problems with invasive species such as Japanese honeysuckle and Asiatic bittersweet even more severe (Sasek and Strain 1990).

Section 3.B: Prevention Strategies for Unintentional Species Introductions

Section 3.B.1: Pests and Pathogens

Pest and pathogens refer to insects or diseases that are considered invasive to forest trees or agricultural commodities. Pests and pathogens are generally introduced unintentionally through untreated wood packing materials (WPM) and shipments of live plants. The U.S. is a signatory to the World Trade Organization Sanitary and Phytosanitary Agreement and the International Plant Protection Convention (IPPC), which requires adherence to inspection programs for imports and exports.

Recently, the IPPC issued guidelines to regulate WPM in international trade. The guidelines are referred to as International Standards for Phytosanitary Measures (ISPM) No. 15 and can be downloaded at http://www.ispm15.com/ISPM15%202006.pdf. There are 134 countries participating in this program, which requires WPM to be treated with either methyl bromide or heat to eliminate harmful pests and pathogens of forests and crops. A trial treatment program and survey is being conducted to detect the effectiveness of the program and preliminary results show that treatment in the country of origin is over 99% effective (C. Schulze, personal communication). In addition, the growing use of alternatives to WPM, including metal, presswood or recycled plastic pallets, should also reduce the spread of pests and pathogens throughout the world. Full implementation of this program and use of alternatives to WPM

shows great promise toward reducing future threats to New Jersey's natural and agricultural systems.

The role of the USDA-APHIS has already been discussed (see Section 1.C.1), including the PPQ program which ensures that all plants entering the country be accompanied by a phytosanitary certificate indicating that the shipment is free of pests listed by the USDA-APHIS. Their Regulated Pest List of 405 agents includes bacteria, fungi, insects, mites, nematodes, phytoplasma, viroids, viruses and weeds (USDA-APHIS 2000). Despite its six-person staff, the NJISC recommends two new federal positions be sought for the Linden, NJ facility to provide increased inspection capacity.

The USDA may impose quarantines and other restrictions to inhibit the spread of pests and pathogens once they have been detected in the U.S. However, these methods are not always effective and require significantly more resources than pre-border or border prevention. The invasive emerald ash borer (EAB) had originally established near Detroit in 2002. It rapidly spread to Ohio (2003), Indiana (2004) and Illinois (2006) despite a federal quarantine of infested areas and restrictions on the shipment of firewood. EAB was detected in Maryland in 2006 through a deliberate violation of the federal quarantine that prohibited the movement of firewood from contaminated areas in Michigan. To date, EAB has killed 20 million ash trees in affected states and it has the potential to arrive in New Jersey.

The shipment of nursery products within the U.S. is also a potential pathway for pests and pathogens to enter New Jersey. The most notable recent instance involved the introduction of sudden oak death (SOD) to over 125 nurseries in 17 states in 2004. Although New Jersey requires phytosanitary certification for all plant shipments from other states, SOD arrived at a Cape May nursery. Fortunately, NJDA response was rapid and tests of areas surrounding the nursery showed no sign of SOD establishment.

Section 3.B.2: Recreational Activities

All terrain vehicle (ATV) riders, hikers, hunters and fishers, birders and other outdoor enthusiasts are unintentional dispersers of invasive plants. Mud clinging to vehicles, boots and equipment often contains seeds of invasive species such as Japanese stiltgrass, garlic mustard and other invasive plants with small seeds. Boats, bait buckets and other gear may contain fragments of aquatic plants or small aquatic animals that are transferred to new bodies of water. Trails and boat launches are often introduction points for invasive species into unimpacted areas. These problems cannot be easily addressed, but boot-cleaning stations accompanied by an educational kiosk/signage and other public outreach efforts would be beneficial especially at pristine areas that do not currently have infestations. Model programs already exist to stem the spread of aquatic invaders (See examples in Section 2.C.1). There are several 'rules of thumb' for recreational fishing that could reduce the spread of aquatic invasive species. Steps include: a) never empty bait buckets into a different body of water from where you obtained the bait; b) throw unused bait into the garbage (including earthworms); c) don't transfer live fish from one body of water to another; d) remove all plant fragments and rinse mud from equipment/waders before leaving the access area; and e) drain all water from your boat before leaving the launch site. ATVs act as an even larger pathway for the introduction of invasive species. The tires of rapidly moving vehicles carry mud that contains seeds over large distances. The action of

churning tires also disturbs the soil, which creates ideal locations for invasive species to germinate. ATVs are a chronic problem for most land managers. The NJISC recommends minimizing invasive species spread through interpretive signage at trailheads and boat launches along with the installation of boot cleaning stations at trailheads located in pristine areas.

Section 3.B.3: Forestry Activities

Forestry activities may also introduce invasive species. Mud containing seeds of invasive species is inadvertently carried on machinery from site to site. In addition, disturbances created through clearing and transporting timber create ideal situations for invasive species to establish in new areas. The cleaning of machinery prior to its transport to another job site could be a simple technique to minimize the spread of invasive species in forest habitats. The NJISC recommends an outreach effort to encourage voluntary measures involving the cleaning of forestry equipment prior to arriving at new job sites. The NJISC further recommends the incorporation of invasive species issues and ED/RR principles into the development and update of municipal Community Forestry plans.

Section 3.B.4: Marine Invasive Species

The most significant sources of marine invasive species are ballast water discharge at receiving ports and ship hull fouling, which involves the transport of marine organisms attached to the hull. Additional pathways include: a) shellfish and aquaculture introductions; b) marine recreational activities; c) commercial and recreational fishing; d) ornamental trades; e) canals; f) drilling; g) hull cleaning activities; and h) floating marine debris. The majority of New Jersey's marine invasive species originate from Europe because Asian ships generally go to Pacific coast ports. However, Asian species may arrive in the Northeast after first being introduced to European ports (Pederson et al. 2003).

In 2004, the U.S. Coast Guard began a mandatory ballast water program for all large ships traveling from overseas. The program requires ships to empty ballast water from their point of origin and replace it with ocean water 200 miles from their receiving port with the expectation that coastal marine species cannot survive in open water. This process is intended to reduce the number of non-native organisms unintentionally introduced to receiving ports. This may be an important step in reducing the continued introduction of non-native marine species. The NJISC recommends determining appropriate prevention strategies following communications with the New Jersey Marine Science Consortium (http://www.njmsc.org/) and other relevant stakeholders.

Section 3.C: Prevention Strategies for Intentional Species Introductions

Section 3.C.1: Pre-Border Screening Protocols for Plants

Scientists have been developing and testing a variety of protocols to predict which non-native species may ultimately become invasive (Baker 1965, Scott and Panetta 1993, Ruesink et al. 1995, Karieva 1996, Rejmanek and Richardson 1996, Reichard and Hamilton 1997, NRC 2002, Krivanek and Pysek 2006, Caley et al. 2006). These methods involve determining characteristics of plants that lend themselves to invasiveness. This research has informed efforts of national governments developing regulations and methods to screen plant introductions and has been used as a basis to prioritize control efforts for invasive species.

The governments of Australia and New Zealand have already implemented systems and the USDA-APHIS is currently considering regulatory screening protocols to prevent potentially invasive species from entering the U.S. (see Text Box 2). The impact of this potential regulation could have enormously beneficial impacts for New Jersey by reducing the continued flow of potentially invasive species. The NJISC recommends encouragement of federal representatives to support passage of revised Quarantine 37 rules that require pre-screening of plant introductions.

Section 3.C.2: Creating Invasive Species Lists Through Evaluation of New Jersey's Non-native Species

The creation of lists of non-native species and evaluation of their invasive status is critical for New Jersey to move forward with its invasive species program. This has been performed by reviewing existing literature and communicating with various experts to identify non-native species known to occur in natural habitats or agricultural systems in New Jersey (Hough 1983, Ehrlich et al. 1988, Anderson 1999, Pederson et al. 2003, Campbell 2007, Fofonoff et al. 2007, GISP 2007, Meade 2007, NJDA 2007a, NJDEP 2007a, Steves et al. 2007, USDA-NRCS 2007, USGS-NAS 2007, P. Fofonoff - personal communication) (See Appendices 2 - 6). It is important to note that this attempt to list all non-native species is necessarily incomplete due to incomplete knowledge of distributions for many species, especially for insects and other organisms that are difficult to identify.

The second step in this process was to adopt a definition of an invasive species and then categorize the invasive status of each non-native species. The NJISC adopted the invasive species definition developed by the National Invasive Species Council (see Text Box 1).

For plants, the NJISC recommends that a slightly modified procedure utilized by the Massachusetts Invasive Plant Advisory Group (MIPAG 2005) be applied as soon as possible following plan adoption to create a current prioritized list of non-native plants of New Jersey. This will involve the participation of a multidisciplinary group of experts that will use developed criteria to categorize all non-native plant species. The NJISC recommends that all cultivars, varieties and subspecies of an evaluated species be categorized the same as the "straight species" in this listing and ranking process (See Section 3.C.3 for discussion). Ultimately, an official invasive plant list will include all species categorized as 'Demonstrably Invasive' or 'Potentially Invasive.'

A consensus of NJISC members was used to categorize non-native animals, pests and pathogens, and marine species. The numbers of non-native and invasive species are summarized in Table 5 and annotated species lists are reported in Appendices 4 - 6 along with their invasive species status.

The NJISC recommends that non-native species known to occur in the state be re-evaluated every five years to account for potential changes in statewide distribution. Additionally, the NJISC recommends all non-native species used in trade be evaluated for invasive potential. This includes species that are currently not known to spread into natural or agricultural systems. Species to evaluate include those used for agricultural, horticultural, medicinal or other purposes.

The NJISC also recommends the annual production of a report of new plant species introductions based upon information gathered through the Quarantine 37 process.

Text Box 6. NJ Action! - Municipal Lands: Chester Township, Morris County

Chester Township consists of nearly 40% protected open space and farmland and the township owns 1,500 acres of parkland. Former Mayor Benjamin Spinelli is keenly aware of the stewardship responsibilities associated with ownership. The town administers a deer management program that carefully tracks hunting activity and harvest data to ensure success in reducing impacts on natural lands. The Township also has a cooperative agreement with the Morris County Park Commission to manage 600 acres of township land.

Invasive species control has been initiated at their 300-acre Evans Family Forest Preserve and 500-acre Tiger Brook Park. Control treatments have focused on their worst species including Japanese barberry, Asiatic bittersweet, autumn olive, and multiflora rose. Volunteers have been recruited by the Township and through the Morris Land Conservancy's Partners for Parks program. Funding and technical assistance through NRCS ($16,000 WHIP grant) allowed the township to hire a contractor to remove 30 acres of autumn olive on abandoned agricultural fields and plant native warm-season grasses, which provides habitat for rare grassland birds.

At their Evans Family Forest Preserve, the Township has constructed two 0.25 acre deer exclosures to serve a source of seeds to spread into surrounding areas after the deer population is reduced. Invasive species have been removed from the deer exclosures and native species such as witch hazel have been replanted. Plants such as spicebush that had been severely browsed by deer have already made a dramatic come back. Native plants, free from deer browse, are expected to reduce future infestations by invasive species. This important work was supported by Township funds (<$1,000) and volunteers, including an Eagle Scout.

Other important efforts in the Township have included the release of biocontrol agents to eliminate purple loosestrife at the Black River Wildlife Management Area, which has had dramatic results in only a few years. Biocontrol agents have also been released to protect hemlock trees being attacked by hemlock wooly adelgids in the Black River Gorge. Although the success of this effort is undetermined, it is hoped that the hemlock grove can be saved.

Native white water lily. Photograph by Michael Van Clef.

Text Box 7. NJ Action! - State Lands: Washington Crossing State Park

David Donnelly, superintendent of Washington Crossing State Park, has been working to control invasive species within his park and throughout lands managed by the Division of Parks and Forestry, NJ Department of Environmental Protection. He initiated the 'Parks Invasive Species Committee' and has been educating his colleagues and staff about the threats posed by invasive species through presentations and walks through parklands that involve identification of invasive species and demonstration of control techniques.

Washington Crossing is infested with a variety of invasive species including lesser celandine, Japanese barberry, multiflora rose, Japanese knotweed, purple loosestrife, Japanese stiltgrass, garlic mustard, winged burning bush, Asiatic bittersweet, bush honeysuckles, Japanese honeysuckle, tree-of-heaven and Japanese wisteria. In addition, native species of grape are pulling down forest trees leaving open areas vulnerable to infestation by invasive species.

Overall, Dave's strategy is to treat emerging infestations and create demonstration areas because staffing limitations preclude a more intense effort. Phragmites has been reduced by 85%, patches of Japanese knotweed have been treated using cut stem applications of herbicide, individual Norway maple trees have been treated via an injection method, tree-of-heaven individuals have been treated, and infestations of grape vines have been strategically cut to foster survival of canopy trees to help resist future invasions by light-demanding invasive species. In addition, Washington Crossing has received a biocontrol agent (*Rhinoncomimus latipes*, a weevil) from the New Jersey Department of Agriculture to control an emerging infestation of mile-a-minute weed, which has been spreading rapidly throughout the state over the last 10 years. Dave also works with the NJ Forest Fire Service to burn grasslands to remove invasive species such as multiflora rose and autumn olive. Finally, Washington Crossing received WHIP funding from the NRCS to research various multiflora rose control techniques in an area containing a rare plant species. A mapping program using existing park staff will be implemented to guide future treatments throughout the park.

Because deer hunting occurs on only a limited portion of the park, providing insufficient deer management, Dave recently installed a deer exclosure to enhance survival and stimulate growth of native species that can ultimately act as a source of seeds to spur regeneration of the forest if deer populations are reduced in the future. He also plans to install fencing around a portion of landscape plants installed at the Park entrance as an educational demonstration of deer impacts for visitors. Ultimately, it is hoped that a comprehensive deer management program will result in a reduction of deer browse on native plants, which will reduce infestations of invasive species.

Native bog asphodel – a globally rare species found in the New Jersey Pine Barrens. Photograph by Michael Van Clef.

Section 3.C.3: Voluntary and Regulatory Approaches for Invasive Plant Species

The most significant voluntary measure is the St. Louis Declaration Voluntary Codes of Conduct, which was a landmark agreement between the horticultural industry and the conservation community (see Section 1.C.1 and Appendix 9). The NJISC recommends a statewide outreach program to encourage the adoption and adherence to these Codes by a wide variety of stakeholders. NJISC also recommends a rewards and recognition program that encourages voluntary nursery industry efforts to eliminate the production of invasive and potentially invasive plants. Rewarded efforts would include stopping propagation of invasive species before regulatory requirements take effect or producing only clean listed species (see below). Specific guidance on implementation of voluntary efforts may be sought through colleagues in California where the PlantRight program has recently been initiated. The ultimate goal of these outreach efforts is for the nursery industry and other stakeholders to voluntarily contribute to the mitigation of our invasive species problems.

In general, the horticultural industry has been slow to consider potential invasiveness when developing new products (Anderson et al. 2006). Their process involves four phases: 1) plant exploration; 2) initial trial; 3) fast-tracking; and 4) selection and improvement. Each of these phases affords opportunities to evaluate invasive potential before importation to a new country. Although some industry professionals will consider additional risk assessment onerous, there is both promise and practicality to working with regulators and scientists to prevent the introduction of potentially invasive species. The current model of unguided introductions, substantial investment in plant development, determination of invasive status and subsequent banning from the market (in selected states and countries) is ultimately not cost-effective. The industries' investment may involve decades of research and development before introduced plants ultimately become available at nurseries (tree development ranges from 17-46 years, herbaceous perennials 8-16 years – LPDC 2007). The consideration of USDA-APHIS regulatory revisions that employ risk assessment of plant introductions could dramatically change the rules for importation of new plants species, but partnerships between industry, scientists and regulators will still need to be strengthened for effective implementation.

The horticultural industry is beginning to address the invasive species problem through the development of assessment tools and breeding programs resulting in sterile (or 'highly infertile') cultivars of known invasive species (Anderson et al. 2006, Knox and Wilson 2006, Lehrer et al. 2006a, Lehrer et al. 2006b, LPDC 2007). The nursery and landscape industry is also beginning to support these initiatives (the Massachusetts Nursery & Landscape Association is funding three research projects). Research centers actively working on invasive species issues include the Landscape Plant Development Center, U.S. National Arboretum, University of Connecticut, University of Minnesota, University of Arkansas and Hebrew University. Their current research on the evaluation of invasive tendencies and development of sterile (or 'highly infertile') cultivars includes Japanese barberry, winged burning bush, butterfly bush, amur maple), Callery pear, privet, rose-of-sharon, brumald spirea, heavenly bamboo and various herbaceous perennials (see above for citations).

Japanese barberry has received particular attention due to its significant market value and its growing legal status as an invasive plant (it is formally listed or informally considered invasive

in 30 states). Ironically, Japanese barberry was introduced in 1875 to replace European barberry that was the subject of an eradication effort after being discovered as a host plant for wheat stem rust fungus. In Connecticut, Japanese barberry has an annual crop value of $5 million and its total market value in the U.S. far exceeds this figure (Lehrer et al. 2006b). The species is highly valued by the industry and gardeners because of its excellent growth performance in a variety of landscape situations and its avoidance by white-tailed deer.

Issues with banning this species are further complicated by the production of nearly 40 varieties and cultivars and the general lack of availability of the original 'straight species' (Dirr 1990, Lehrer et al. 2006b). Natural areas containing Japanese barberry are usually infested by the 'straight species' whose leaf color is green and height ranges to six feet (individuals with red leaf color and height to six feet are infrequently encountered in natural areas, D. Snyder, personal communication). Lehrer et al. (2006b) evaluated cultivars and found that none were completely sterile, but six cultivars produced very small amounts of viable seed. Importantly, Lehrer et al. (2006a) found that yellow- and purple-leaf cultivars can produce green-leaved progeny. It is uncertain whether these cultivars are producing the wild-type 'straight species,' but this study suggests that possibility. To date, there is no evidence that Japanese barberry cultivars do not pose similar risks of becoming invasive species or producing the 'straight species' that is a notorious invader of forests in New Jersey.

Ultimately, the development of sterile cultivars of any invasive species must be carefully evaluated. The early lessons learned through the production of "self-sterile" cultivars of purple loosestrife (named 'Morden Pink') and Callery pear (Culley and Hardiman 2007) are instructive – both are "self-sterile" (i.e., they cannot pollinate themselves to produce fruit/seeds) but both produced copious amounts of fertile seeds after being pollinated by their close relatives under landscape conditions.

A primary discussion topic of the NJISC involved the mechanisms to categorize non-native plant species and the implications of creating an invasive species list. The use of voluntary vs. regulatory measures regarding the production and sale of listed invasive species was debated. Although the nursery industry is beginning to embrace voluntary measures, there is little information regarding the effectiveness of voluntary programs to eliminate the sale of listed invasive plant species. Caton (2005) examined the effectiveness of a voluntary 'do not sell' list created by the Florida Nursery Growers and Landscape Association and the Florida Exotic Pest Plant Council. There was no evidence that sale of invasive species had diminished three years following program inception. In 2003, the New Jersey Nursery and Landscape Association (NJNLA) showed great initiative by voluntarily adopting the St. Louis Codes of Conduct and listing 15 invasive species. To date, there has been no analysis regarding the effectiveness of these actions in reducing the quantity of invasive species produced in New Jersey.

Several Northeastern states have passed regulatory lists through consultations with their respective nursery industries. This includes Massachusetts, which banned all varieties/cultivars/subspecies of listed species (MIPAG 2005). In developing a prioritized, non-native list of plants for New Jersey, species will be categorized as either demonstrably invasive, potentially invasive, watch list species or clean list species. The use of a 'clean list' will be unique to New Jersey and will provide growers with a sense of security that these species are less

likely to ever be considered invasive in the State. The NJISC recommends that species categorized as demonstrably invasive or potentially invasive be banned from production and sale in New Jersey, and denied entry via interstate commerce utilizing the interstate phytosanitary inspection program administered by NJDA. This should be implemented using an administrative rule-making process that utilizes existing regulation. The NJISC recommends that this regulatory species ban be enforced by the NJDA through its existing nursery inspection and certification program. Further, NJISC recommends fines for violations of the ban, with the proceeds distributed to the NJISC to fund control programs. Additionally, the NJISC recommends that formally banned plant species and species categorized as 'watch list' species should not be intentionally planted by any state agency. In other words, the state would intentionally use only native plant species or non-native species appearing on a clean list. This would occur initially through enforcement of NJDEP Policy Directive 2004-02 and more fully implemented upon development of an official invasive plant species list.

Public gardens are often used as models by gardeners and their influence necessitates demonstration of the seriousness of the invasive species problem. The NJISC recommends a permitting and licensing program for public gardens that wish to maintain listed invasive species. Requirements would include a licensing fee based upon the number of individual plants of invasive species maintained in their collection. Certification under this program would require public gardens to monitor spread from plantings and implement control programs as necessary. Distribution of propagules to any outside entity would be prohibited. Licensing fees would be used to fund the inspection program administered by NJDA.

The primary concern expressed by NJISC growers regarding regulatory banning of species is the provision of sufficient time to transition to alternative commodities. The NJISC recommends a time frame of three years to allow growers to avoid undue financial impacts that would be caused by prohibiting the production of popular species. In addition, all cultivars/varieties/selections/ sub-species of listed species will be assigned the same status as their 'straight species' unless they are proven to be completely sterile through published scientific research. An extended phase-out period of five years is proposed for commercially valuable cultivars of Japanese barberry to allow significant time to develop alternatives or for the horticultural industry to deliver sterile cultivars.

Section 3.D: Early Detection and Rapid Response (ED/RR)

Section 3.D.1: Introduction to ED/RR Programs

Early detection and rapid response is the most cost efficient post-border mechanism to treat invasive species. ED/RR describes a program that eradicates or contains invasive species just beginning to establish in natural or agricultural systems. It also describes efforts to prevent the spread of widespread invasive species into new areas. A recent New Jersey example of application of ED/RR is the Central Jersey Invasive Species Strike Team (see Text Box 8). The most effective example of an ED/RR program in our region is the Invasive Plant Atlas of New England (IPANE) (see Text Box 9). Active or developing state and regional programs include Delaware – plants (DISC-DISTS 2007), Maine – aquatic plants (Maine Volunteer Lake Monitors 2007), New Hampshire – aquatic plants (NHDES 2007) and the Great Lakes aquatic invasion system (Great Lakes Panel on Aquatic Nuisance Species 2004). Plans and guidelines for a

comprehensive national ED/RR program have also been created (FICMNEW 2003, NISC 2003, NBII 2007, USDA Forest Service - undated).

The backbone of any ED/RR program is an established and efficient organization. Technical aspects of a successful program include: 1) reporting suspected new species to a designated office; 2) identification and vouchering of submitted specimens; 3) archival of new records in a centralized, spatially-referenced database; 4) assessment of potential impacts created by the new introduction; and 5) rapid response to eradicate any new introductions that are deemed potentially invasive.

Effective ED/RR requires a centralized office to provide oversight, coordination and rapid response. ED/RR also requires a core of trained volunteers and the ability to capitalize on observations of natural resource professionals, outdoor enthusiasts and the general public. Volunteers that are part of a formal early detection network require training on plant identification, preparation of a coarse voucher specimen, and ability to make a simple map to allow field verification of their observations. Effective volunteers would have to be familiar with common species to know when they are observing species new to our state. A formal training program involving a volunteer job description, identification guides and a handbook of procedures is required. Sources of information on volunteer recruitment, training materials and reporting formats are available (Zerbe et al. 2003, Ontario Federation of Anglers and Hunters 2007, USDA-NAL 2007). Huebner et al. (2004) produced a particularly thorough and durable resource to identify many forest invaders, which would make an excellent field guide for volunteers.

Section 3.D.2: Overview for Selecting ED/RR Priorities

New Zealand has implemented an innovative approach that could be adapted for New Jersey (Timmins and Owen 2001). The overall approach is to prioritize ED/RR control efforts by either 1) individual invasive species ("species-led" approach), or 2) sites containing significant biodiversity ("site-led" approach). The highest control priority is ED/RR for emerging threats posed by invasive species that can either be eradicated or contained ("species-led"). Ranked invasive species are placed into four possible groups based upon an overall score that considers its potential to spread and potential impacts on native species. The practicality of control is then estimated based upon required level of effort (see Figure 1).

Site-led ED/RR control programs are prioritized based upon existing biodiversity value and the urgency of control, which considers the implications if the site becomes infested (e.g., local extinction of a rare native plant or ecological community, reduction in biodiversity, etc.). Timmins and Owen (2001) also provide guidance to assess the practicality of eradication of an invasive species at a particular location. Eradication should be the goal when efforts are relatively short-term (i.e., less than five years). Relatively long-term eradication efforts should only be considered when feasible. When eradication is impractical, the goal should shift to minimization of impact within areas containing defined conservation targets and/or the prevention of spread to non-impacted areas.

The National Park Service (NPS) has adopted an analytical ranking approach to prioritize control efforts by species at particular sites (Hiebert and Stubbendieck 1993). This system, utilized by

their Exotic Plant Management Teams (see Section 4.E.3), considers the significance of the impact and feasibility of control to formulate 'urgency ranks' that are specific to each site. Morse et al. (2004) have developed a protocol to prioritize control efforts by species. This protocol involves answering 20 questions involving four basic categories: ecological impact, current distribution and abundance, trend in distribution and abundance, and management difficulty. The scores for each question are calculated into an 'Invasive Rank' for each species.

Section 3.D.3: Selecting ED/RR Species in New Jersey

Invasive animal species (including insect pests and pathogens) that require ED/RR in New Jersey include feral hog, Asian longhorned beetle, Chronic Wasting Disease, emerald ash borer, zebra mussel, mute swan, quagga mussel, flathead catfish, nutria, snakehead fish, sudden oak death, Asian gypsy moth, avian influenza, Eurasian nun moth, European oak bark beetle, pine flat bug, Asian soybean rust, golden nematode, sirex woodwasp, khapra beetle, Mediterranean fruit fly, Africanized honey bee, common pine shoot beetle and white pine blister rust. All of these species either do not exist or have limited distributions in New Jersey, but are considered to pose serious threats to natural or agricultural systems based upon the biological potential of the species and/or observations of invasive characteristics in surrounding states. All of the above animals (including insect pests and pathogens) are considered to be invasive or potentially invasive based upon the consensus of NJISC members (See Appendices 4 - 6).

Plant species ultimately categorized as 'Potentially Invasive' and 'Watch List' following development of an official list could become subjects of an ED/RR program (see Section 3.C.2).

The decision tool used to determine whether a particular species, either plant or animal, should be a candidate for a species-led ED/RR program is presented in Figure 1. Additionally, a decision-making guide to evaluate the feasibility of control of any invasive species is presented in Figure 2. The NJISC recommends that prioritization among acceptable ED/RR candidate species should be evaluated on a case-by-case basis by the proposed Office of Invasive Species after consultations with the NJISC and other experts.

Initially, NJISC recommends starting an ED/RR program that targets five species that have a limited distribution in New Jersey, but with high potential to become serious pests. The species are feral hog, Asian longhorned beetle, Chinese silvergrass, water chestnut and giant hogweed. Although these targeted species are only a small fraction of potentially harmful invasive species in New Jersey, they represent a broad class of taxa and can serve as examples for more comprehensive efforts in the future.

Feral hog represents a mammal species that threatens both natural and agricultural resources. They are known to occur in 31 states and their damage to forests can be severe. They may transmit pseudorabies and swine brucellosis, which triggers USDA requirements to test domestic pigs in states that have populations of feral hogs.

Asian longhorned beetle is already a subject of ED/RR in New Jersey, but constant vigilance will be required for many years to assure that eradication is complete (see Section 4.E.1 for a case study of premature easing on efforts to eradicate European gypsy moth in New Jersey).

Chinese silvergrass has been present in natural habitats in small numbers throughout the state for many years (Hough 1983). However, the use of this species for ornamental purposes has grown substantially over the last 10-15 years and recent observations at Duke Farms in Hillsborough indicates strong invasive potential (T. Almendinger, personal communication). This species has also been documented spreading in Hopewell Township. This species has potential to become a serious pest of woodland edges and meadows.

Water chestnut is known to be a serious invader in surrounding states and is beginning to become more prevalent in New Jersey. This aquatic species can completely alter biological characteristics of open water habitats and reduce recreational values.

Giant hogweed was detected at one location in Mendham Township, which was initially treated by NJDA. However, follow up treatments are required to ensure eradication and additional searching should be conducted in the area of the original infestation. An additional small population was detected and eradicated in Hillsborough Township by Duke Farms. This species is problematic in surrounding states and can directly harm humans through severe contact dermatitis.

The NJISC recommends that active searching for new introductions occur in a systematic fashion at areas near ports of entry or sensitive habitats that are prone to invasion, contain rare species or are currently pristine. However, coincidental observation at any natural area should be encouraged by tapping into a wide group of potential 'Weed Watchers' including professionals involved with natural resources or the general public that participates in outdoor recreation.

3.D.4: Selecting ED/RR Sites in New Jersey

Determining Ecological Values

The selection of ED/RR sites should be based on the ecological value of the site, as well as the urgency and feasibility of invasive species control at the location. Two key factors in determining ecological value are the presence of rare species and ecological communities, and the amount of contiguous habitat found at the site. There are several Geographic Information System (GIS) datasets that can be easily accessed at the NJDEP GIS website (http://www.state.nj.us/dep/gis/download.htm) and used to help determine the ecological value of a site.

The New Jersey Natural Heritage Program tracks locations of rare species and ecological communities (NJDEP 2007d). Boundaries are developed around areas containing rare species, which are referred to as Natural Heritage Priority Sites (NHPS). These sites are then provided a global biodiversity significance rank (B-Rank) that ranges from 1-5 with B1 sites having the highest global significance. The biodiversity significance rank is based on the global and state rarity of the species as well as the viability of the individual occurrences. In the Highlands Planning and Preservation Areas, priority sites are specific to rare plant species and ecological communities. Outside the Highlands region, priority sites may also contain occurrences of rare animal species, although the primary focus is rare plants and ecological communities.

The Division of Fish & Wildlife's Endangered and Non-game Species Program (ENSP) developed the 'Landscape Project,' which prioritizes areas based upon the biodiversity

significance of rare animal species utilizing patches of habitat (Niles et al. 2004). Habitat patches are ranked from 1-5. Patch ranks are based upon the level of rarity of the species found within the patch. A rank of '5' signifies patches containing federally listed species, Rank 4 patches contain state endangered species, Rank 3 patches contain state threatened species, Rank 2 patches contain state species of concern, and Rank 1 patches have suitable habitat for rare animals but do not contain confirmed occurrences. Landscape Project version 2.1 is available statewide. The Highlands area is covered by Version 3.0, which utilizes the most recent land use/land cover data. Statewide coverage for Version 3.0 is expected in the near future.

The size of contiguous habitat is critical to the overall health of ecological communities. Habitat patches in Landscape Project Version 2.1 (or 3.0 for the Highlands) may consist of forests, grasslands, emergent wetlands or coastal systems. The size of a habitat patch has critical implications for area-demanding animal species and potential to contain current and future population sites for rare plants (i.e., allowance for metapopulation dynamics). The largest patches represent the 'wildest' places in New Jersey and their conservation should be a high priority. Through the Landscape Project, patch sizes of contiguous habitat of various types are calculated and can be easily accessed using GIS.

It is critical to consider all three of these factors (presence of rare plants/ecological communities, presence of rare animals, and amount of contiguous habitat) when selecting sites and implementing ED/RR programs. Sites with multiple rare species should be managed to protect all the rare species occurrences at that location. In particular, to ensure success, the rarity of the individual species should be considered throughout the entire process of designing and implementing every ED/RR project.

Figure 3 provides a proposed methodology to convert information from the NHPS and Landscape Project into a site 'Ecological Value Score.' The total 'Ecological Value Score' for a given site is the sum of individual values from: 1) NHPS biodiversity significance rank, 2) Landscape Project habitat patch rank and 3) contiguous habitat size derived from the Landscape Project. It should be noted that this 'Ecological Value Score' can only provide a rough estimate of the biodiversity value at any given site. This is due to a number of factors, including the different systems used by the NHPS and Landscape Project to map and rank biodiversity. Additionally, new information is constantly being collected which may not be reflected in the current NHPS or Landscape Project data sets.

In general, invasive species control work should focus on the portion of any given site with the highest ecological value. Projects should be designed to preserve all the rare biodiversity at a given location, with the highest priority of ensuring the survival of the rarest species and the best habitat. This and other potential methodologies should be explored in order to evaluate the ecological value of sites for the application of ED/RR techniques.

Evaluating Infestation Values

'Infestation Value Scores' are based upon the percent of ground covered by invasive species. Thresholds are based upon personal experiences of the author toward controlling invasive species and the level of effort required to clear heavy infestations.

A guide to determining the feasibility of control is depicted in Figure 2. These guidelines should be considered when selecting from multiple sites with similar ecological values. Feasibility of control varies by goals established to protect conservation targets, the invasive species present, and accessibility to infested areas. For example, feasibility is high when the goal is to protect a population of rare plants located within a relatively small area, the invasive species can be controlled with a single application of herbicide, and/or the area of interest is located within a short walking distance from a parking area. A more complex example could involve a conservation target covering thousands of acres (e.g., large contiguous forest tracts), an invasive species that requires multiple applications of an herbicide, and/or a remote area of interest that requires a significant amount of hiking to reach infested patches. Both of these areas should receive stewardship, but time and resource requirements would vary widely.

Initially, the NJISC recommends six sites with high ecological value and low infestation levels (i.e., less than 10% invasive species cover) as sites to begin preventive ED/RR. These sites could be used as part of an outreach program to allow stakeholders to understand what we are trying to protect from invasive species. The sites should be a representative sample of habitats within New Jersey. One site should be selected from each of the five geographic areas in the state - i.e., Ridge and Valley, Highlands, Piedmont and Coastal Plain (one Inner Coastal Plain and one Outer Coastal Plain (Pine Barrens) site). An additional site should be selected from a coastal environment. Site selection should be followed by the creation of comprehensive management plans that focus on protecting the health of biodiversity.

Section 3.D.5: An ED/RR Program for New Jersey

The NJDA has addressed several threats very well, but it does not have the capability to respond to the numerous invasive species associated with natural systems. There is a strong need for improved ED/RR in New Jersey. Training a core of volunteer 'Weed Watchers,' establishment of partnerships with a wide variety of natural resource professionals and taxonomists, implementation of public awareness campaigns, maintenance of a database and ability to assess, eradicate or contain new or expanding infestations cannot be accomplished in New Jersey without the dedication of stable and consistent funding and additional staff positions.

A conceptual design for an ED/RR program in New Jersey is presented in Figure 4. The base of this design consists of a proposed Office of Invasive Species with assistance provided by the NJISC. The NJISC would coordinate with RCE, NJDA and NJDEP - Division of Watershed Management (DWM), Flora of New Jersey Project and the Native Plant Society of New Jersey to share various responsibilities associated with the ED/RR Program. Specific responsibilities would include public awareness campaigns, design and maintenance of a database, assessment of new introductions and continued spread of currently widespread invasive species into pristine areas, and rapid response to treat invasive species. Rapid response would be the primary responsibility of the NJ-Invasive Species Strike Team (NJ-ISST) that would have expertise in the use of all available control techniques. Additional rapid response support would be provided by volunteers from RCE and DWM. Training and method development for all ED/RR functions would be provided through the Office of Invasive Species and would be linked to a strong regional program (see Text Box 8 for a New Jersey pilot program and Text Box 9 for an example of a strong regional program).

RCE is well positioned to assist with the implementation of an ED/RR program by supplying professional staff including diagnostic services, trained volunteers and recognized points-of-contact with offices located throughout the state. RCE's Master Gardener and Environmental Steward graduates could provide valuable services, such as surveying for new species or training others to become part of an early detection network. In 2005, nearly 300 Master Gardeners were trained as First Detectors™, which is part of the National Plant Diagnostic Network (NPDN) designed to provide early detection of introduced pests and pathogens in agricultural systems. First Detectors™, along with land grant university faculty and extension staff, are trained to efficiently communicate information, images and methods of detection throughout the NPDN system. In addition, RCE has an established network of local offices, existing public recognition and staff with taxonomic expertise. Extension offices are located in every county and also include nine Agricultural Experiment Station Research and Extension Offices. These offices historically serve as a point of contact for members of the agricultural community and the general public who seek identification and information on insects, weeds and pathogens. RCE responds to thousands of requests through extension office visits and internet requests, mass media and structured training courses. The focus of RCE has traditionally been agricultural, but additional resources could expand this well-established entity to cover the full range of invasive species occurring in natural systems.

Text Box 8. NJ Action! - Central Jersey Invasive Species Strike Team

The Central Jersey Invasive Species Strike Team (CJISST) was created in 2008 as a partnership between the Friends of Hopewell Valley Open Space and the Upper Raritan Watershed Association. CJISST represents New Jersey's first public-private cooperative effort to reduce the spread of invasive species by detecting and eradicating newly emerging populations of invasive species. There are currently 23 partner organizations including state agencies, county park systems, land trusts, Master Gardeners, municipalities and private citizens. Searching performed in 2008 has begun to reveal the extent of newly emerging invasive species. For example, species such as Siebold's viburnum have been found to have a limited distribution consisting of small groups of plants, and eradication over large areas is quite possible. Other species such as Oriental photinia were found to have several very large populations and a coordinated response from all CJISST partners is being planned to reduce the risk of spread into new areas. This effort can provide a model for cooperative invasive species management in New Jersey.

The Division of Watershed Management (DWM) administers the Watershed Watch Network. This program has well-established protocols to monitor water quality through a network of volunteers (over 10,000 volunteers have been trained since its inception). The program has four levels of involvement requiring successively more rigor so that a wide variety of volunteers can participate. The administration of their program is a model for the use of volunteers to collect biological data. The program has the potential and desire to be expanded to include surveys for invasive species. This potential arises from the experience and knowledge of existing staff that can provide training to its established network of volunteers. Volunteers could also be trained to map areas that are free of invasive species that could be targeted for site-led control efforts if new infestations of widespread invasive species are detected. The outreach potential, along with ED/RR functions, is enormous due to the number of volunteers in the program. Currently, the Watershed Watch Network covers portions of nearly all watersheds in the state with over 1,000 active volunteers monitoring streams, lakes and coastal areas. Riparian areas are known to be prone to invasive species infestations because of the extent of disturbance they receive through flooding, which makes monitoring riparian areas a priority.

The Flora of New Jersey Project (FNJP, http://njflora.rutgers.edu/index.html) was started in 2004 by field botanists including professional consultants/botanists and university research professors. Their goal is to generate a comprehensive and updated description and distribution for all plant taxa in New Jersey. The group consists of expert botanical volunteers that search herbarium records and perform field inventories. Their final products will be an atlas, manual and a website which will be made freely available. This group consists of New Jersey's most talented and dedicated botanists. Their taxonomic expertise would be critical in the detection and identification of emerging threats.

Text Box 9. A Model for New Jersey: The Invasive Plant Atlas of New England

Dr. Les Mehrhoff and others have spearheaded an unprecedented regional campaign to map and control invasive and potentially invasive plant species. The program, known as the Invasive Plant Atlas of New England (IPANE), involves a dedicated network of professionals and volunteers coordinated by a 10-person Project Team (4 paid staff) and a 13-person Advisory Committee. The goals of the project are to facilitate education and research to better understand plant invasions and to detect and treat emerging threats. Volunteers are trained to identify, map and report invasive species occurrences through formalized training sessions. In addition, volunteers also participate in management workdays to eradicate newly emerging species. The innovative project has been primarily funded through grants from the USDA, but contributions have been received from the Massachusetts Nursery and Landscape Association, Mad Gardeners of Connecticut, The Horticultural Research Institute and private donors.

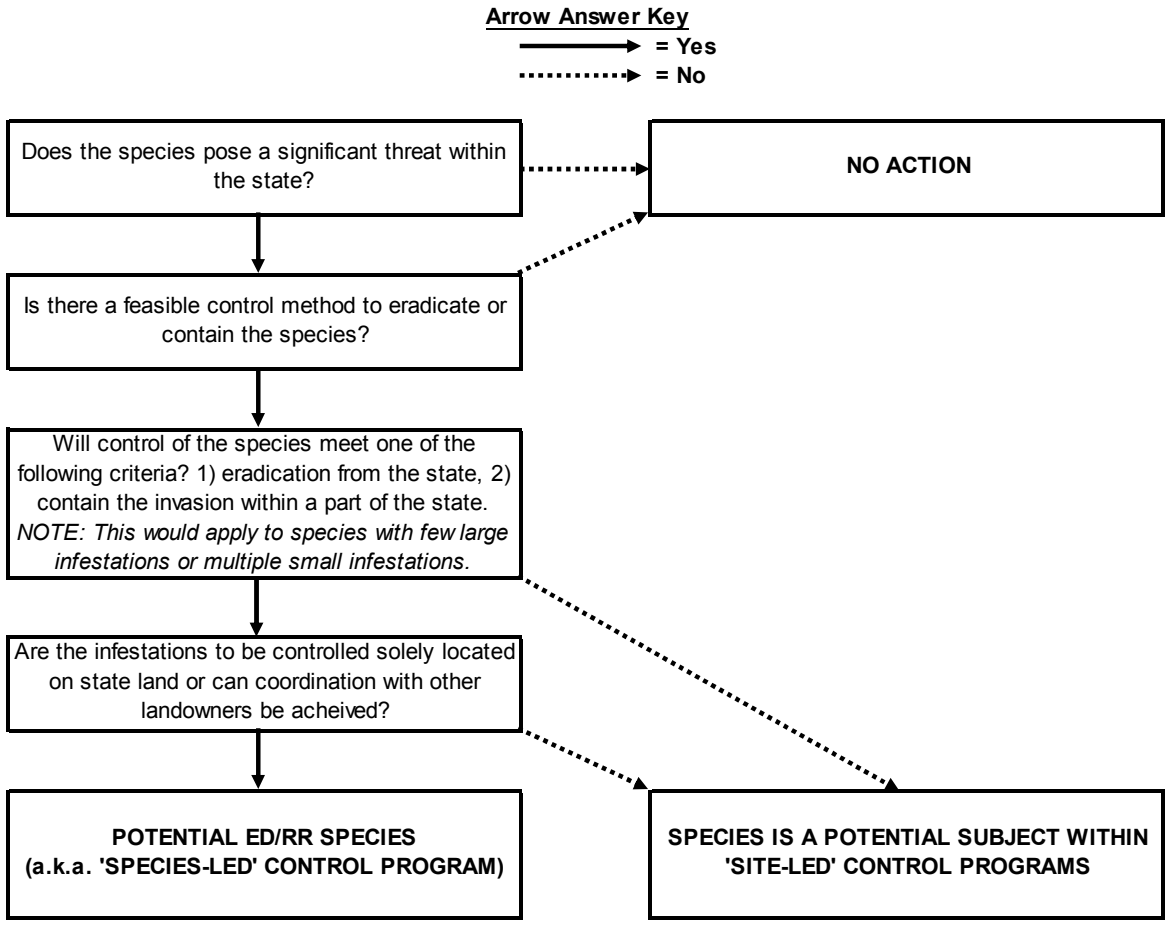
The IPANE project produces tangible products that are easily accessed through the internet (their website is http://nbii-nin.ciesin.columbia.edu/ipane/index.htm). Products include detailed species descriptions and distribution maps. Species descriptions provide taxonomy, multiple photographs to facilitate identification, horticultural properties, threats posed to natural systems, links to other websites and literature citations. Importantly, each species description lists documentation needs that can be provided by web users. Maps for each species can be viewed at various scales from the regional to municipal level. Most importantly, data collected through IPANE has been used to detect emerging problems, which has been followed by eradication treatments.

The IPANE program provides a model system to understand and react to invasive plant species. Currently, IPANE includes Connecticut, Rhode Island, New Hampshire, Vermont and Maine. The NJISC should coordinate with the IPANE program to allow expansion into New Jersey. This expansion would quickly allow New Jersey to initiate a program, while supporting a broader regional effort that would benefit all stakeholders. The Center for International Earth Science Information Network (CIESIN) at Columbia University has initiated an effort to expand IPANE into New York and New Jersey through a pilot program involving mile-a-minute. It is hoped that expansion of IPANE, with the support of state governments, will attract additional federal funds to strengthen invasive species detection and control.

The Native Plant Society of New Jersey (NPSNJ) is a statewide non-profit organization that fosters appreciation, protection and study of our native flora. NPSNJ has 450 members and provides educational tours, advice on home gardening and professional speakers for events. The Society has recently expanded to create three regional chapters in northern, central and southern New Jersey. Officers and members have great expertise in plant identification that can be harnessed within an ED/RR program. In addition, NPSNJ could provide professional advice to home gardeners on the use of native species and provide outreach on invasive species issues.

In addition to trained volunteers through RCE, DWM, FNJP and NPSNJ, an effective ED/RR program would capitalize on thousands of hours spent in the field by a variety of natural resource professionals and outdoor enthusiasts. The building of an expansive base of loyal 'Weed Watchers' is contingent upon effective response to identified invasive species threats. Volunteers will quickly abandon the system if they feel their efforts are in vain.

Figure 1.
Selecting Species for an ED/RR Program
Source: Adapted from Timmins and Owen (2001)



The NJISC recommends the creation of a comprehensive ED/RR program utilizing the concepts and strategies discussed in this section of the plan. The conceptual design for this program is depicted in Figure 4.

Figure 2.
Feasibility of Control Considerations for ED/RR Species
Source: Timmins and Owen (2001)

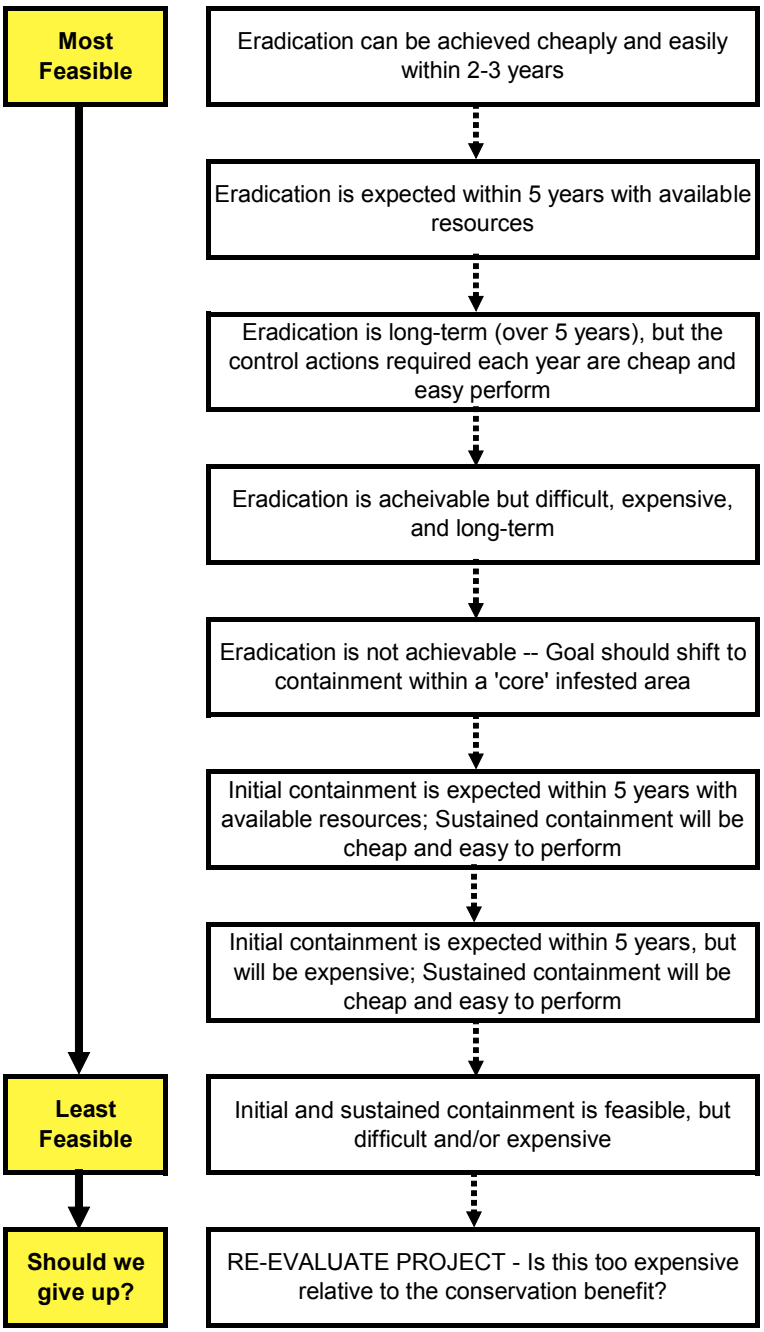


Figure 3.
Priority Matrix for 'Site-Led' Control Efforts

	Biodiversity Score (sum of three ranks - maximum score = 15)					
Infestation Score	*Score > 12*	*Score 9-12*	*Score 6-8*	*Score 3-5*	*Score 1-3*	*Score = 0*
5	Very High	Very High	Very High	High	Moderate	Low
4	Very High	Very High	High	High	Moderate	Low
3	Very High	High	High	Moderate	Low	Low
2	High	High	Moderate	Moderate	Low	Low
1	Moderate	Moderate	Low	Low	Low	Low
0	Low	Low	Low	Low	Low	Low

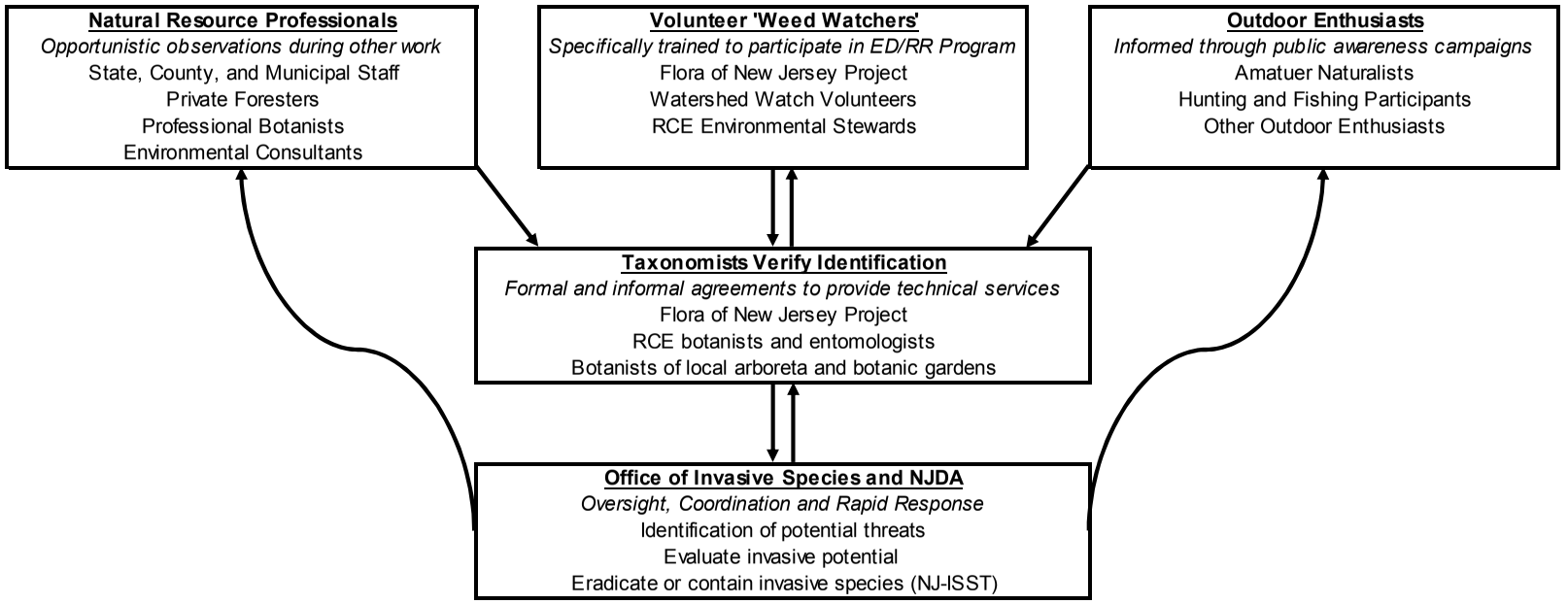
Biodiversity Value

Metric Value	Metric Rank
NJ Natural Heritage Program	
B1	5
B2	4
B3	3
B4	2
B5	1
NONE	0
ENSP Landscape Project	
Rank 5	5
Rank 4	4
Rank 3	3
Rank 2	2
Rank 1	1
NONE	0
Contiguous Habitat	
Rank 1 (> 10,000 acres)	5
Rank 2 (5,001-10,000 acres)	4
Rank 3 (2,501-5,000 acres)	3
Rank 4 (1,001-2,500 acres)	2
Rank 5 (100-1,000 acres)	1
Rank 0 (< 100 acres)	0

Infestation Value

Invasive Species Cover	Infestation Score
< 5%	5
5-10%	4
11-25%	3
26-50%	2
51-75%	1
>75%	0

Figure 4.
Conceptual Design of an ED/RR Program in New Jersey



Section 3.E: NJISC Recommendations for Prevention
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
8	Tier 2	3.B: Prevention Strategies for Unintentional Species Introductions	Prepare a recommendation to ensure that Federal inspection efforts are commensurate with the risks posed to NJ	The recommendation should seek two new federal positions at the Linden facility to provide increased inspection capacity.	NJISC, OIS, NJDA	Recommendations delivered and implemented
9	Tier 2	3.B: Prevention Strategies for Unintentional Species Introductions	Minimize the spread of invasive species through recreational activities	Install boot cleaning stations at trailheads; Install interpretive signage at trailheads and boat launches	NJISC, OIS, NJDEP	50 boot cleaning stations with informational brochure installed; 50 signs located at popular boat launches
10	Tier 2	3.B: Prevention Strategies for Unintentional Species Introductions	Minimize the spread of invasive species through forestry activities	Provide outreach to foresters and request voluntary cleaning of equipment prior to arriving at new job sites to remove mud that potentially contains seeds of invasive species	NJISC, OIS	Brochure created and mailed to all certified foresters
11	Tier 2	3.B: Prevention Strategies for Unintentional Species Introductions	Minimize spread of invasive species in marine systems	Marine system threats are not deeply explored in the plan. Specific goals to determine appropriate prevention strategies should follow communications with the New Jersey Marine Science Consortium (http://www.njmsc.org/) and other relevant stakeholders.	NJISC, OIS	Marine system prevention goals are outlined and implemented
12	Tier 1	3.C: Prevention Strategies for Intentional Species Introductions	Formalize NJ banned plant species list	Use a modified Massachusetts protocol to seek peer-review of the DEP's 2002 Prioritized Listing of New Jersey's Nonindigenous Plant Species to better promote education and outreach efforts and as a basis for potential regulatory programs. Incorporate into this effort the development of a "Clean List" of nonindigenous species that lack invasive qualities and are safe for planting. Formal list will be created through an administrative rule making process and will include all cultivars/varieties of listed species and fines for non-compliance.	NJISC, NJDA	List created through NJISC approved process

Section 3.E: NJISC Recommendations for Prevention
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
13	Tier 1	3.C: Prevention Strategies for Intentional Species Introductions	Enforce ban on the production and sale of demonstrably invasive or potentially invasive listed plant species through inspections of propagators and retailers	Use current nursery inspection and certification program to enforce banned species list with fines for violators. Revenue generated from violations to be distributed to the NJISC to fund control programs. Program provides licenses to 990 certified nurseries and 1,510 certified plant dealers. A time frame of three years is recommended to allow growers to avoid undue financial impacts that would be caused by prohibiting the production of popular species. In addition, all cultivars/varieties/selections/sub-species of listed species will be assigned the same status assigned to the 'straight species' unless they are proven to be completely sterile through published scientific research. An extended phase-out period of five years is proposed for commercially valuable cultivars of Japanese barberry to allow significant time to develop alternatives or for the horticultural industry to deliver sterile cultivars. An annual report will be prepared that summarizes findings of the inspections (including species and quantities produced).	NJDA	Compliance rate of 95%.
14	Tier 1	3.C: Prevention Strategies for Intentional Species Introductions	Eliminate use of invasive species on state lands	Enforce Policy Directive 2004-04 prohibiting the intentional introduction of specified invasive species into DEP lands and waters, and require planting of native or "Clean Listed" non-native species only on all State-owned lands.	NJISC, OIS, NJDEP, NJDA, NJDOT	Policy Directive revised and implemented
15	Tier 1	3.C: Prevention Strategies for Intentional Species Introductions	Educate Federal representatives and request increased federal legislation for prevention measures	Encourage passage of revisions to the Quarantine 37 rules to require pre-screening of plant introductions.	NJISC, OIS, NJDA	US implements requirements to pre-screen plant introductions for invasive potential

Section 3.E: NJISC Recommendations for Prevention
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
16	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Evaluate invasive potential in all non-native plant species used in trade in New Jersey	A comprehensive list would be developed to incorporate all non-native plant species used for agricultural, horticultural, or medicinal purposes to include all species commercially available and capable of growing in NJ. These species require evaluation and categorization as performed for all non-native plant species currently found in our flora. This will require searching NJDA importation records (Quarantine 37 process), nursery growers and dealer plant lists, and mail-order catalogs.	NJISC, OIS	List created and species evaluated through NJISC approved process
17	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Prohibit shipment of invasive species into New Jersey	Deny any shipment of plants or animals considered invasive species through the interstate phytosanitary inspection certification program.	NJISC, OIS, NJDA	Rules adopted and implemented
18	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Re-evaluate all non-native species every 5 years	Coordinate continued listing and evaluation of non-native species to determine threats and control decisions	NJISC, OIS	List created and species evaluated through NJISC approved process
19	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Produce an annual report and database of new plant introductions to NJ through the Quarantine 37 process	Circulate annual report for public review and comment. This is very important to establish a successful ED/RR program.	NJISC, OIS, NJDA	Annual reports produced, Comments received, Database of reports maintained
20	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Create regulation of public gardens regarding the maintenance of invasive species	Create a permitting and licensing program for public gardens that wish to maintain listed invasive species. Requirements would include a licensing fee based upon the number of individual plants of invasive species. Certification under this program would require public gardens to monitor spread from plantings and implement control programs as necessary. Distribution of propagules to any outside entity would be prohibited.	NJISC, OIS, NJDA	Regulation adopted and implemented

Section 3.E: NJISC Recommendations for Prevention
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
21	Tier 1	3.D: Early Detection and Rapid Response	Incorporate invasive species strategies into Community Forestry plans	Require the incorporation of invasive species issues and ED/RR principles into the development and update of municipal Community Forestry plans.	NJISC, NJDEP	All new and updated plans address invasive species
22	Tier 2	3.D: Early Detection and Rapid Response	Prioritize non-native species identified as having the potential to become invasive species in New Jersey	Develop a process to rank potentially invasive species of greatest concern to New Jersey's biodiversity, natural resources, and agricultural resources for ED/RR efforts. This would require coordination with neighboring states and regional entities to determine invasive species threats to NJ.	NJISC, OIS	Prioritized list of species created
23	Tier 2	3.D: Early Detection and Rapid Response	Prioritize areas within the state to conduct searches for newly establishing invasive species	Prioritize and select areas for ED/RR that should be searched based upon sites with high probabilities of occurrence (e.g., ports, warehouses) and pristine areas where new invasions would be most detrimental. Pristine areas with high biodiversity value should be selected by utilizing a site prioritization system, such as that outlined in this plan.	NJISC, OIS, NJDA, NJDEP	Prioritized list of sites created
24	Tier 2	3.D: Early Detection and Rapid Response	Begin a site-led ED/RR program by focusing on six pristine sites throughout the state	Begin site-led ED/RR by initially selecting six sites and create comprehensive management plans that focus on protecting the health of biodiversity elements threatened by invasive species. One site should be selected from each of the geographic areas in the state - i.e., Ridge and Valley, Highlands, Piedmont, Inner Coastal Plain, Outer Coastal Plain (Pine Barrens) and coastal dune system. These areas would serve as a site-based ED/RR for all known and potential invasive species and could be highlighted on the website as 'what it should look like.' This effort would also have great research value by increasing our understanding of site susceptibility to infestations.	NJISC, OIS, NJDEP	Sites selected, plans created and treatments performed

Section 3.E: NJISC Recommendations for Prevention
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
25	Tier 2	3.D: Early Detection and Rapid Response	Create a comprehensive ED/RR program	Early detection and taxonomic verification of species through RCE, Watershed Watch Program, and volunteers; response and record keeping through NJISC and NJDA. Integrated state database maintained by NJISC. Develop training program for volunteers (e.g., IPANE). Ensure that ED/RR program has access to expertise in taxonomy, ecology, and risk assessment through the NJISC. Eliminate fee for species ID to a free program through RCE; Enlist support from the Flora of New Jersey Project and the New Jersey Native Plant Society. Advertise new program through website to recruit volunteers. Create a large base of 'coincidental' Weed Watchers through outreach to consulting foresters, CTE, DEP land managers, wetland delineators, land use managers, arborists, environmental consultants, etc. Simple forms provided to professionals would include a list of species and gross estimate of infestation severity. Request that they fill out whenever possible during their normal business activities. This also supports the assessment of non-native plant distribution in NJ.	NJISC, OIS, NJDA, NJDEP, RCE	Comprehensive program established
26	Tier 2	3.G: Site-based Control Efforts	Begin species-led ED/RR program by focusing on five invasive species that have limited distribution in New Jersey	The goal for these species would be eradication. Initial invasive species should include feral hog, Asian longhorned beetle, Chinese silver grass, water chestnut and giant hogweed.	NJISC, OIS, NJDA, NJDEP	Five invasive species eradicated from NJ

SECTION 4: CONTROL AND RESTORATION

Section 4.A: Introduction

Stewardship may be considered the mitigation of disproportionate human impacts on natural systems. It is employed only when natural processes that maintain ecosystems are severely and/or perpetually impacted by human activities. [Humans are of course part of natural systems, but our impacts/demands are disproportionate to other biota on the planet.] The management of invasive species is a form of stewardship utilizing five basic control methods: mechanical, chemical, biological, ecological and cultural (see Section 4.D). In particular situations, restoration through physical habitat manipulations or planting of native species is required following treatment of invasive species. Readers should refer to Appendix 14 for a sample of web sources for control and restoration techniques.

In a more perfect world, we would be able to undo all of the damage we have created through the spread of invasive species. However, even if this were possible, it would potentially divert a tremendous amount of resources that are currently needed to protect our remaining lands from the primary threat of permanent loss through development. This dilemma warrants a triage approach consisting of a suite of strategies that should be implemented as soon as possible across the state. The guiding principal of this work should not be removal of invasive species, but management for defined conservation targets or agricultural commodities. In other words, land managers should manage FOR something they value, not AGAINST invasive species. The extent and intensity of control measures should be dependent on and proportionate to the threats posed to the highest priority conservation or agricultural targets.

It is strongly recommended that a written plan guide management for conservation targets. Stopping momentarily to create a management plan requires temperance, but represents a logical and ultimately cost-effective mechanism to reasonably address threats posed to conservation targets. A plan need not be a lengthy treatise but should minimally include: 1) identification and mapping of conservation targets; 2) identification and mapping of threats to conservation targets (including threats other than invasive species); 3) listing of methods and techniques to mitigate threats to conservation targets (delineated by threats and sub-areas within an entire area of interest); and 4) simple methods to monitor effectiveness of threat mitigation to provide for adaptive management over time. The NJISC recommends that the proposed Office of Invasive Species strongly encourage and support development of management plans by land managers prior to conducting invasive species control efforts.

Controlling existing infestations of invasive species in New Jersey will be very difficult due to the number of invasive species and the extent of current infestations. Our state has nearly 1,000 non-native plant species (See Appendix 2). In New Jersey, the total number of species, subspecies, varieties and hybrids of plants is approximately 3,500 (Snyder and Kaufman 2004); therefore non-native species represent nearly 30% of the total flora of the state. Fortunately, the great majority of non-native plants occurring in New Jersey are not considered invasive (see Appendix 2). However, the extent of infestation by these invasive species, while unmeasured, is likely to be hundreds of thousands of acres based upon the observations of scientists and natural

resource managers. A strategic vision will be required to efficiently and realistically address control efforts.

Section 4.B: Native and Non-native Animals

Section 4.B.1: White-tailed Deer

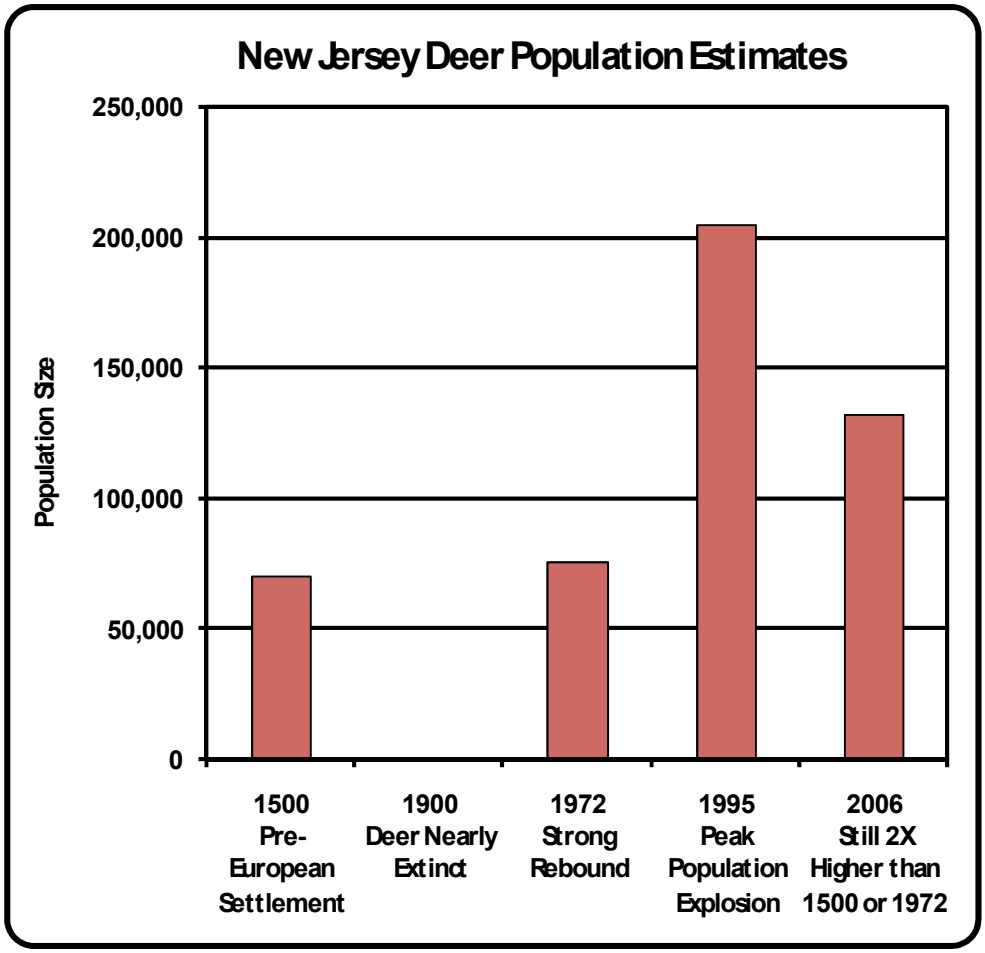
The control of invasive species and restoration of native plant communities will not be successful without addressing the impacts of white-tailed deer (See below and Sections 4.C and 4.D). The deer population has fluctuated widely since pre-European settlement (Figure 5). The estimated number of deer in 1500 is based upon the average deer density across North America (9.5 per square mile) reported by McCabe and McCabe (1984) and the New Jersey land area reported by the US Census Bureau (7,417 square miles). By 1900, deer were nearly eliminated in New Jersey due to unregulated hunting spurred by the market value of venison. Conservation efforts aimed at restoring the deer population through the first half of the 20th century were successful and the estimated deer population in 1972 was similar to pre-European settlement. Using population estimates from Figure 5, overall deer densities in particular years are: 1500 – 9.5, 1972 – 10.1; 1995 – 27.6 and 2006 – 17.8. It should be noted that current deer densities are significantly greater than pre-European densities because a considerable amount of land area in New Jersey is developed and cannot serve as deer habitat. In absolute numbers, the New Jersey deer population peaked in 1995 with 2.9X more individuals than pre-European estimates. Innovations in hunting regulations (e.g., liberalization of doe harvests) have reduced the population in recent years. The result of changes implemented in the late 1990s was an overall increase in the total deer harvest (as a percentage of the entire deer population) and an increase in the percentage of the harvest composed of antlerless deer. However, the 2006 population estimate was still 1.9X higher than before European settlement. The population growth during the later part of the 20th century may have been caused by multiple factors including the production of habitats ideally suited to deer (e.g., forest edges, suburban landscapes and agricultural fields) and reduced hunting opportunities primarily caused by suburban development and hunting restrictions on both private and public lands.

Deer produce severe impacts on natural systems and agricultural commodities that are most pronounced in areas where hunting is prohibited, but severe negative impacts may also be observed in areas where hunting pressure is insufficient. It should be noted that the deer population size or density is less significant than their overall impacts on ecosystem health or agricultural viability, which can be directly measured to inform deer management harvest goals.

The food preferences of white-tailed deer may foster the spread of unpalatable invasive species by eliminating more palatable native plants. The differential impacts of deer on native and invasive plants has been documented in New Jersey (Eschtruth and Battles 2008) and more widely recognized in the eastern United States (Rawinski 2008). Other scientific literature describing impacts specific to New Jersey include Schweitzer (2002) and Ruhren and Handel (2003). Additional anecdotal evidence of this phenomenon can be observed through differences in vegetation inside and outside of deer exclosures located throughout the state (although invasive species may grow within exclosures, many native plants do not successfully grow outside of exclosures where deer populations are high). In general, New Jersey's natural resource managers commonly perceive a causative link between deer population size and

invasive plant species (see Text Boxes 5, 6, 7, 10, 12 and 13). Ecological observations over 30 years at Morristown National Historic Park, where hunting is prohibited, provide strong anecdotal evidence of the link between deer overabundance and invasive species (see Text Box 10). With only a few exceptions (e.g., multiflora rose and winged burning bush that receive low to moderate deer browse), the majority of invasive species appear to be very resistant to deer browse (e.g., Japanese barberry, shrub honeysuckles, garlic mustard and Japanese stiltgrass).

Figure 5. Deer Population Size Estimates from 1500 - 2006
(Sources: McCabe and McCabe 1984 , NJDEP 1990, 1999, C. Kandoth, personal communication)



Conversely, many native plants (e.g., maple-leaved viburnum, spicebush, witch-hazel, most herbs and most tree seedlings) growing alongside these invasive species are often severely browsed. This very significant difference in the food preferences of deer can be widely observed throughout the state. In addition, restoration following invasive species control efforts, either through natural recruitment or direct planting by humans, can be severely limited by white-tailed deer (Kuser and Zimmerman 1995, Mylecraine and Zimmermann 2000, Zimmerman and Mylecraine 2005, Pinelands Forestry Advisory Committee 2006).

Extensive reviews and original scientific literature document the impacts of white-tailed deer on natural systems (Alverson et al. 1988, Anderson 1994, Augustine and Frelich 1998, deCalesta 1994, McShea and Rappole 2000, McShea et al. 1997, Miller et al. 1992, Rooney and Dress 1997, Rooney et al. 2004, Stromayer and Warren 1997, Vega Rivera et al. 1998). Sources of information on the biology and behavior of deer include Jones et al. (1997), Matthews (1989), Miller and Ozoga (1997), NJDEP (2002b) and White and Bartmann (1997). Sources of information on management of white-tailed deer include deCalesta and Stout (1997), Maryland Department of Natural Resources (1998), McCabe and McCabe (1984), McCullough (1984), McNulty et al. (1997), NJDEP (2000, 2004, 2007b), Quality Deer Management Association (2004), and Warren (1997). An important historical perspective on hunting issues in New Jersey can be found in Tillett (1963), which explored the case study of a proposed management technique to reduce deer population size in the state.

Importantly, deer cause significant financial harm to New Jersey's agricultural industry. Drake et al. (2002) report nursery stock losses of nearly $8,000/acre/year due to deer browse. The same report estimates annual agricultural losses at $5-$10 million/year. Impacts include loss of planted crops, switching from profitable crops to crops that are less palatable to deer, and complete abandonment of tillable land that is highly susceptible to deer browse.

To facilitate the reduction of invasive species through ecological control (See Section 4.C and 4.D below), the NJISC strongly recommends that the state continue and expand its comprehensive program to manage the white-tailed deer population. Currently, the Division of Fish & Wildlife's existing Deer Research Project includes strategies to reduce deer densities in 64 percent of the state under the Division's existing legislative authorities. However, more extensive efforts by the entire conservation community, including both public and private entities, will be required to fully mitigate the impacts of overabundant deer. Expanded goals should include: 1) improvement of hunting access on both public and private lands with limited or no hunting opportunities; and 2) utilization of ecosystem health evaluation protocols when setting annual harvest goals. For forest communities in New Jersey, M. Van Clef (personal communication) has developed science-based evaluation protocols that are simple and inexpensive and are being utilized by sixteen different entities including the U.S. Fish & Wildlife Service, counties, municipalities, private conservation groups and individual private citizens. These and other protocols (Latham et al. 2005, Diefenbach and Fritsky 2007, C. Kandoth, personal communication) should be assessed for scientific and practical merits and be considered for guiding future statewide efforts.

An important limiting factor for hunters is that they may not take as many deer as regulations allow because they have few outlets for venison beyond their immediate consumption and storage capacity. The Hunters Helping the Hungry program facilitates the donation of harvested deer through regional food banks that distribute venison to those in need (http://www.huntershelpingthehungry.org/). However, this program is currently geographically limited and annual private funding is variable, which reduces its potential effectiveness toward reducing the deer population and serving an important human need. The NJISC recommends state re-appropriation of the Hunters Helping the Hungry (HHH) program, which enables hunters to donate venison to regional food banks throughout NJ, with a suggested restart amount of $250,000, to enhance incentives for increased deer hunting in New Jersey.

Text Box 10. NJ Action! - Federal Lands: Morristown National Historical Park

Robert Masson manages Morristown National Historical Park. This site has great importance in the history of our Country and also faces many severe ecological challenges. The park has numerous invasive species including Japanese barberry, Japanese stiltgrass, garlic mustard, tree-of-heaven, black locust, garlic mustard, winged burning bush, multiflora rose, Japanese honeysuckle, and Asiatic bittersweet. It is also home to newly emerging species such as Siebold's viburnum (*Viburnum sieboldii*), black swallowwort (*Cynanchum louiseae*), Oriental photinia (*Photinia villosa*), and kiwi vine (*Actinidia arguta*) that have limited distributions elsewhere in New Jersey.

Bob has written an invasive species management plan that incorporates both historic and natural resource management goals. The park also has a very detailed resource and management report that involved current surveys and reviews of ecological investigations (dating back 30 years) performed by Dr. Joan Ehrenfeld and Dr. Emily Russell. This information has been valuable in tracking the dramatic changes that have occurred in the park. For example, Japanese barberry distribution had increased from isolated patches to a large infestation within 20 years (1977 and 1995). Similarly, Japanese stiltgrass infestations are severe, although the species was only first observed in 1989. Coincidentally, the deer population at the park rose dramatically during the same time period. In 1977, the park had no visible browse line and native tree and shrub seedlings were abundant. By 1988, deer population density was 170 per square mile and individuals were dying from starvation. Currently, the population is 60 per square mile, which far exceeds the ability of the forest to support a healthy native understory. This information is very significant because it documents trends that are likely to be occurring throughout the state on properties where no deer hunting is permitted. It is important to note that hunting is not allowed at the park and that the severity of ecological degradation is a direct result of this policy.

The park has initiated a prioritized control effort by focusing on the newly emerging Siebold's viburnum. Invasive vine species are also targeted because of the compounding impacts they have on forest health. Other efforts are underway to keep more widespread invasive species from continuing to spread into more pristine areas of the park. Control work is being performed by an NPS-EPMT (see Section 4). The EPMT utilized the plans, which identified the distributions of species and the management priorities of the park. In addition, the park is a continuing site of research on the impacts of invasive species and deer overabundance by Dr. Joan Ehrenfeld and her students. The site has a series of small deer exclosures and two large exclosures that have received invasive species treatments and plantings of native species.

Section 4.B.2: Resident Canada Geese

Historically, Canada geese had resident populations along each of their four major migratory flyways (one of which passes through New Jersey) (Coluccy 2007). The species was nearly extirpated by the early 20th Century due to unregulated hunting and egg collecting. The efforts of wildlife managers and scientists to increase the dwindling population have been very successful. However, current resident Canada geese originated from privately maintained captive flocks used for live decoys and food (Coluccy 2007).

Natural or agricultural resource problems are associated with resident populations that do not migrate to Arctic breeding grounds. The North American population of resident geese has increased by a factor of eight over the last 20 years (Clark 2003). Resident geese have become problematic by fouling parks and lakes. They are also very problematic for riparian restoration efforts. Although definitive data are lacking, Canada geese have been implicated in the spread of diseases such as avian pox, Campylobacter, *E. coli*, exotic Newcastle disease, foot and mouth disease and particular strains of avian influenza. Populations are partially sustained through the creation of detention basins lined with mowed grass and other human-related landscape features (Coluccy 2007). Efforts to remove geese from selected areas have been effective, but a statewide effort would be required to resolve this problem. The NJISC recommends that the

NJDEP-DFW continue to take advantage of liberal hunting opportunities and depredation orders allowed under U.S. Fish and Wildlife Service (USFWS) regulations.

Section 4.B.3: Snow Geese

Snow goose populations have also risen dramatically in recent decades. This native species winters in New Jersey and nests in Canada. These geese have converted vegetated marshes to mud flats through feeding habits that include uprooting grasses. Although hunting 'bag limits' are generous, the snow goose population remains very high. The NJISC recommends that the NJDEP-DFW continue to take advantage of liberal hunting opportunities and adopt any additional means of take that are being considered by the USFWS.

Section 4.B.4: Non-native Feral and Domestic Cats

Feral and domestic cats have been estimated to kill nearly 500 million wild birds per year (Pimentel et al. 2005). The New Jersey Audubon Society in partnership with the American Bird Conservancy is sponsoring the "Cats Indoors!" campaign, which can be accessed at http://www.njaudubon.org/Conservation/CatsIndoors/. The program encourages cat owners to support the health of wildlife and their pets by not allowing them to freely roam outdoors. The NJISC recommends that outreach programs such as "Cats Indoors!" become part of overall efforts to communicate the invasive species problem.

Section 4.B.5: Mute Swans

Mute swans are native to Eurasia and were introduced to North America in the late 1800s as a decorative waterfowl for parks, zoos, and private estates. By the early 1900s, small numbers of birds had escaped into the wild, began nesting, and soon established feral populations. In New Jersey, the population has been monitored since 1986 through a mid-summer survey conducted every three years. During the past 20 years, the average annual growth rate was 6.7% per year. 1,253 mute swans were counted in New Jersey in 2008.

Tatu et al. (2007) found that mute swans reduced submerged aquatic vegetation (SAV) about 75% in Chesapeake Bay, Maryland. In Rhode Island, herbivory by mute swans reduced SAV biomass by 95% in coastal ponds (Allin and Husband 2003). Although no specific studies have been conducted in New Jersey, general observations suggest that mute swans cause considerable damage to SAV in many coastal impoundments. SAV are particularly damaged in those impoundments managed for migratory and wintering waterfowl both on the Atlantic and Delaware Bay coasts. In addition, due to their aggressive behavior, mute swans can compete with native wildlife for critical habitats (Therres and Brinker 2004). Due to their strong territorial defense, some pairs will vigorously defend nest and brood sites from intrusion by other wildlife and have attacked humans, causing serious harm.

In 2005, federal rulemaking removed protection of mute swans under the Migratory Bird Treaty Act and put authority for management of mute swans with the states. The NJISC recommends that the NJDEP-DFW meet the population objectives of the Atlantic Flyway Mute Swan Management Plan. This plan calls for a population of no more than 500 mute swans in New Jersey by 2013. The mute swan population should be reduced with techniques that are humane and efficient. Using stochastic modeling, Ellis and Elphick (2007) found that a period of intensive culling of adults would be the most efficient option in terms of biological effectiveness,

economic costs and minimizing the total number of swans that ultimately had to be culled. To further facilitate population reduction and stabilization, the NJISC recommends that legislative changes should be considered to include mute swans as game birds in New Jersey. This change would allow the mute swan to be efficiently controlled through hunting seasons.

Section 4.C: Susceptibility to Infestations by Invasive Plant Species

The author conducted rapid assessments of selected parks, wildlife management areas and preserves as part of preparing this plan (Table 6, supplemented by E. DeVito, personal communication). Several important trends emerged from this assessment, past experience and shared observations of multiple researchers, naturalists, natural resource managers, and land stewards. It is important to note that the observations in this section are not supported by scientific experimentation, but are presented as an effort to understand postulated infestation susceptibility factors. Figure 6 was developed by the author to graphically illustrate the key postulated elements.

New Jersey contains portions of five broad geological areas (a.k.a. physiographic provinces). These areas include the Ridge and Valley, Highlands, Piedmont, Inner Coastal Plain and Outer Coastal Plain. The coastal plain is characterized by relatively sandy soils that have lower ability to hold water and nutrients than the soils found in the three physiographic provinces located in northern New Jersey. The Pine Barrens, located within the outer coastal plain, is distinguishable from the remainder of coastal plain areas by having very sandy and nutrient poor soils.

The Pine Barrens is the least susceptible to invasion and represents the largest portion of the state (about 1 million acres) containing areas largely free of invasive plant species. This very unique habitat is dominated by a small number of native species (e.g., pitch pine, scrub oak, post oak, blackjack oak, huckleberry, etc.), but also contains a wide variety of unique species specially adapted to the Pine Barrens. Invasive species, in general, are confined to highly disturbed areas such as roadsides and edges of cranberry bogs or developed areas. The two species of greatest concern are Chinese bush clover and Phragmites. Chinese bush clover primarily occupies roadsides that contain numerous flowering herbs (including many rare species). Phragmites establishes in disturbed areas, but has the potential to spread into more pristine wetlands. Invasive species that commonly infest natural areas in other parts of the state may be present in disturbed areas of the Pine Barrens, but their growth is believed to be severely restricted by the lack of soil moisture and nutrients. Two emerging potential threats in the Pine Barrens include African lovegrass and Chinese silvergrass.

Other locations within the coastal plain that contain areas that are also relatively resistant to invasive plant species include Allaire State Park, Cheesequake State Park and Jamesburg County Park. In some ways, these parks represent ‘mini-Pine Barrens’ or outliers where sandy soils low in moisture and nutrients seem to resist invasion. They are typically oak forests with an understory of blueberry, huckleberry or mountain laurel (coincidentally, these native shrubs are also relatively resistant to deer browse). However, forested wetlands contained within these parks are often infested with Japanese stiltgrass or Japanese knotweed. This syndrome of non-infested upland habitat and severely infested wetland habitat likely occurs in the sandiest locations throughout the inner coastal plain. Although northern New Jersey is very susceptible

to invasive species, isolated areas containing particularly sandy or rocky soils also seem resistant to infestation. Examples of relatively resistant sites occur throughout the dry, rocky soils of the northern Highlands, Kittatinny Ridge and Piedmont (e.g., Wawayanda State Park - Bearfort Mountain, Stokes State Forest - Kittatinny Ridge, High Mountain Park - Watchung Mountains, respectively). Unique areas within the 'valley' of the Ridge and Valley section that contain sandy outwash soils from past glaciations can also be resistant to invasion (e.g., Blair Creek Preserve, which contains a forest type reminiscent of the coastal plain located at Cheesequake State Park).

Coastal dune systems, despite harsh environmental conditions, including sandy soils and salt spray, appear to be susceptible to particular invasive species. Constant natural and human disturbance of dune habitats allows establishment of species such as Asiatic sand sedge, Asiatic bittersweet and rugosa rose.

Although some areas of the state appear to be less susceptible to invasive plant species, it is very important to note that all areas of the state are at risk to invasive plant infestations. The apparently less susceptible areas noted above usually contain small amounts of invasive species. It is also very important to note that the majority of infestations in our state are relatively new (<50 years) and it is possible that any area may become infested with time. The reader should refer the discussion of propagule pressure and lag time in Section 3.A.3.

The large remainder of natural areas located in the Inner Coastal Plain, Piedmont, Highlands, and Ridge and Valley sections are very susceptible to invasive species. Although a comprehensive scientific study has not been performed, sites that appear most susceptible to invasion have a history of agricultural use (especially on formerly plowed land) and/or where the health of native plant communities is compromised by an especially high deer population. For example, forested areas that were never plowed for agricultural fields tend to be more resistant than forests that arose from previously plowed fields (possibly due to destruction of natural soil layers, changes in soil pH, and/or persistent phosphorous loads due to past farming practices). In addition, forests that arose from abandoned farmland greater than 100 years ago tend to be more resistant to infestations than forests that developed in more recent times (possibly due to the ever increasing number of invasive species available to infest young forests in recent times). A relatively unknown complication toward interpreting these patterns is the introduction of European earthworms. (Note: There are no native earthworms in New Jersey due to past glaciations - Edwards 2004). Earthworms have the ability to alter soils (e.g., pH, nutrient availability, soil microbes) in a way that favors 'weeds.' It is likely that earthworms are associated with past agricultural activities and may be a major factor in the establishment of invasive species on former agricultural land.

Table 6. Preliminary Infestation Assessment for Selected Sites

Physiographic Province	*Examples of Sites Containing Minimally Invaded Areas**	*Examples of Sites Containing Severely Infested Areas**	*Some Representative Invasive Species*
Ridge and Valley	Blair Creek Preserve (uplands), High Point State Park, Johnsonburg Swamp Preserve, Mashipacong Bogs Preserve, Stephens State Park, Stokes State Forest, Worthington State Park	Blair Creek Preserve (wetlands), Delaware Water Gap National Recreation Area, Johnsonburg Swamp Preserve, Whittingham Wildlife Management Area	autumn olive, garlic mustard, Japanese barberry, Japanese stiltgrass, multiflora rose, Phragmites, purple loosestrife
Highlands	Lewis Morris County Park (small portions), Mahlon Dickerson Reservation, Morristown National Historic Park (small portions), Pequannock/Newark Watershed, Scherman-Hoffman Sanctuary, Wawayanda State Park	Allamuchy State Park, Lewis Morris County Park (majority), Morristown National Historic Park (majority), Scherman-Hoffman Sanctuary, Silas Condict Park	autumn olive, garlic mustard, Japanese barberry, Japanese stiltgrass, multiflora rose, Phragmites, purple loosestrife
Piedmont	Great Swamp National Wildlife Refuge (portions), Highland Avenue Woods (South Plainfield), High Mountain Park (portions), Pin Oak Forest (Avenel), Soldiers and Sailors State Park (Edison), South Mountain Reservation (portions), Ted Stiles Preserve at Baldpate Mountain (portions)	Great Swamp National Wildlife Refuge (portions), Hackensack Meadowlands, High Mountain Park (portions), Hutcheson Memorial Forest, Kilmer Woods, South Mountain Reservation (portions) Washington Crossing State Park, Ted Stiles Preserve at Baldpate Mountain (portions)	autumn olive, Japanese honeysuckle, Japanese stiltgrass, multiflora rose, purple loosestrife, Phragmites
Inner Coastal Plain	Allaire State Park (uplands), Burden Hill (Salem County), Cheesequake State Park (uplands), Island Beach State Park (portions), Jamesburg County Park	Allaire State Park (wetlands), Assunpink Wildlife Management Area, Cheesequake State Park (wetlands), Harthorne Woods, Island Beach State Park (portions) Little Woods (Moorestown), Rancocas Woods, Thompson Park	Asiatic bittersweet, autumn olive, garlic mustard, Japanese honeysuckle, Japanese stiltgrass, multiflora rose, rugosa rose, Asiatic sand sedge, Phragmites, tree-of-heaven
Outer coastal Plain (Pine Barrens)	Most areas within the core Pine Barrens	Highly disturbed areas (e.g., roadsides, edges of cranberry bogs, etc.)	Chinese bush clover, Phragmites, African lovegrass (emerging), Chinese silvergrass (emerging)

*Portions of the same site may either be minimally invaded or severely infested

Excessive deer browse has the effect of removing competing native vegetation that creates opportunities for unpalatable invasive species to flourish (see Section 4.B.1 and references therein). It should be noted that the link between excessive deer browse and infestation by invasive species is not universal. Some areas within forests that have been completely cleared of native vegetation below the browse line have no invasive species either (examples can be seen at Morristown National Historical Park, Lewis Morris County Park and Scherman-Hoffman Sanctuary). It is unclear why invasive species have not infested these areas, but soil types and/or tree canopy composition may be controlling factors. Additional scientific research would be valuable to determine the links between invasive species, soil type, past land use, earthworms

and deer browse. The recent and continuing work of Dr. Joan Ehrenfeld and her students has begun to explore these complexities in New Jersey (Ehrenfeld 1999, Ehrenfeld 2003, Ehrenfeld 2004, Ehrenfeld et al. 2005, Kourtev et al. 1999, Kourtev et al. 2002a, Kourtev et al. 2002b).

The landscape context of a site may also strongly influence its susceptibility to infestation. The type of land cover surrounding a natural area defines its landscape context. For example, relatively small forests surrounded by agricultural lands tend to be more invaded than large, intact forests that have minimal agricultural cover in the vicinity. This pattern may be related to locally elevated deer densities that are maintained through feeding on agricultural crops. Examples of this phenomenon can be observed throughout the state (e.g., Kittatinny Valley - Warren and Sussex Counties, Piedmont - majority of Hopewell Township). This argument may be supported indirectly by observations at particular urban forests that contain minimal deer, but are essentially islands surrounded by development. Sites such as Highland Avenue Woods (South Plainfield), Pin Oak Forest (Avenel) and Soldiers and Sailors State Park (Edison) are virtually deer free and contain healthy forests with a variety of native species. Invasive species can be observed along roadsides adjacent to these natural areas, but they seem unable to infest the forest interior (E. DeVito, personal communication). Scientific studies involving the role of landscape context should consider historical land use on current forest lands. In the examples provided above, it is possible that past land uses may better explain variations in susceptibility to infestation.

Other susceptibility factors involve human activities including all terrain vehicles, forestry activities, etc. that may act to cause soil disturbances and/or introduce weed seeds. One obvious impact of human disturbances to natural systems includes the introduction of Japanese stiltgrass, which is often first observed along trails. See Sections 3.B.2 and 3.B.3 for additional discussion and NJISC recommendations.

The “crew cut” effect. This native winterberry holly has numerous small shoots that are repeatedly browsed by deer. As taller mature stems die, the entire plant will die if new shoots cannot grow out of the reach of deer. Photograph by Michael Van Clef.

Figure 6. Postulated Relationship Between Native and Non-native Plant Abundance in Relation to Land Use Intensity and Deer Abundance

In addition to deer abundance, the proliferation of invasive species at individual sites is influenced by the intensity of human activity, as well as the resistance provided by intact natural communities

Deer Abundance (Current or recent)	Land Use Intensity (Past and/or current): High	Land Use Intensity (Past and/or current): Low
High	Invasive species: ↑ Native species: ↓	Invasive species: 0* ---> ↑ ** Native species: ↓
Low	Invasive species: ↑ Native species: ↑	Invasive species: ↓ Native species: ↑

*When Land Use Intensity is low, non-native species may be slow to infest sites with high community resistance (but see below).
**Invasive species may infest resistant communities over time if native species have been removed by excessive deer browse.

Important Land Use Intensity Factors	
High	Past soil tillage or past intensive livestock grazing
	Current intense forestry
	Heavy human traffic
Low	No past soil tillage or grazing
	Absent or limited forestry
	Light human traffic

Important Community Reistance Factors	
High	Surrounding landscape context with high natural cover
	Densely shaded communities (e.g., sugar or Norway maple canopy and sub-canopy)
	dry and/or nurtient poor soils
Low	Surrounding landscape context with high agricultural or suburban cover
	floodplains (i.e., high natural disturbance)

Section 4.D: Control Methods and Techniques

The control of invasive species can be classified into five broad methods (Table 7). Control methods may be used alone or in combination depending upon the resource to be protected and budgetary constraints. In the past, many groups performing invasive species control relied entirely on mechanical methods. Although mechanical methods are the most appropriate choice in limited situations, many groups have abandoned this option because progress is exceedingly slow and the re-sprouting ability of many invasive species is very high (see Text Boxes 5, 12 and 13). Chemical control is the most commonly used method. It can be used in concert with mechanical control (e.g., cutting plants and applying herbicide to the stump), but can also be used with great efficiency on its own merits.

Biological control is the most effective treatment technology for the limited number of invasive species where biocontrol agents have been developed (see Text Box 11). Other methods are generally much more expensive and less effective at larger scales, but can be very effective at local scales. Biological control has had notable success stories and notorious failures. The non-native Indian mongoose was released to control non-native rats (European and Asian) in sugarcane plantations in the West Indies. The mongoose was only partially effective (only controlled the Asiatic rat), but proceeded to consume native birds, amphibians and reptiles (about 10 species were driven to extinction). They also preyed upon domesticated poultry. Finally, the mongoose became a vector of infectious diseases (e.g., rabies). The total economic cost of this biocontrol agent approaches $50 million dollars per year (Pimentel et al. 2005). Notable success stories include the control of alligator weed (New Zealand, Australia, US), mist flower (Hawaii), nodding thistle (New Zealand), prickly pear (Australia), ragwort (New Zealand) and St. John's wort (New Zealand, Canada).

Modern biological control involves thorough testing for 'host specificity' (making sure that the newly released biocontrol agent doesn't harm anything but the invasive species being targeted). This does not guarantee unintended consequences, but provides a reasonable reduction of risk and is presumably preferable to leaving the species unchecked. The USFS has recently published volumes that will assist with future development of biocontrol agents for some of North America's worst invasive species (Van Driesche et al. 2002, Zheng et al. 2004, Zheng et al. 2006).

Currently, researchers are working to develop a biocontrol agent for garlic mustard, which is one of New Jersey's most harmful invasive species (Van Driesche et al. 2002 and reprinted at http://www.invasive.org/eastern/biocontrol/29garlicmustard.html). Research to determine natural enemies of garlic mustard began in 1998. Five weevil species and one flea beetle species were selected as potential biological control agents based upon field observations of host specificity and extent of damage to garlic mustard in its native range. Researchers are currently in the process of performing laboratory tests of host specificity that includes related native plant species and agricultural crops in the mustard family (Brassicaceae). In addition, studies will be conducted to determine which biological control agents or combination of agents may result in the greatest impacts on garlic mustard. Some of this research will be conducted during field trials in garlic mustard's native range, while other will occur under laboratory conditions. All

testing will be done using widely standardized techniques and following guidelines established in the literature and by USDA.

Text Box 11. NJ Action! - Phillip Alampi Beneficial Insect Lab

Robert Chianese (recently retired) led NJDA's Phillip Alampi Beneficial Insect Laboratory, which is one of the nation's premier facilities for rearing beneficial insects to control invasive species. The lab is one of only several state facilities found across the country. Their mission is to reduce impacts on agricultural and natural systems caused by invasive pests and pathogens. The lab works cooperatively with the federal government, neighboring states, and university researchers to develop rearing techniques for biocontrol agents.

One of the lab's greatest successes involves the production and release of biocontrol agents that attack purple loosestrife, which threatens wetland communities and their inhabitants including the federally threatened bog turtle. In 1996, they began producing beetles (*Galerucella* spp.) that feed on loosestrife plants. Nearly 1,500,000 biocontrol beetles have since been released across 100 sites in New Jersey. Dramatic reductions in purple loosestrife have occurred at multiple wildlife management areas throughout the state including Whittingham, Columbia Lake, Amwell Lake and Black River Greenway. Importantly, beetles have been found up to 29 miles from their original release points, which indicates that control may ultimately occur across the state.

Hemlock woolly adelgid (HWA) has caused severe damage to the state's Eastern hemlock trees. The 26,000 acres of hemlock forests located across the state have been reduced by half and nearly all remaining stands are infested with this invasive insect. In 1998, the lab began producing biocontrol agents (*Sasajiscymnus tsugae*, a beetle from Japan). Approximately 270,000 beetles have been released at 70 sites across the state. Although the 'verdict is out' regarding the ultimate effectiveness of the biocontrol beetle, it represents our best hope to save an important portion of our natural heritage.

The lab is also currently working with the USFS and University of Delaware to produce a biocontrol agent for mile-a-minute weed. A tiny weevil from China, *Rhinoncomimus latipes*, has been released in a limited number of field trials and appears to be very effective at controlling mile-a-minute. Increased production and releases are planned upon evaluation of field trials. With Bernd Blossey of Cornell University, the lab is also involved with pre-release research of a biocontrol agent for garlic mustard, which is one of our most pernicious invasive species in forests. Release of a successful biocontrol agent for this species would dramatically improve forest health across the state.

The lab also actively produces biocontrol agents for Mexican bean beetles, Canada thistle, elongate hemlock scale, euonymus scale, and tarnished plant bugs that impact natural systems and/or agricultural commodities.

The NJISC recommends that the state provide $100,000 annual to fund research, development and production of biological control agents to address widespread control of New Jersey's most harmful invasive species. Initial priority should be given to garlic mustard, Japanese stiltgrass and Japanese barberry. Additionally, the NJISC recommends seeking federal grant funds of $500,000 for the NJ Beneficial Insect Lab to mass produce existing biological control agents for release at subsidized prices for interested public and private landowners.

Table 7. Description of Invasive Species Control Methods

Control Method	*Description*	*Pros*	*Cons*	*Notes*
Mechanical	Physical removal of all or portions of an invasive species	No requirement for specialized training, can be performed by volunteers	Very labor intensive, may require specialized equipment, site accessibility issues, impractical for large infestations, re-sprouting or further invasive species dissemination may occur	Common techniques include mowing, cutting, pulling, girdling. Could also include prescribed fire.
Chemical	Application of herbicides to all or portions of an invasive species	Most effective and efficient method in most cases, staff can be assisted by volunteers	Labor intensive, site accessibility issues, requires specialized training/license and equipment, may require repeated applications for more difficult species	Common applications include foliar, cut stump, basal bark, and injection
Biological	Introduction of a biocontrol agent (e.g. insect) from the invasive species' native range	Dramatic reductions in abundance with minimal application costs, minimal accessibility issues	Limited number of invasive species have control agents, potential for unintended consequences if the biocontrol agent 'switches' to non-target host species	Requires extensive research to provide effective, host-specific agents, which requires initial investment but is presumably very cost effective
Cultural	Removal of invasive species through coincidental human activities	Very cost effective	Applies to a small fraction of infested areas	Generally a subset of mechanical or chemical control; primarily applies to agricultural systems, but may apply to the maintenance of early successional natural systems
Ecological	Allowing natural ecological processes (e.g., competition for light and soil resources, predator-prey relationships, etc.) to reduce invasive species over time	Very cost effective, allows natural processes to 'balance'	May not occur in many systems due to persistent or continuing human impacts (e.g., overabundant deer, continued physical disturbance, fragmentation, etc.)	This can only occur when deer populations are low. Research and strong anecdotal evidence suggest that overabundant deer facilitate infestations by invasive species in forests.

Text Box 12. NJ Action! - Private Lands: Great Swamp Watershed Association

Hazel England and a group of dedicated volunteers have been working on invasive species at their 50-acre Great Swamp Watershed Association preserve for 10 years. Their worst infestations are from multiflora rose, bush honeysuckles, privet and Japanese barberry. Efforts to manage the preserve have focused on reduction of deer browse, removal of invasive species, and planting of native species. Hazel also regularly provides outreach on the impacts of invasive species and native alternatives for landscape plantings to garden clubs and other interested groups in the watershed.

Initial work involved cutting of dense thickets of rose. The use of weed wrenches to pull out roots and the application of herbicides to cut stumps has been implemented to improve the success of the program. In many cases, native species are being planted following the removal of invasive species. This effort was being hampered by overabundant white-tailed deer, which led to the construction of a 23-acre deer exclosure funded through a grant from the Great Swamp National Wildlife Refuge. This exclosure, installed in 2005, is one of the largest in New Jersey. Their efforts to replace invasive species with native plants have increased now that deer browsing has been addressed.

Their work has been made possible by grants from NRCS (WHIP) and USFWS (PFW). Hazel and the Morris Land Conservancy's Partners for Parks program recruit volunteers to implement control efforts. Corporations such as Goldman-Sachs, Arventis, and SmithKline regularly volunteer at the Preserve. In total, the Watershed Association supervises nearly 1,000 volunteer hours per year, which is used to match direct financial support provided through grants. The Watershed's comprehensive removal and re-planting effort restores about four acres of native floodplain forest per year. Hazel has plans to begin control efforts on Japanese stiltgrass and Japanese knotweed in the coming year.

Cultural control is similar to the concept of 'best management practices' in agricultural systems. There are numerous practices that have the effect of reducing invasive species impacts. These practices could involve promoting beneficial insects, timing of herbicide applications and crop selection. Cultural control may also apply to the maintenance of early successional habitats. For example, the maintenance of grassland bird habitat requires techniques to minimize the growth of trees and shrubs (both native and invasive). Mowing, prescribed fire and herbicide applications may be used to maintain grasslands. The use of soil disking followed by planting of native, warm-season grasses is another method. This technique is a required practice to maintain commercial hayfields and may be adapted to the maintenance of grassland bird habitat. Another potential cultural control method for grassland and other early successional natural systems is prescribed or targeted grazing, which is defined as the application of a specific kind of livestock at a determined season, duration and intensity to accomplish defined vegetation or landscape goals (Launchbaugh 2006). The benefits of using livestock to control invasive species have been demonstrated for New Jersey's bog turtles (Tesauro 2001). This work primarily involved the use of cows to consume and destroy root mats of invasive species such as Phragmites and purple loosestrife. Another potential application may be the use of goats or other livestock to consume dense thickets of multiflora rose or autumn olive. This could be especially valuable in situations where the target ecological community is grassland or as a pre-treatment prior to re-establishing forest communities. There are a number of practical considerations (e.g., cost associated with fencing materials), but targeted grazing may be the best option for land managers under certain conditions. The NJISC encourages the creation of public/private partnerships in managing invasive species on state-owned lands through a creative agricultural lease program with farmers and the involvement of trained and certified volunteers.

Land managers should refer to an excellent guide on the phenology and timing of treatment techniques for 30 species found in the Delaware River watershed (Zerbe et al. 2003). This

concept and additional technical information regarding treatments are provided by the Friends of Hopewell Valley Open Space and Upper Raritan Watershed Association (see http://www.fohvos.org/CJISST.html). The NJISC recommends that this model be expanded for all invasive species in New Jersey to create a comprehensive and easily accessible database of the phenology of invasive species and treatment options. The guide should include all of the appropriate treatment options listed in this section, where appropriate, for individual invasive species. This resource would create greater efficiency and accuracy among public and private land managers.

Ecological control of invasive species refers to the reduction of invasive species through competitive interactions with native species and should be considered the 'ultimate desired condition.' There are a variety of factors that limit our native systems' ability to exert ecological control, but overabundant deer is one of the most significant factors in forest communities (See Sections 4.B and 4.C). The Ted Stiles Preserve at Baldpate Mountain provides a working example of the role of effective deer management leading to a resurgence of native species. The Mercer County Park Commission established its deer management program over a decade ago by focusing on doe harvests. Currently, portions of the park are in full recovery with dense stands of native species such as spicebush, freed from excessive deer browse, beginning to overtop invasive species such as Japanese barberry, multiflora rose and Japanese stiltgrass (see photo below). This example provides evidence that infestations can be reversed through effective deer management programs.

Statewide, it is imperative that consideration of ecosystem health be one of the primary determinants for statewide deer population goals (i.e., to ensure that native plants have the ability to compete with invasive plants without being disproportionately browsed). In addition, careful consideration of other activities, including forestry and recreational pursuits, is advised to determine impacts.

Left: Photo of native spicebush thicket at the Ted Stiles Preserve at Baldpate Mountain. Right: Close-up photo of thicket showing spicebush (larger leaves) overtopping Japanese barberry. Photographs by Michael Van Clef.

Section 4.E: Coordinated Control Programs

Section 4.E.1: A New Jersey Example – European Gypsy Moth

There are numerous government and private groups conducting control of invasive species throughout New Jersey. A sample of these efforts is reported in "NJ ACTION!" text boxes located throughout this plan (see Text Boxes 3, 4, 5, 6, 7, 8, 10, 11, 12, 13 and 14). These pioneering efforts serve as models and inspiration for increased control efforts across the state.

The State's most long-standing and comprehensive control effort is the Gypsy Moth Cooperative Suppression Program. The European gypsy moth was originally introduced near Boston in 1869 as a business venture to create silk. Its initial discovery in New Jersey occurred in 1920 at Duke Farms in Hillsborough and was probably imported from New England through contaminated landscape plants (Rutgers University 2007). The state and federal response was rapid and intense. Over 12 years, a dedicated group actively exterminated insects over a 175 square mile area. By 1932, there remained only scattered individual gypsy moths. Efforts to detect and treat gypsy moths slowed considerably under the assumption of successful eradication. However, isolated observations began to grow through the 1930s and 1940s and periodic outbreaks have occurred over the ensuing decades. This early failed attempt at ED/RR is instructive and should be considered for current efforts to control Asian longhorned beetle (see Text Box 3).

The modern control effort represents a persistent effort with the goal of minimizing impacts to forest health. For example, in 2006 it is estimated that over 125,000 acres were infested statewide. Treatments of affected areas involve aerial spraying of the bacteria *Bacillus thunbergii* var. *kurstaki* (B.t.k.). The bacteria is not known to be toxic to humans or wildlife and persists less than 10 days in the environment. A total of 27,000 acres were treated in 2006 at an approximate cost of $1 million dollars ($40/acre). These efforts are likely to continue into the foreseeable future and serve to minimize the chances of severe outbreaks.

Section 4.E.2: Cooperative Weed Management Areas (CWMA's)

The function of a CWMA or Cooperative Invasive Species Management Area (CISMA) is to integrate all invasive plant management resources across jurisdictional boundaries in order to achieve widespread prevention and control (MIPN 2006). The CWMA concept was developed in the western states as a mechanism to combat invasive species over large areas by coordinating strategies and pooling resources of multiple stakeholder groups. Participants include local citizens, landowners, non-profit groups and all levels of government. Functionally, a CWMA is led by a steering committee of stakeholder representatives that operate under a formal cooperative agreement. The CWMA forms the basis of a network for all stakeholders to share resources that collectively address their common invasive plant problems. Benefits of forming a CWMA include sharing and leveraging of limited resources (e.g., volunteers, tools, herbicides, media contacts, etc.), education of the public about invasive species, presentation of a 'united front' to state and federal legislators, creation of an ED/RR network, and greater ability to secure funding for control efforts and other needs. One of the larger funding sources for invasive plant control work is the National Fish and Wildlife Foundation's Pulling Together Initiative, which strongly favors the funding of multi-partner organizations working across boundaries.

New York has taken the lead in the formation of CWMA's in the Eastern states. The Long Island CWMA was formed in 2001. Long Island has already been successful in establishing a volunteer 'Weed Watcher' group that has located numerous occurrences of emerging invasive species, developed a strategic management plan adopted by 14 partners, mapped weeds in 800 acres of their Pine Barrens region, worked with the nursery industry to adopt the St. Louis Declaration Voluntary Codes of Conduct and created educational materials. In upstate New York, similar groups called PRISMs (Partnerships for Regional Invasive Species Management) consisting of multiple counties are being formed. The Catskill Mountains, Adirondack Mountains and St. Lawrence - Eastern Lake Ontario regions are examples of PRISMs in New York. PRISMs have been initially funded through legislation passed by the state.

The NJISC recommends that the proposed Office of Invasive Species be the nucleus for New Jersey CWMAs to stimulate active partnerships with the many organizations that have taken up invasive species control on their lands (examples are found in Text Boxes throughout this report, but there are many other groups participating in control efforts). This partnership would take the form of shared grant proposals to provide financial assistance to these groups, who in return would provide a wealth of expertise and practical knowledge to control invasive species across the state.

Section 4.E.3: Federal Strike Teams

The National Park Service (NPS) has established 16 Exotic Plant Management Teams (EPMTs) since 1997. Each team was established to serve one of 16 regions covering the United States. The purpose of EPMT's is to provide coordinated services to each National Park to control invasive species across their vast acreages in a cost-effective manner. Each team consists of two full-time employees (Team Liaison and Team Leader) and 3-4 seasonal employees that perform the majority of control work under the supervision of the Team Leader. Seasonal employees are usually hired from the Student Conservation Association (SCA). The salary costs for a six-month SCA intern is approximately $12,000 (housing costs are additional). Staff and volunteers of their host park often join the Team Leader and seasonal staff. In the most ideal situation, parks receiving the services of an EPMT have already formulated a strategic plan that identifies conservation targets along with an inventory of invasive plants that are of greatest concern. This allows EPMTs to focus on control work that produces the 'biggest bang for the buck.'

The U.S. Fish and Wildlife Service (USFWS) began employing Invasive Species Strike Teams (ISSTs) in 2004 and several teams have since been established across the country (FL, MO/CO/WY, ND, HI). These teams vary in structure and mission, but involve one or two federal employees that coordinate seasonal staff or contractors performing the bulk of control responsibilities. The Florida team (Region 4 ISST) consists of two permanent staff (Team Leader, GS12; Team Assistant, GS9). Their primary functions include: 1) administer mapping and control contracts; 2) assess, monitor and treat new plant introductions and new infestations of existing invasive species; 3) provide technical assistance to refuge managers; 4) represent the USFWS on various task forces; 5) assist with removals and volunteer coordination; and 6) form partnerships with local governments near the refuge where they are based. This team had a $500,000 annual budget in 2004 and approximately half was used to hire contractors to perform control work on heavy infestations. This approach is considered very cost effective because the use of contractors relieves the need to hire additional permanent staff and purchase/maintain

heavy equipment. In addition, contractors are capable of clearing large areas of heavy infestations that could not be practically accomplished through the use of seasonal interns. This structure allows the permanent team to focus on ED/RR and other specialized tasks.

Section 4.F: Restoration

Restoration ecology developed in response to the massive degradation of natural systems. The goal of restoration is to encourage the re-establishment of native systems on derelict sites including abandoned mines, quarries, landfills and other areas heavily impacted by human activities. Overall, restoration may be considered the initial 'jump start' that ensures that the natural system continues on a path toward recovery, but the ultimate goal is for the system to 'manage itself' if continuing negative influences of humans can be reduced or eliminated.

Restoration at various levels of intensity may be required following the removal of severe invasive species infestations. Techniques range from complex engineering endeavors involving correction of hydrology to simple tree seedling planting events conducted by school children. The most common form of restoration ecology involves repairing riparian areas with severe bank erosion. Techniques involve engineering principles and materials to physically stabilize the banks followed by planting of native species to further stabilize the banks and create wildlife habitat.

Plantings intended to foster the development of forests often employ the 'habitat island' approach. This technique involves planting trees and shrubs in clusters that attract birds. The birds use these islands as perches and bring seeds from surrounding areas. Additionally, birds may move seeds from plantings throughout the entire restoration area. The overall effect is to maximize the speed of recovery with a minimum of installation expense. The intention is to provide native species with a head start that will allow them to compete with invasive species that capitalize on forest clearings.

The impact of white-tailed deer is a matter of practical concern for restoration projects. Restorations often cannot occur without special measures to protect plantings. At substantial cost, this involves fencing of entire areas or installing protective devices on individual plants. In many instances these measures are not optional and failure is guaranteed without considering the added expense and time required to stop deer from destroying entire restoration projects. This problem occurs statewide and includes Atlantic white cedar restorations in the core of the Pine Barrens where deer densities are lower than other regions of the State.

Text Box 13. NJ Action! - County Lands: Morris and Monmouth County Park Commissions

Monmouth County Park Commission - Ken Thoman has been controlling invasive species since 1993. Invasive species that have been treated include autumn olive, tree-of-heaven, Norway maple and mugwort. Several projects have involved the clearing of invasive species and creation of grassland habitat used by meadowlarks, Northern harriers and bobwhite quail. Monmouth County has utilized a combination of volunteers and contractors with heavy equipment to clear dense infestations, and in-house seeding of native grasses. Thompson Park had nearly 40 acres of autumn olive converted to native grasses with the help of Sierra Club volunteers and a contractor (cost of $21,000). Harthorne Woods was cleared of nearly 15 acres of Norway maple. Charleston Springs Golf Course received a 50-acre native grassland 'rough' area, which replaced the invasive common mugwort. The Commission has also benefited from a WHIP grant to create 20 acres of early successional habitat (grasses and wildflowers) at its Sunnyside Park. Species such as Norway maple, autumn olive, and tree-of-heaven have been mapped at Tatum Park and are being systematically treated with herbicide.

The Park Commission has begun investing in staff training and assessments of natural resource values to prioritize future control work. Each manager is provided with identification and control guides for a target species as part of their new ranger training program. With the help of Dr. Joan Ehrenfeld and her students, the Park Commission has a forest evaluation program on 2,600 acres of parklands. Botanical surveys have been used with the Plant Stewardship Index (developed through efforts of the Bowman's Hill Wildflower Preserve) to determine areas of greatest biodiversity value to target for future invasive species control efforts.

The Monmouth County Park Commission recently initiated a deer management program, which was justified by observations of excessive browse on native plants and resulting infestations of invasive species. This program involves 10 parks and nearly 700 hunters. The goal of the program is to reduce the density of deer to 10 individuals per square mile. The construction of deer exclosures and results of forest health monitoring will allow the Park Commission to determine the long-term effectiveness of their deer management program and experimentally test the role of deer browse on the extent of invasive species infestations.

Morris County Park Commission - Rob Jennings has taken the lead in controlling invasive species since 1996. The Park Commission manages 17,000 acres over nearly three dozen parks. Rob's strategy was to initiate efforts in the smallest parks to establish mapping, control and monitoring protocols. Their properties contain a wide variety of invasive species including multiflora rose, Japanese barberry, Asiatic bittersweet, wineberry, autumn olive, Japanese stiltgrass, tartarian honeysuckle, garlic mustard, porcelain berry, European privet and Japanese honeysuckle.

He created a uniquely titled volunteer program (Free-A-Tree Volunteers) consisting of a wide diversity of private individuals and organizations. Volunteers logged over 5,000 hours since 1996 and have cleared over 60 acres of severely infested lands (about 80 volunteer hours/acre). The primary methods involved manual removal with a variety of tools, but judicious herbicide treatments were initiated in 2005. Other Park Commission staff, including maintenance crews and environmental educators, have participated in the control efforts. Volunteers have also participated in restoration efforts through the planting of native species on formerly infested areas.

The Morris County Park Commission has also linked the overabundance of deer with infestations of invasive species and lack of regeneration of native species in treated areas. They initiated a deer management program in 1996 utilizing natural resources, maintenance and park police staff. The effectiveness of their program is being monitored through a cooperative agreement with municipalities to estimate deer populations through aerial infrared surveys. Their goal is to survey each park every 3-5 years and determine whether deer densities are being reduced through their program. Surveys from Lewis Morris Park indicate that eight years of hunting have reduced the population density from 62 to less than 16 deer per square mile. In addition, the Park Commission is participating in a regional study to determine the impacts of white-tailed deer on forest regeneration. Tree seedlings were planted in an experimental design at two parks (Lewis Morris and Mahlon Dickerson) to determine the severity of deer browse during winter months. Results of this study will be used to further guide their deer management program.

The use of 'native ecotypes' should be employed in all restorations. Native ecotype refers to the use of plant species whose seeds come from the same area as the restoration site. This ensures that 1) genes of installed plants are well-adapted to local conditions, and 2) 'foreign genes' from native plants derived from individuals located far from the restoration site are not introduced. The ideal situation involves the use of plants grown from seeds of individuals naturally occurring near the restoration site. Encouraging nurseries to grow local ecotypes of native plants is essential.

The NJISC recommends the creation of a list of native plants for various habitat types for use in restoration efforts. Additionally, NJISC recommends the formulation of protocols for restoration success by geographic regions within New Jersey.

A meadow restoration performed through a cooperative grant
between Chester Township and the USDA-NRCS. Photograph courtesy of Charles Gilbert.

Text Box 14. NJ Action! - Private Lands: Duke Farms

Unprecedented deer densities resulting from a long-standing prohibition on hunting and severe infestations of invasive species have ravaged Duke Farms' 2,740-acre property, but they are on their way to achieving one of the most dramatic restorations in the state. In 2004, Duke Farms had a deer density of 250 per square mile! With the understanding that native plants had little chance of recovery with such high deer densities, they, with the assistance of the Division of Fish & Wildlife, instituted an intensive deer management program that has reduced the density to 37 per square mile. Their ultimate goal is to achieve healthy forests that have the ability to produce seedlings of native trees and a diversity of native shrubs and herbs.

In addition, Duke Farms recently installed a one square mile deer exclosure that surrounds a previously installed 30-acre deer exclosure (inner area has been deer free for 4.5 years). Their most intensive invasive species control has occurred within a 9-acre area called 'Research Woods' located within the exclosure. The area was infested with Japanese barberry and Japanese stiltgrass. The barberry was manually removed as part of an Eagle Scout project and re-sprouted individuals were treated with herbicide. A contractor was hired to spray Japanese stiltgrass with an herbicide and follow-up treatments will be conducted until the seed bank is exhausted. Other less severe infestations of invasive species in this area included lesser celandine, Devil's walking stick, garlic mustard, winged burning bush, Japanese honeysuckle and tree-of-heaven. Dr. Mikael Forup of Rutgers University and 15 staff members of Duke Farms manually removed lesser celandine. Other invasive species with minimal populations are removed manually as encountered. Native species such as blue stem goldenrod, mayapple, jack-in-the-pulpit and Solomon's seal have begun to flourish in the absence of deer and invasive species. An Eagle Scout project has added 600 seedlings of native shrubs including winterberry, witch hazel, spicebush, highbush blueberry and arrowwood.

Importantly, Duke Farms actively encourages ecological research on their property through the Center for Urban Restoration Ecology (a collaborative effort between Rutgers University and Brooklyn Botanic Garden). A small sample of research topics related to invasive species include: assessing the influence of deer and invasive species on forest tree seedlings; impacts of invasive species on plant communities; impacts of invasive herbs and grasses on native herb populations; demography of lesser celandine; and determining insect vectors of bacterial leaf scorch disease. The information derived from these studies has capitalized on stewardship activities and, in turn, will inform future stewardship activities.

Duke Farms is also performing outreach to its visitors through its project at 'Research Woods.' In addition, they are developing a brochure to inform their visitors of the invasive species problem and guide their home landscaping choices. Duke Farms has begun to reconcile their long horticultural history with the now widely recognized problem of invasive species. In the past, invasive species such as winged burning bush, Norway maple and Japanese barberry were planted for their ornamental value. Currently, Duke Farms is beginning to replace these plantings with native species such as redbud, arrowwood and sugar maple.

Finally, Duke Farms has begun the process of mapping invasive species across their entire property and developing a comprehensive invasive species management plan. This plan will integrate their conservation goals and prioritize their control efforts. Mapping has revealed the scope of invasive species infestation: over 50 non-native species; severe infestations of widespread invaders such as Norway maple, Japanese barberry, Japanese stiltgrass and lesser celandine; large areas with overlapping infestations containing up to 15 invasive species; and emerging statewide threats including Chinese silver grass, fiveleaf aralia, English elm, Amur corktree, desert false indigo, small carpgrass, beefsteak plant and European alder. Fortunately, grassland bird habitat (their primary conservation target) is not severely impacted by invasive species. However, forest areas are enormously impacted and will require long-term control and restoration. Strong organizational support with a long-term vision for success coupled with a strategic approach will assure the ultimate success of this most ambitious stewardship endeavor.

Section 4.G: Guide for Site-Based Control Efforts

Control efforts should be guided by a rapid initial inventory of invasive species infestations throughout the state. This inventory should be initiated at areas of greatest biodiversity value (see Section 3.D.3) before extensive control work is initiated. The suggested rapid inventory should be followed by continued monitoring and research on New Jersey's non-native species. Snyder and Kaufman (2004) cite the lack of basic data including current distribution, estimated abundance, rate of migration, and identification of natural plant communities most vulnerable to invasion. The NJISC recommends that the proposed Office of Invasive Species determine the distribution of invasive species currently found in New Jersey by using existing data and additional data collected through a volunteer 'Weed Watchers' Program along with data from the NJ Natural Heritage Program and the Endangered and Nongame Species Program (see Section 3.D.1).

In addition, it will become necessary to fill large gaps in our knowledge on the status of rare plant populations and ecological communities across the state. Breden et al. (2006) report that only 10% of all recorded rare plant populations have been assessed since 1990. This will make site prioritization based upon our state's rare plants speculative without additional inventory and monitoring. The NJISC recommends that the NJ Natural Heritage Program lead new field surveys to update old records of rare species/ecological communities and searches for additional rare plant species occurrences to provide improved ability to prioritize invasive species prevention and control efforts.

Control efforts are time intensive and expensive. Limited resources require prioritization based upon ecological values and current levels of infestation. Simply put, sites of greatest ecological value with the lowest levels of infestation (i.e., less than 10% ground cover) should be the highest priority for site-based ED/RR control efforts (see Section 3.D.3). It should be noted than even pristine sites may contain adjacent areas with high levels of infestation requiring intensive treatment.

For sites containing infestations levels that exceed 10% ground cover, a significant and persistent effort will be required to reduce the impacts of invasive species. These more infested sites should be considered for control within a prioritized system based upon ecological values and severity of infestations (see Section 3.D.3 and Figure 3). It would be very easy to become bogged down in sites containing infestations that have grown too large for feasible control outcomes in a reasonable amount of time. It is imperative that newly discovered infestations in pristine sites be protected through site-based ED/RR (see Section 3.D.3).

It is important to note that there are no locations where invasive species control is unjustified – all natural systems need stewardship to mitigate the impacts of invasive species. Many organizations have decided to control invasive species on their own properties irrespective of high biodiversity values or even currently high levels of infestation. Supporting the continuation of this work is vital as everyone chips away at this enormous problem. The NJISC recommends the formulation of a prioritized list of public lands to focus future control activities.

In all cases, work should be guided by written management plans to ensure efficiency of control and efficacy toward protecting desired conservation targets (see Section 4.A). In addition, it is critical to note that any control effort be preceded by the development of a comprehensive deer management program (see Section 4.B.1) to facilitate natural regeneration of native plants following the removal of invasive species. The ultimate goal is that natural systems exert their own 'ecological control' over invasive species after dense infestations have been largely controlled through other methods (see Section 4.D).

Initially, the NJISC recommends that the proposed Office of Invasive Species select one site to demonstrate various innovative strategies and techniques required to control and restore a heavily infested area of at least 500 acres. The selected site should primarily consist of upland habitat to provide an alternate example to the Cape May Meadows Ecosystem Restoration (see Text Box 4), which involved a coastal wetland system.

Section 4.G.1: Prioritizing Invasive Species at Selected Sites

The prioritization of invasive species control efforts is completely site-dependent and a specific system is not recommended – the judgment of those implementing control efforts will be required. Factors contributing to the decision include (in order of importance): 1) conservation goals; 2) landscape context and land use history; and 3) degree of infestation by each invasive species present. All of these components should be addressed in a comprehensive management plan before proceeding with control efforts.

As a general rule, land managers should consider that clearing an area of one invasive species often results in infestation by another invasive species especially where white-tailed deer populations are overabundant. For example, removal of Japanese barberry (an invasive shrub) may release Japanese stiltgrass (an invasive grass) or garlic mustard (an invasive herb) that had originally been suppressed by the barberry's shade. Similarly, the removal of invasive trees such as Norway maple may release numerous invasive shrubs, herbs and grasses upon removal of the maple's shade. These complexities generally require that entire areas within a site be treated for all invasive species present.

Another prioritization strategy may involve treatment of invasive species that are newly emerging at a site. For example, a site may be heavily infested with garlic mustard but have only small pockets of Japanese stiltgrass. In this case, it would be reasonable to first treat Japanese stiltgrass before it becomes a serious problem.

In all cases, sites containing newly emerging species to the state should receive the highest priority for treatment. All efforts should be reported to the proposed Office of Invasive Species and assistance should be sought if eradication cannot be accomplished with existing staff.

The most critical component of invasive species control is that it be guided by the protection of conservation targets. An example from the personal experience of the author will be used to illustrate this concept:

Site: Mashipacong Bogs Preserve; *Size*: 1,000 acres; *Conservation Target*: globally rare acidic bogs and dragonfly species; *Landscape Context*: Excellent, > 90% forest cover wedged between Stokes State Forest and High Point State Park; *Degree of Infestation*: Low to High for several

invasive species - Japanese barberry (around youth camp), Japanese stiltgrass (most wet forest areas), Phragmites (small patches near outlet of acidic bog). *Recommended Management Actions*: 1) initiate deer management program to improve forest health leading to increased resistance to continued invasion of Japanese barberry and Japanese stiltgrass; 2) eradicate small patches of Phragmites because it is the only species that seriously threatens the primary conservation targets; 3) avoid control of barberry or stiltgrass because staff resources are limiting; 4) perform periodic monitoring of success of deer management program, invasive species treatments and changes in abundance of untreated invasive species; and 5) adapt management scheme if conditions change.

Section 4.H: NJISC Recommendations for Control and Restoration
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
27	Tier 1	4.A: Control and Restoration	Encourage management of state-owned lands through agricultural lease program	Encourage public/private partnerships in managing invasive species on state-owned lands through a creative agricultural lease program with farmers and the involvement of trained and certified volunteers.	NJISC, NJDEP, NJDA	Initiate one pilot project
28	Tier 2	4.A: Control and Restoration	Perform field surveys to update status of rare plant species and ecological communities	New Jersey Natural Heritage Program to lead new field surveys to update old records of rare species/ecological communities and search for additional occurrences to provide prioritization of invasive species prevention and control efforts.	NJISC, OIS, NJDEP	Existing occurrences updated; completed survey of 20 potentially important sites
29	Tier 2	4.A: Control and Restoration	Create a prioritized list of public lands to focus future control activities	Use existing and newly collected data within a site prioritization protocol to create a prioritized list of public lands for future control activities.	NJISC, OIS, NJDEP	Prioritized list created
30	Tier 2	4.G: Site-based Control Efforts	Determine distribution of invasive species currently found in New Jersey	Use existing data (e.g., Brooklyn Botanic Garden, municipal inventories, etc.) and additional data collected through volunteer 'Weed Watchers' program along with NJNHP and ENSP. This recommendation would complement an ED/RR program. The Invasive Plant Atlas of New England can be used as a model for this program.	NJISC, OIS, NJDEP	Data collection and management program developed; 100 volunteers recruited
31	Tier 2	4.A: Control and Restoration	Encourage completion of comprehensive management plans by public and private land managers prior to initiating invasive species control efforts	The creation of management plans encourages efficacious and efficient treatment of invasive species based upon conservation goals.	NJISC, OIS	10 plans created; Provide text and web links through NJISC website
32	Tier 2	4.A: Control and Restoration	Select one site to demonstrate a major control and restoration effort	Demonstrate various innovative strategies and techniques required to control and restore one heavily infested area of at least 500 acres. The selected site should primarily consist of upland habitat to provide an alternate example to the Cape May Meadows Ecosystem Restoration (see Text Box 4), which involved a coastal wetland system.	NJISC, OIS, NJDEP	Complete a management plan and meet its control and restoration goals

Section 4.H: NJISC Recommendations for Control and Restoration
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
33	Tier 1	4.B: Native and Non-Native Animals	Implement a comprehensive program to reduce the white-tailed deer population	Improve hunting access on lands with limited or absent hunting opportunities on public and private lands. Determine protocols to guide harvest goals by measuring the health of ecological systems. This program would provide outreach and technical assistance to support increased hunting access on public and private lands across the state. These efforts would be implemented by the Division of Fish & Wildlife with support from NJISC and its constituent members along with OIS. The ultimate goal is to reduce the deer population and allow the potential for ecological control of invasive species.	NJISC, OIS, NJDEP, NJDA	Program developed and implemented; Available acreage and hunting days increased by 25% across state, measurable indicators of ecological health above established thresholds
34	Tier 1	4.B: Native and Non-Native Animals	Provide state financial support for Hunters Helping the Hungry program	Seek re-appropriation of the Hunters Helping the Hungry (HHH) program, which enables hunters to donate venison to needy individuals throughout NJ, with a suggested restart amount of $250,000, to enhance incentives for increased deer hunting in NJ. This program can increase deer harvest numbers and support ecological control of invasive species.	NJISC, NJDEP, NJDA	HHH program statewide and fully funded
35	Tier 2	4.B: Native and Non-Native Animals	Provide greater outreach to reduce impacts of feral and outdoor domestic cats	Provide outreach through support of NJAS "Cats Indoors!" program and encourage participation in the existing cat spay/neuter program.	NJISC, OIS, NJDHSS	Participation in program increased by 10%
36	Tier 2	4.B: Native and Non-Native Animals	Implement a plan to reduce resident Canada geese, snow geese and mute swans	Canada Goose: NJDEP-DFW should continue to take advantage of liberal hunting opportunities and depredation orders allowed under U.S. Fish and Wildlife Service (USFWS) regulations; Mute Swan: Legislative changes should be considered to include mute swans as game birds in New Jersey. This change would allow the mute swan to be efficiently controlled through hunting seasons, with reduction of population to 500. Snow Goose: NJDEP-DFW should continue to take advantage of liberal hunting opportunities and adopt any additional means of take that are being considered by the USFWS	NJISC, OIS, NJDEP, NJDA	Plan prepared; populations reduced by 50%

Section 4.H: NJISC Recommendations for Control and Restoration
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
37	Tier 1	4.E: Coordinated Control Programs	Establish Cooperative Weed Management Areas (CWMAs) in New Jersey and request federal funding for the establishment of a State-sponsored cost-share program that encourages control of invasive species	Encourage linkages between land managers and volunteer groups willing to perform invasive species control. Use advertising (e.g., NJISC website, Central Jersey Invasive Species Strike Team, MA-EPPC, Environmental Stewards Program, Watershed Watch Program, Morris Land Conservancy's - Partners for Parks Program) to reach potential groups including corporations, scouts, schools, etc. Seek grant funding to establish and maintain the program.	NJISC, OIS, RCE, NJDEP	CWMAs established, 5 CWMA projects funded
38	Tier 2	4.D: Control Methods and Techniques	Request federal grant funding to enhance biocontrol agent production by the New Jersey Beneficial Insect Laboratory	Mass produce and offer biocontrol agents at a subsidized price to landowners interested in control. Also see Section 5.	NJISC, OIS, NJDA	Funding received - $500,000, agents produced and released, sites treated, invasive cover reduced
39	Tier 1	4.F: Restoration	Create list of native plants recommended for various habitat types for use in restoration efforts	This would not include non-invasive, non-native plants because it would be for native community restoration.	NJISC, OIS, NJDEP	List created and added to NJISC website
40	Tier 2	4.F: Restoration	Formulate protocols for restoration success by geographic region	This would be a restoration 'tool kit' with goals for successful restoration projects.	NJISC, OIS, NJDEP	Protocols created and added to NJISC website
41	Tier 2	4.D: Control Methods and Techniques	Create comprehensive phenology and treatment table for all invasive species	Using Zerbe et al. (2003) as a model, create comprehensive source of information on phenology and treatment options across the year for all invasive species. See Central Jersey Invasive Species Strike Team efforts at www.fohvos.org for initial efforts.	NJISC, OIS	Guide created and posted on website

SECTION 5: STRUCTURE OF NEW JERSEY'S INVASIVE SPECIES PROGRAM

Section 5.A: Introduction

This section describes a proposed structure to implement the recommendations of the New Jersey Strategic Management Plan for Invasive Species. It includes the vision, mission and role for the proposed permanent New Jersey Invasive Species Council, resource requirements, potential funding sources and partnerships, and regional cooperation. The implementation of this plan to formulate a comprehensive invasive species program in New Jersey requires that funding be commensurate with the threats posed by invasive species and the damage they cause to our natural and agricultural resources.

The Environmental Law Institute (ELI 2002) performed a comprehensive review of regulatory components required to meet the challenge of invasive species by examining existing programs in all 50 states with advice sought from external reviewers. They produced three standards to describe levels of response to invasive species (Appendix 10). Existing and potential authorities for New Jersey to implement its recommendations are summarized in Appendix 8. The 'Gold Standard' requires exemplary policies across all sets of tools (regulatory guidance is provided by the "Comprehensive Model State Law" - ELI 2004a). The 'Silver Standard' involves strong steps, but falls short of comprehensively addressing the threat. The 'Bronze Standard' involves the implementation of a minimum set of tools that should be easily obtainable by all states. Currently, New Jersey does not meet the 'Bronze Standard.' The NJISC recommends that New Jersey meet the requirements of the 'Silver Standard' within 10 years by implementing the recommendations of this plan. References to NJISC recommendation numbers are included with ELI standards in Appendix 10.

Section 5.B: Recommended Role for a Permanent New Jersey Invasive Species Council

The Council's vision statement is "*To reduce the impacts of invasive species on New Jersey's biodiversity, natural resources, agricultural resources and human health through prevention, control and restoration, and to prevent new invasive species from becoming established*." The Council's mission is to provide overarching coordination and guidance for invasive species activities throughout the state and to act as a liaison for regional and national cooperative efforts. The Council will be guided by five principles: 1) require measurable results for all activities; 2) consider the needs of all stakeholders; 3) adapt and improve strategies and techniques based upon past activities; 4) build partnerships and cooperation into every endeavor; and 5) design invasive species program activities that support biodiversity, natural resources and agricultural resources, not against invasive species.

A permanent NJISC, co-chaired by NJDEP and NJDA should continue in its capacity as advisory body to the Governor of New Jersey and be represented by the Departments of Environmental Protection, Agriculture, Transportation, and the New Jersey Economic Development Authority. The NJISC would advise various state commissions including but not limited to the Pinelands Commission, New Jersey Highlands Council, Meadowlands Commission, Port Elizabeth Committee and the Port Authority of New York and New Jersey. Existing agencies should maintain their current authorities. The potential expansion of

authorities that would be created through adoption of NJISC's regulatory recommendations would also be handled by existing agencies.

The NJISC will emphasize partnerships among governmental agencies, non-governmental and private-sector organizations representing the full range of stakeholders affected by invasive species problems, as well as concerned citizens. Responsibilities would include representing the state in policy decisions where invasive species may be an issue. The NJISC will meet at least quarterly, promote volunteer-based actions to reduce the impacts of invasive species and educate the public, and ensure that the requirements of the Environmental Law Institute's 'Silver Standard' for state action on invasive species are met.

Stakeholders include farmers, nursery industry, conservation community, academic scientists, water resource purveyors, land managers, foresters, sport fishing, hunting and boating groups and representatives from federal, county and municipal agencies. The NJISC recommends Federal participation on the Council to ensure integration and cooperation both regionally and nationally. Federal representatives with official membership should include the U.S. Department of Agriculture, Department of Interior and the Environmental Protection Agency. The Council will continue to be co-chaired by the NJDEP and the NJDA. The overarching role of the NJISC will be to ensure that the requirements of the Environmental Law Institute's 'Silver Standard' for state action on invasive species are met in New Jersey through the implementation of its recommendations.

Section 5.C: Resource Requirements

Current state funding toward invasive species is disproportionately low relative to the severity of the problem. A reasonable first step toward mitigating the risks posed by invasive species will be to acquire additional staffing and resources. The NJISC recommends a fully staffed Office of Invasive Species along with additional state staff and resources to initiate a variety of programs leading to the accomplishment of its recommendations and attainment of ELI's 'Silver Standard.' The estimated total annual cost is $2.5 million. Although the NJISC feels that this would provide sufficient funding to address the seriousness of the invasive species problem, every effort will be made to leverage state funding with federal and private grants and encourage increased activity among public and private stakeholders. A summary of estimated resource requirements is provided in Table 8.

Table 8. Summary of Resource Requirements for a New Jersey Invasive Species Program

Item	*Brief Description and Activities – See Section 5.C.1 and 5.C.2 and NJISC recommendations for further justification of resource requirements*	*# of Staff Positions**	*Estimated Annual Cost*
Office of Invasive Species - Core Staff	Multiple activities that lead to overarching guidance of a statewide invasive species program.	7	$700,000
Office of Invasive Species - NJ-ISST	On-the-ground control efforts including rapid response to new invasive species; training of public and private staff; administration of $500,000 in annual contracts for control efforts on state lands.	3	$800,000

	Note: One of the staff positions consists of two 6-month seasonal interns.		
NJDEP - Division of Fish & Wildlife	Further efforts to improve access on public and private lands and fully integrate use of ecological health evaluations to guide harvest goals.	1	$100,000
NJDEP - Division of Fish & Wildlife (ENSP)	Determine susceptibility of key sites to invasive species infestation.	1	$100,000
NJDEP - Division of Parks and Forestry (NJNHP)	Determine susceptibility of key sites to invasive species infestation and address stewardship responsibilities. Update rare plant/ecological community data and priority site boundaries.	2	$200,000
NJDEP - Division of Watershed Management	Train ED/RR volunteers and provide support for outreach, mapping and control work through volunteer participation.	1	$100,000
Rutgers Cooperative Extension	Incorporate invasive species into multiple existing programs and administer various tasks involving outreach, ED/RR, mapping, and control.	2	$200,000
NJDA	Additional inspectors to enforce new invasive species regulations. Support ED/RR program.	2	$200,000
NJDA Administered Biological Control Matching Grant Fund	Administer program to provide funding to a research institution and seek matching funds from federal or other sources to combine with NJ contribution.	0	$100,000
TOTALS	All of the above are required to have a comprehensive invasive species program for NJ.	19	$2,500,000

*Includes incidental operating expenses (e.g., office space, supplies, etc.) and minimal programmatic expenses (e.g., outreach materials, meetings, etc.)

The NJISC recognizes the need for the Division of Parks & Forestry to directly address stewardship. Currently, none of the designated staff categories (i.e., administration, maintenance, interpretation and law enforcement) have stewardship responsibilities. Maintenance and interpretation staff each has skills required to address invasive species issues, but neither are charged with this task. In addition, staffing across the Division has been shrinking while the amount of land assigned to the Division has been dramatically growing through aggressive efforts to protect New Jersey's remaining open space from development. The NJISC recommends that consideration be given to incorporation of funding for stewardship into future GSPT bond initiatives, and explore additional funding sources, recognizing that habitat lost through the proliferation of invasive species represents the loss of our State's capital assets.

Section 5.C.1: Office of Invasive Species (OIS)

The Council recommends staffing a state Office of Invasive Species. Staff would consist of the following: 1) Director (coordinate activities between state agencies, staff supervision, liaison to regional and national efforts); 2) Grant Coordinator (partially fund the Office of Invasive Species, obtain and administer grant funding for cost-share programs provided to non-state programs); 3) Prevention Coordinator (ED/RR program implementation, risk assessment and pathway analyses); 4) GIS/Information Manager (administer tabular and spatial data, website

administration); 5) Research Coordinator (liaison to universities and other researchers, track latest innovations in prevention, control and restoration); 6) Outreach Coordinator (liaison to stakeholders and the public, foster formation of Cooperative Weed Management Area's, recruit volunteers for prevention, control and restoration activities); and 7) Administrative Assistant (staff and program support). This office would provide the majority of expertise required to create a robust program that addresses the many impacts of invasive species. The OIS would require approximately $700,000 of annual funding for staff and related expenses.

Control and restoration functions within the OIS would be the responsibility of the New Jersey Invasive Species Strike Team (NJ-ISST) that is modeled from NPS-EPMTs and USFWS-ISSTs (see Section 4.E.3). The NJ-ISST would report directly to the Director of the Office of Invasive Species. The mission of the NJ-ISST is to provide site- and species-based ED/RR, control and restoration functions, and training to state staff performing invasive species control. The NJ-ISST would administer contracts to control large-scale infestations on state lands. The NJ-ISST should consist of two permanent staff and two seasonal staff. Permanent staff would consist of a Team Leader and Team Assistant. The Team Leader would provide significant experience with invasive species and administration of contracts. The Team Assistant would provide additional biological expertise and direct supervision of seasonal staff. This would require approximately $800,000 of annual funding for staff and related expenses. Within this budget, $500,000 per year would be appropriated to hire contractors to treat severe infestations.

Additionally, the NJISC recommends that the OIS dispense grant funding received from non-state sources to a variety of private groups that are in alignment with its mission and goals. The OIS would establish a cost-share arrangement through Cooperative Weed Management Areas (CWMAs). Potential recipients could include land trusts, watershed associations or universities that have expertise in stewardship, outreach/education, fundraising, policy or research (see Section 4.E.2).

Section 5.C.2: Supplementing Existing Agencies and Programs

The NJDEP (Divisions of Parks & Forestry, Fish & Wildlife and Watershed Management), NJDA (Division of Plant Industry) and the Rutgers Cooperative Extension would require additional staff and associated operating budgets to implement the NJISC recommendations detailed throughout this plan.

NJDEP - Division of Parks & Forestry
The NJ Natural Heritage Program (NJNHP) has significant expertise in rare plants and ecological communities. However, Breden et al. 2006 indicates that a large proportion of data related to our rare flora has not been updated since 1990. This problem does not allow accurate identification of biodiversity areas requiring protection from invasive species. In addition, the NJNHP does not have the staffing capability to address invasive species issues. The NJISC recommends providing one additional position for the NJNHP with expertise in invasive and rare species. In addition, to begin to address the deficiency in the Division of Parks & Forestry to address its critical stewardship responsibilities, the NJISC recommends the creation of a new position specific to this need.

NJDEP - Division of Fish & Wildlife
The NJISC acknowledges that white-tailed deer overabundance represents a serious aggravating factor to the state's invasive species problem (see Section 4). To facilitate the control of invasive species, the NJISC strongly recommends that the state continue and expand upon its comprehensive program to reduce the deer population. This program should involve coordinated effort between the NJISC, OIS, Division of Fish & Wildlife, NJDA and the wider conservation community including other public and private entities and require the addition a new position within the Division of Fish & Wildlife. Expanded goals should include: 1) improvement of hunting access on both public and private lands with limited or absent hunting opportunities; and 2) utilization of ecosystem health evaluation protocols to consider when setting annual harvest goals.

The Division of Fish & Wildlife - Endangered and Nongame Species Program (ENSP) is analogous to the NJNHP, but with significant expertise with rare animals. ENSP does not have dedicated staff or specific expertise with invasive species, which pose a serious threat to rare animal populations. The NJISC recommends providing one additional position within ENSP with expertise in invasive species.

NJDEP - Division of Watershed Management
The Division of Watershed Management (DWM) has great potential to provide invasive species education to a wide audience while providing volunteer support for ED/RR and control efforts (see Section 3.D.4). They have trained over 10,000 volunteers since the inception of their Watershed Watch Network and currently have over 1,000 active volunteers. The NJISC recommends the addition of one position for the DWM to increase capacity to produce materials and training suited for its existing Watershed Watch Program.

Rutgers Cooperative Extension
Rutgers Cooperative Extension (RCE) has extensive expertise, infrastructure and public recognition to provide significant support for an ED/RR program while providing effective outreach to the general public and a variety of stakeholders (see Sections 2.C and 3.D.4). RCE has existing relevant programs (i.e., Environmental Stewards, Master Gardeners) and could provide additional training opportunities to reach a wider range of stakeholders (e.g., foresters, pesticide applicators, etc.). The NJISC recommends two positions for RCE to increase capacity and leverage existing expertise and resources.

NJDA - Division of Plant Industry
The NJDA currently provides annual monitoring and inspections to certify nurseries and plant dealers. However, expanding their role to accommodate duties related to NJISC regulatory recommendations requires additional resources. The NJISC recommends the addition of two positions to meet these new responsibilities.

In addition, the NJISC recommends the contribution of $100,000 of state funding for the exploration and development of biological control agents for New Jersey's worst invasive species, which would be administered by NJDA. NJDA would seek federal matching funds for this initiative.

Section 5.D: Potential Funding Sources

Section 5.D.1: Funding in Other States

The U.S. General Accounting Office (USGAO 2000) reviewed invasive species funding for seven states in FY2000. Florida and California provided $128 million and $87 million, respectively. Hawaii ($7.6 million), Idaho ($4 million), New York ($2.6 million), Michigan ($1.9 million) and Maryland ($1.8 million) also provided significant funding toward invasive species programs.

The funding mechanisms chosen by other states may provide potential options for New Jersey. The state of Florida has exemplary funding for invasive species control through their "Florida Forever Act," which is analogous to New Jersey's Garden State Preservation Trust. They have also established an Invasive Plant Control Trust Fund that generates over $30 million per year and is funded through documentary stamps, state gas taxes and vessel registration. Importantly, Florida has attracted significant federal funding to supplement state spending (including $36 million from USDA grant programs). State agencies, including their Bureau of Invasive Species Management, provide cost-share programs to counties to further leverage state funding. California also provides cost-share programs to non-state entities.

New York partially funds invasive species programs through a real estate transfer tax and is quickly becoming a leader in combating invasive species through state efforts. Idaho raises $390,000 from phytosanitary certification and nursery surveillance fees and raises over $3 million per year from property taxes for invasive species control. They are considering establishing additional stable sources of funding through boat, RV or ATV licenses, fishing and hunting licenses, species importation permits or using General Fund tax revenues to improve their invasive species control programs.

Section 5.D.2: Potential Funding Sources for New Jersey's Program

Ideally, New Jersey's invasive species programs would be wholly funded as a new line item under the General Fund. If this is not possible, the NJISC suggests that a minimum of 50% come from this source to maintain the stability of program funding. Regardless of the source, if New Jersey provides significant resources toward invasive species, then it is very likely to attract funding through federal and private sources. Success tends to breed greater success regarding continued grant funding.

Additional program funding may be provided through a wide variety of USDA grant and partnership programs related to invasive species (USDA 2007). One USDA program includes the Wildlife Habitat Incentive Program (WHIP) administered by the Natural Resource Conservation Service (NRCS). This program has been very successful in New Jersey and is administered by knowledgeable staff that are familiar with invasive species management. The USFWS provides 'Partners for Fish and Wildlife' grants that are often used for invasive species management or restoration and are also administered by knowledgeable staff in New Jersey. The National Fish and Wildlife Foundation (NFWF) administers the 'Pulling Together Initiative,' 'Native Plant Conservation Initiative,' and 'Delaware Estuary Grants Program.' NFWF is particularly interested in partnerships represented by CWMA's. Overall, grant funding for projects can come from a very wide variety of sources related to the conservation of flora and

fauna because invasive species are widely recognized as a serious threat by granting agencies. The Private Stewardship Grants Program (USFWS) is an additional example. New Jersey would be able to receive grant funds from a variety of sources because the focus will be managing for biodiversity, natural resources or agricultural resources rather than managing against invasive species.

Section 5.E: Partnerships and Regional Cooperation

Invasive species do not confine themselves to political boundaries. To protect New Jersey, a strong Federal authority is required (existing Federal authorities are presented in Appendix 7). The National Invasive Species Council is charged with providing a coordinating role at the federal level (the proposed NJISC role is analogous at the state level). Several recommendations of the NJISC foster a strong relationship with the federal government to support federal legislation, receive technical advice and produce a reciprocal relationship. The NJISC recommends federal participation in a permanent Council, communication of NJ's Strategic Management Plan for Invasive Species to the Port Elizabeth Committee, and inviting participation from various public and private interests (private arboreta/botanic gardens, shade tree commissions, environmental commissions, etc.) that are not formally represented on the permanent Council.

There are numerous regional and neighboring state efforts to reduce the impacts of invasive species. Some of these include the Delaware River Invasive Plant Partnership (DRIPP), Mid-Atlantic Exotic Pest Plant Council (MA-EPPC), Invasive Plant Atlas of New England (IPANE), Pennsylvania Invasive Species Council (PISC), New York Invasive Species Task Force, New York State Invasive Plant Council, and Delaware Invasive Species Council. These groups provide multiple opportunities for New Jersey to learn and participate in regional efforts. The NJISC recommends two-way communications with neighboring states and regional entities to foster coordination and cooperation that facilitates information flow into and out of New Jersey.

Section 5.F: NJISC Recommendations for Structure of New Jersey's Invasive Species Program
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
42	Tier 1	5.B: The Role of a Permanent NJ Invasive Species Council	Create a permanent New Jersey Invasive Species Council	A permanent NJISC, co-chaired by NJDEP and NJDA, should continue in its capacity as advisory body to the Governor of New Jersey. The NJISC will emphasize partnerships among government agencies, non-governmental and private-sector organizations representing the full range of stakeholders affected by invasive species problems, and concerned citizens. Responsibilities will include representing the State in policy decisions where invasive species may be an issue. The NJISC will meet at least quarterly, promote volunteer-based actions to reduce the impacts of invasive species and educate the public, and ensure that the requirements of the Environmental Law Institute's 'Silver Standard' for state action on invasive species are met.	NJISC	Council made permanent with recommended structure and function
43	Tier 2	5.B: The Role of a Permanent NJ Invasive Species Council	Recommend that NJ comply with the Environmental Law Institute's 'Silver Standard'	ELI's 'gold standard' is an exhaustive list of recommendations to fully address the threat of invasive species. The 'silver standard' involves strong steps, but falls short of comprehensively addressing the threat. However, it is reasonable for New Jersey to meet this standard within 10 years if all recommendations are implemented. Achievement of the 'gold standard' should be the ultimate goal for New Jersey, but this cannot reasonably be achieved in less than 10 years.	NJISC	Silver Standard achieved

Section 5.F: NJISC Recommendations for Structure of New Jersey's Invasive Species Program
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
44	Tier 2	5.C: Resource Requirements	Create an Office of Invasive Species	A total of seven staff would consist of a Director (coordinate activities between state agencies, staff supervision, liaison to regional and national efforts), Grant Coordinator (partially fund the Office of Invasive Species/ obtain and administer grant funding for cost-share programs provided to non-state programs), Prevention Coordinator (ED/RR system implementation, risk assessment and pathway analyses), GIS/Information Manager (administer tabular and spatial data, website administration), Research Coordinator (liaison to universities and other researchers, track latest innovations in prevention, control, and restoration), Outreach Coordinator (liaison to stakeholders and the public, foster CWMAs, recruit volunteers for prevention, control, and restoration), and an administrative assistant.	NJISC, NJDA, NJDEP	staff positions filled with a stable source of funding
45	Tier 2	5.C: Resource Requirements	Create a NJ Invasive Species Strike Team	The NJISST would report to the Office of Invasive Species and consist of two full-time staff positions and two seasonal staff positions. They would also administer $500,000 annually for invasive species control contracts across all state lands.	NJISC, NJDA, NJDEP	staff positions filled and contract fund allocation maintained with a stable source of funding
46	Tier 2	5.C: Resource Requirements	Recommend the addition of one new staff position for the Division of Fish and Wildlife	It is extremely important to enhance programs to reduce deer densities. This recommendation represents a cost effective method to reduce existing invasive species through 'ecological control' (see Plan text).	NJISC, NJDEP	staff position filled with a stable source of funding
47	Tier 2	5.C: Resource Requirements	Recommend the addition of two new NJDA inspection staff	NJDA inspection is vital to enforcing the banned plant species list.	NJISC, NJDA	staff positions filled with a stable source of funding

Section 5.F: NJISC Recommendations for Structure of New Jersey's Invasive Species Program
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
48	Tier 2	5.C: Resource Requirements	Provide funding to biological control researchers and seek federal matching funds	Provide $100,000 of state funding and seek federal matching grants to be provided to researchers. Communicate NJ's priority species for biological control to researchers. Initial priority should be given to the most harmful pests including garlic mustard, Japanese stiltgrass and Japanese barberry.	NJISC, OIS, NJDA, NJDEP	State provides $100,000 to promote development of a new biocontrol agent. Federal government match of at least 1:1.
49	Tier 2	5.C: Resource Requirements	Recommend the addition of two new staff position at the Rutgers Cooperative Extension	RCE is integral to the completion of numerous goals.	NJISC, RCE	staff positions filled with a stable source of funding
50	Tier 2	5.C: Resource Requirements	Recommend the addition of two new invasive species staff positions – one at the New Jersey Natural Heritage Program and one at the Endangered and Nongame Species Program	Positions would focus on mapping threats posed by invasive species and monitoring health of selected rare species and communities.	NJISC, NJDEP	staff positions filled with a stable source of funding
51	Tier 2	5.C: Resource Requirements	Recommend the addition of one new staff position for the Division of Watershed Management - Watershed Watch Program	This program has the potential to harness thousands of volunteers for detection and control of invasive species.	NJISC, NJDEP	staff position filled with a stable source of funding
52	Tier 2	5:D: Potential funding sources	Encourage invasive species control through use of existing state and federal cost-share programs	Maximize use of programs such as the USDA-NRCS Conservation Reserve Enhancement Program (CREP) and Wildlife Habitat Incentives Program (WHIP).	NJISC, NJDEP, NJDA	Provide outreach to private citizens and create ongoing communications with USDA-NRCS

Section 5.F: NJISC Recommendations for Structure of New Jersey's Invasive Species Program
Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements
53	Tier 2	5.D: Potential Funding Sources	Seek State funding for New Jersey's Invasive Species Program	Consider incorporation of funding for stewardship into future GSPT bond initiatives, and explore additional funding sources, recognizing that habitat lost through the proliferation of invasive species represents the loss of our State's capital assets.	NJISC	Annual funding of $2.4 million for programs identified in the plan
54	Tier 1	5.E: Partnerships and Regional Cooperation	Enhance federal participation within a permanent NJ Invasive Species Council	Federal agencies have significant expertise and resources to assist NJ. Invite US Department of Agriculture, US Department of Interior and US Environmental Protection Agency.	NJISC	3 new groups participating, communication timely and effective
55	Tier 1	5.E: Partnerships and Regional Cooperation	Expand statewide efforts for two-way communications on invasive species issues	Invite representatives from private arboreta/botanic gardens, shade tree commissions, environmental commissions, etc. to NJISC meetings.	NJISC, OIS	Create a e-mail distribution list and advertise all upcoming meetings
56	Tier 1	5.E: Partnerships and Regional Cooperation	Expand regional efforts for two-way communications on invasive species issues	Multiple groups from adjacent states and the region face similar problems with invasive species. Create dialogue through meetings/conferences to standardize data collection and archiving to ensure two-way data flow. Cooperation between New Jersey and other groups, including invasive species councils from adjacent states, could increase the efficiency of regional efforts.	NJISC, OIS	Regular communication with all neighboring states and regional invasive species groups
57	Tier 1	5.E: Partnerships and Regional Cooperation	Communicate goals of NJ Strategic Management Plan for Invasive Species to the Port Elizabeth Committee	Group consists of APHIS, DHS, Customs, and NJDA. The group assesses risk assessment to better target inspections.	NJISC, OIS, NJDA	NJ plan distributed to Committee.

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Appendix 1
Glossary of Selected Acronyms

New Jersey Strategic Management Plan for Invasive Species

Abbreviation	Full Name
ALB	Asian longhorned beetle (invasive insect species)
APHIS - PPQ	Animal and Plant Health Inspection Service - Plant Protection and Quarantine (part of USDA)
CWMA	Cooperative Weed Management Area
DPF	Division of Parks and Forestry (part of NJDEP)
DVM	New Jersey Division of Watershed Management
EAB	Emerald ash borer (invasive insect species)
ED/RR	Early Detection / Rapid Response
ELI	Environmental Law Institute
ENSP	Endangered and Nongame Species Program (NJDEP-F&W)
EPMT	Exotic Plant Management Team (part of the NPS)
F&W	Division of Fish and Wildlife (part of NJDEP)
GMO	Genetically-modified Organism
HWA	Hemlock wooly adelgid (invasive insect species)
IPANE	Invasive Plant Atlas of New England
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
ISPM No. 15	Guidelines for Treating Wood Packaging Material in International Trade
ISST	Invasive Species Strike Team (part of the USFWS)
MAM	Mile-a-minute (invasive plant species)
NISC	National Invasive Species Council
NJDA	New Jersey Department of Agriculture
NJDEP	New Jersey Department of Environmental Protection
NJDHSS	New Jersey Department of Health and Senior Services
NJISC	New Jersey Invasive Species Council (a.k.a. the “Council”)
NJJJP	New Jersey Juvenile Justice Program
NJNHP	New Jersey Natural Heritage Program (part of ONLM)
NJNLA	New Jersey Nursery and Landscape Association
NRCS	Natural Resource Conservation Service (part of USDA)
ONLM	Office of Natural Lands Management (part of NJDEP)
PFW	Partner for Fish and Wildlife (grant program administered by USFWS)
QDM	Quality Deer Management
RCE	Rutgers Cooperative Research and Extension Service
USDA	United States Department of Agriculture
USDHS	United States Department of Homeland Security
USDOI	United States Department of Interior
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WHIP	Wildlife Habitat Incentive Program (grant program administered by USDA-NRCS)
WPM	Wood Packaging Material

Appendix 2

Prioritized Listing of New Jersey's Nonindigenous Plant Species

New Jersey Strategic Management Plan for Invasive Species

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Working Draft -November 14, 2002

The attached list of nonindigenous plant species are ranked according to their relative degree of invasiveness in natural plant communities and their documented impacts to these communities. Both the list of ranked nonindigenous species and the accompanying definitions of the four rank categories were developed by David Snyder, botanist for the New Jersey Natural Heritage Program, Department of Environmental Protection, as part of a comprehensive white paper on New Jersey's invasive and nonindigenous plant species. The ranking system was the basis for the identification of New Jersey's 29 most invasive plant species highlighted in the DEP's *An Overview of Nonindigenous Plant Species in New Jersey* (Snyder and Kaufman 2004). The ranking system and listing was developed from 2000 through early 2002, with a working draft prepared in late 2002. It has not been subjected to peer review. It should be considered a preliminary treatment and is by no means a complete or comprehensive summary of the ranking system. Despite these and other limitations, the attached prioritized listing of 964 of New Jersey's nonindigenous plant species presents a solid foundation on which to build.

There are four numerical categories ranging from 1-4, with 1 being the most widespread in natural plant communities. Criteria used in categorizing nonindigenous taxa were: 1) the species' ability to successfully invade natural plant communities; 2) the abundance of the species within a natural plant community; 3) whether the species has documented or observed harmful invasive characteristics; 4) the overall distribution of the species within New Jersey; 5) the availability of scientific research or other easily retrievable data documenting known or potential harmful effects on indigenous plant species, natural plant communities, or ecological processes; and 6) the number of additional states in the eastern United States that recognize (either officially or unofficially) the species as a problem species.

Criteria 1 and 2 were the most easily documented data and consequentially were the most heavily weighted during the ranking process. The data used to make this evaluation was primarily based on information gathered from the examination of close to a quarter of a million herbarium specimens at the Philadelphia Academy of Natural Sciences and the Chrysler Herbarium, Rutgers University, and the more than 30 years of extensive fieldwork that I have conducted in New Jersey. The absence or presence of data under criteria 5 and 6 frequently

determined whether species were placed in category 1 or category 2. The source of these data were varied, and included information provided by federal and state agencies, academic institutions, The Nature Conservancy, the Network of Natural Heritage Programs (NatureServe), and the literature.

Category 1 includes species that have many invasive characteristic traits, are generally widespread in New Jersey, and known to invade natural plant communities. All of these species are considered to be invasive or problem species in natural plant communities in at least 5 additional eastern states, some in as many as 11 states (Kaufman unpublished). At this writing, 25 plant species are in category 1.

Category 2 includes species that are considered to be potentially highly invasive, but which are, at present, not documented as widespread in the state, although they may be very abundant in some areas of the state or abundant in very specific habitats (such as calcareous fens or sea beaches). About 131 species are currently placed in category 2.

Category 3 includes species that are widespread and highly invasive but are either not known to invade natural plant communities (a significant distinction), or have only limited or uncertain effects on plant community structure. This category includes most of the familiar nuisance weeds of lawns, gardens, roadsides, disturbed grounds, and urban landscapes. Some of these species are significant weed species of agricultural lands. Approximately 240 nonindigenous species are in category 3.

Category 4 contains those species that are presently not considered to be invasive in New Jersey. These are species largely collected from ballast grounds, dumps, or waste grounds. Many of these species are barely persistent in New Jersey or they are escapes from cultivation that may have formed local populations but have not spread significantly. Some are sterile hybrids, while others are incapable of sexual reproduction in New Jersey's climate. A few are newly established nonindigenous species documented from one or two locations, with little documented information about their potential invasiveness. Category 4 contains between 862 and 929 nonindigenous species.

Collectively, category 1 and category 2 nonindigenous species are believed to be of the most serious concern to natural land managers and a possible threat to biodiversity conservation. Fact sheets have been prepared for 30 of New Jersey's most invasive species and are included as Appendix 2 in Snyder and Kaufman (2004). Most of these fact sheets include species that are currently placed in category 1, but a few fact sheets are category 2 species.

It is important to note that invasive status of many nonindigenous species currently classified in categories 3 and 4 may change as more data become available and their populations continue to increase and spread. Williams and Meffe's (1998) observation is an appropriate caution: "The thousands of established nonindigenous species in the United States that are not known to have caused ecological and economic damage to date should not be viewed as benign biota but as potential time bombs."

The list is arranged alphabetically by species within the numerical categories. The letter "I' preceding the rank in the first column stands for "invasive" and is how the rank is entered in the Natural Heritage Database. Nomenclature largely follows Kartesz (1999).

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Addendum – July 17, 2009

As noted above, the ranking system and prioritized listing of nonindigenous plant species was developed from 2000 through early 2002, with a working draft prepared in late 2002. It is important to note that this "working draft" is a brief summary of the ranking priorities used to generate the prioritized list. It is by no means a complete or comprehensive summary of the ranking system. It is a preliminary treatment, and users need to be aware of its limitations.

Foremost, the information is dated – some of which is nearly a decade old. Most of the nonindigenous species were ranked in 2000, with some adjustments and refinements being made up until early 2002. A number of additions to New Jersey's nonindigenous flora have been made in subsequent years and are not reflected in this list. Many of these additions are species known from one-time collections and most would be placed in Category 4 (having little significant harmful effect on natural plant communities), but some recently discovered species have the potential to become significant harmful invasive species (Categories 1 and 2).

The following additional species are proposed for further review and ranking using the methods outlined above:

INVASIVE	NAME_AUTHOR
I2?	Aralia elata (Miq.) Seem.
I1?	Cardamine impatiens L.
I2?	Euonymus fortunei (Turcz.) Hand.-Maz.
I4?	Heracleum mantegazzianum Sommier & Levier
I2?	Hydrilla verticillata (L.F.) Royle
I2?	Malus toringo (Siebold) Siebold ex de Vriese

I2?	Photinia villosa (Thunb.) DC.
I2?	Pyrus calleryana Decne.
I2?	Trapa natans L.
I2?	Viburnum sieboldii Miq.

INVASIVE	NAME_AUTHOR
I1	Acer platanoides L.
I1	Ailanthus altissima (P. Mill.) Swingle
I1	Alliaria petiolata (Bieb.) Cavara & Grande
I1	Ampelopsis brevipedunculata (Maxim.) Trautv.
I1	Berberis thunbergii DC.
I1	Carex kobomugi Ohwi
I1	Celastrus orbiculata Thunb.
I1	Centaurea biebersteinii DC.
I1	Cirsium arvense (L.) Scop.
I1	Clematis terniflora DC.
I1	Dipsacus fullonum L.
I1	Elaeagnus umbellata Thunb. var. parvifolia (Royle) Schneid.
I1	Eragrostis curvula (Schrad.) Nees
I1	Euonymus alata (Thunb.) Sieb.
I1	Hedera helix L.
I1	Lespedeza cuneata (Dum.-Cours.) G. Don
I1	Lonicera japonica Thunb.
I1	Lonicera morrowii Gray
I1	Lythrum salicaria L.
I1	Microstegium vimineum (Trin.) A. Camus
I1	Myriophyllum spicatum L.
I1	Polygonum cuspidatum Sieb. & Zucc.
I1	Polygonum perfoliatum L.
I1	Potamogeton crispus L.
I1	Ranunculus ficaria L. var. bulbifera Marsden-Jones
I1	Robinia pseudoacacia L.
I1	Rosa multiflora Thunb. ex Murr.
I1	Rubus phoenicolasius Maxim.
I1	Wisteria floribunda (Willd.) DC.
I2	Acorus calamus L.
I2	Amaranthus hybridus L
I2	Amaranthus retroflexus L
I2	Amorpha fruticosa L.
I2	Anthemis arvensis L.
I2	Anthriscus sylvestris (L.) Hoffmann
I2	Arthraxon hispidus (Thunb.) Makino
I2	Buddleja davidii Franch.
I2	Carduus acanthoides L.
I2	Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi

I2	Carlina vulgaris L.
I2	Catalpa bignonioides Walt.
I2	Cirsium vulgare (Savi) Ten.
I2	Cynanchum louiseae Kartesz & Gandhi
I2	Cyperus amuricus Maxim.
I2	Cyperus iria L.
I2	Dipsacus laciniatus L.
I2	Duchesnea indica (Andr.) Focke
I2	Euphorbia cyparissias L.
I2	Glechoma hederacea L.
I2	Helianthus petiolaris Nutt. ssp. petiolaris
I2	Iris pseudacorus L.
I2	Lamium amplexicaule L.
I2	Ligustrum vulgare L.
I2	Lonicera maackii (Rupr.) Herder
I2	Ludwigia peploides (HBK.) Raven var. glabrescens (Kuntze) Shinners
I2	Lysimachia nummularia L.
I2	Magnolia tripetala (L.) L.
I2	Melilotus officinalis (L.) Lam.
I2	Miscanthus sinensis Anderss.
I2	Myosotis scorpioides L.
I2	Phalaris canariensis L.
I2	Pueraria montana (Lour.) Merr. var. lobata (Willd.) Maesen & S. Almeida
I2	Rhamnus cathartica L.
I2	Rorippa nasturtium-aquaticum (L.) Hayek
I2	Rosa rugosa Thunb.
I2	Rubus discolor Weihe & Nees
I2	Rubus laciniatus Willd.
I2	Symphoricarpos albus (L.) Blake var. laevigatus (Fern.) Blake
I2	Symphoricarpos orbiculatus Moench
I2	Veronica hederifolia L.
I2	Viburnum dilatatum Thunb.
I2	Vinca minor L.
I2I3	Aira praecox L.
I2I3	Akebia quinata (Houtt.) Dcne.
I2I3	Albizia julibrissin Durazz.
I2I3	Anthoxanthum odoratum L. ssp. odoratum
I2I3	Arabidopsis thaliana (L.) Heynh.
I2I3	Arrhenatherum elatius (L.) Beauv. ex J.& K. Presl var. elatius
I2I3	Artemisia stelleriana Bess.
I2I3	Artemisia vulgaris L. var. vulgaris
I2I3	Barbarea verna (P. Mill.) Aschers.
I2I3	Barbarea vulgaris Ait. f.
I2I3	Bidens aristosa (Michx.) Britt.
I2I3	Bromus japonicus Thunb. ex Murr.
I2I3	Bromus tectorum L.
I2I3	Calystegia sepium (L.) R. Br. ssp. sepium

I2I3	Chelidonium majus L. var. majus
I2I3	Cichorium intybus L.
I2I3	Coincya monensis (L.) Greuter & Burdet var. recurvata (All.) Leadley
I2I3	Commelina communis L. var. communis
I2I3	Commelina communis var. ludens (Miq.) C.B. Clarke
I2I3	Conium maculatum L.
I2I3	Coronilla varia L.
I2I3	Dactylis glomerata L. ssp. glomerata
I2I3	Datura stramonium L.
I2I3	Daucus carota L.
I2I3	Digitaria ischaemum (Schreb.) Schreb. ex Muhl.
I2I3	Digitaria sanguinalis (L.) Scop.
I2I3	Echinochloa crus-galli (L.) Beauv.
I2I3	Echium vulgare L.
I2I3	Eleusine indica (L.) Gaertn.
I2I3	Eragrostis cilianensis (All.) Vign. ex Janchen
I2I3	Froelichia gracilis (Hook.) Moq.
I2I3	Galium aparine L.
I2I3	Galium mollugo L.
I2I3	Galium verum L.
I2I3	Gleditsia triacanthos L.
I2I3	Helianthus x laetiflorus Pers. (pro sp.)
I2I3	Hemerocallis fulva (L.) L.
I2I3	Hesperis matronalis L.
I2I3	Hypochaeris radicata L.
I2I3	Ilex crenata Thunb.
I2I3	Leucanthemum vulgare Lam.
I2I3	Linaria vulgaris P. Mill.
I2I3	Lycopus europaeus L.
I2I3	Microthlaspi perfoliatum (L.) F.K. Mey.
I2I3	Mirabilis jalapa L.
I2I3	Morus alba L.
I2I3	Origanum vulgare L.
I2I3	Pastinaca sativa L.
I2I3	Paulownia tomentosa (Thunb.) Sieb. & Zucc. ex Steud.
I2I3	Penstemon digitalis Nutt. ex Sims
I2I3	Phleum pratense L.
I2I3	Plantago lanceolata L.
I2I3	Plantago major L. var. major
I2I3	Polygonum hydropiper L.
I2I3	Polygonum orientale L.
I2I3	Polygonum sachalinense F. Schmidt ex Maxim.
I2I3	Populus alba L.
I2I3	Ranunculus acris L. var. acris
I2I3	Ranunculus bulbosus L.
I2I3	Rhodotypos scandens (Thunb.) Makino
I2I3	Rhus aromatica Ait. var. aromatica

I2I3	Ribes rubrum L.
I2I3	Rumex acetosella L.
I2I3	Rumex crispus L.
I2I3	Rumex obtusifolius L.
I2I3	Salix fragilis L.
I2I3	Silphium perfoliatum L. var. perfoliatum
I2I3	Solanum carolinense L. var. carolinense
I2I3	Solanum dulcamara L. var. dulcamara
I2I3	Stellaria media (L.) Vill. var. media
I2I3	Suaeda maritima (L.) Dumort. ssp. maritima
I2I3	Taraxacum laevigatum (Willd.) DC.
I2I3	Taraxacum officinale G.H. Weber ex Wiggers ssp. officinale
I2I3	Torilis japonica (Houtt.) DC.
I2I3	Ulmus parvifolia Jacq.
I2I3	Verbascum thapsus L.
I2I3	Veronica anagallis-aquatica L.
I2I3	Veronica beccabunga L.
I2I3	Veronica officinalis L. var. officinalis
I2I3	Vulpia myuros (L.) K.C. Gmel.
I3	Achillea millefolium L. var. millefolium
I3	Aegopodium podagraria L.
I3	Aesculus flava Ait.
I3	Agrostis capillaris L.
I3	Agrostis gigantea Roth
I3	Agrostis stolonifera L. var. palustris (Huds.) Farw.
I3	Agrostis stolonifera L. var. stolonifera
I3	Aira caryophyllea L.
I3	Allium vineale L. var. vineale
I3	Alnus glutinosa (L.) Gaertn.
I3	Alopecurus pratensis L.
I3	Amaranthus albus L.
I3	Amaranthus cruentus L.
I3	Amaranthus deflexus L.
I3	Amaranthus spinosus L.
I3	Amaranthus tuberculatus (Moq.) Sauer
I3	Anthemis cotula L.
I3	Aralia spinosa L.
I3	Arctium lappa L.
I3	Arctium minus Bernh.
I3	Arenaria serpyllifolia L.
I3	Aristolochia macrophylla Lam.
I3	Artemisia annua L.
I3	Artemisia ludoviciana Nutt. ssp. ludoviciana
I3	Arundinaria gigantea (Walt.) Muhl. ssp. tecta (Walt.) McClure
I3	Asparagus officinalis L.
I3	Bassia hirsuta (L.) Aschers
I3	Bassia scoparia (L.) A.J. Scott

I3	Berberis vulgaris L.
I3	Berteroa incana (L.) DC.
I3	Bidens tripartita L.
I3	Brassica juncea (L.) Czern.
I3	Brassica nigra (L.) W.D.J. Koch
I3	Brassica rapa L. var. rapa
I3	Bromus commutatus Schrad.
I3	Bromus inermis Leyss. ssp. inermis var. inermis
I3	Bromus racemosus L.
I3	Bromus secalinus L.
I3	Bromus sterilis L.
I3	Broussonetia papyrifera (L.) L'H?r. ex Vent.
I3	Buglossoides arvensis (L.) I.M. Johnston
I3	Callitriche stagnalis Scop.
I3	Calluna vulgaris (L.) Hull
I3	Calystegia pellita (Ledeb.) G. Don
I3	Capsella bursa-pastoris (L.) Medik.
I3	Cardaria draba (L.) Desv.
I3	Carex spicata Huds.
I3	Centaurea jacea L.
I3	Centaurea nigra L.
I3	Centaurea nigrescens Willd.
I3	Centaurea transalpina Schleich. ex DC.
I3	Centaurium pulchellum (Sw.) Druce
I3	Cerastium biebersteinii DC.
I3	Cerastium fontanum Baumg. ssp. vulgare (Hartman) Greuter & Burdet
I3	Cerastium semidecandrum L.
I3	Chaenorrhinum minus (L.) Lange
I3	Chenopodium album L. var. album
I3	Chenopodium ambrosioides L. var. ambrosioides
I3	Chenopodium pumilio R. Br.
I3	Chenopodium urbicum L.
I3	Chloris verticillata Nutt.
I3	Chondrilla juncea L.
I3	Coreopsis lanceolata L.
I3	Crataegus phaenopyrum (L. f.) Medik.
I3	Croton glandulosus L. var. septentrionalis Muell.-Arg.
I3	Cycloloma atriplicifolium (Spreng.) Coult.
I3	Cynodon dactylon (L.) Pers.
I3	Cynoglossum officinale L.
I3	Cytisus scoparius (L.) Link var. scoparius
I3	Descurainia sophia (L.) Webb ex Prantl
I3	Dianthus armeria L.
I3	Draba verna L.
I3	Echinochloa frumentacea Link
I3	Eichhornia crassipes (Mart.) Solms
I3	Elaeagnus angustifolia L.

I3	Epilobium hirsutum L.
I3	Epipactis helleborine (L.) Crantz
I3	Eragrostis minor Host
I3	Eragrostis pilosa (L.) Beauv.
I3	Erica tetralix L.
I3	Erodium cicutarium (L.) L'H?r. ex Ait. ssp. cicutarium
I3	Erysimum cheiranthoides L.
I3	Euonymus europaea L.
I3	Euphorbia dentata Michx. var. dentata
I3	Euphorbia esula L. var. esula
I3	Festuca trachyphylla (Hack.) Krajina
I3	Fragaria vesca L. var. vesca
I3	Froelichia floridana (Nutt.) Moq. var. floridana
I3	Galeopsis tetrahit L. var. tetrahit
I3	Galinsoga quadriradiata Cav.
I3	Galium wirtgenii F.W. Schultz
I3	Geranium pusillum L.
I3	Geranium sibiricum L.
I3	Glossostigma diandrum (L.) Kunze
I3	Gnaphalium uliginosum L.
I3	Helenium flexuosum Raf.
I3	Helianthus annuus L.
I3	Helianthus mollis Lam.
I3	Heracleum sphondylium L. ssp. sibiricum (L.) Simonkai
I3	Hieracium caespitosum Dumort.
I3	Hieracium pilosella L. var. pilosella
I3	Hieracium piloselloides Vill.
I3	Hieracium sabaudum L.
I3	Hieracium x flagellare Willd. (pro sp.) var. flagellare
I3	Holcus lanatus L.
I3	Hosta ventricosa (Salisb.) Stearn
I3	Humulus japonicus Sieb. & Zucc.
I3	Humulus lupulus L. var. lupulus
I3	Hydrocotyle sibthorpioides Lam.
I3	Hypericum perforatum L.
I3	Inula helenium L.
I3	Ipomoea coccinea L.
I3	Ipomoea hederacea Jacq.
I3	Ipomoea purpurea (L.) Roth
I3	Jasione montana L.
I3	Kyllinga gracillima Miq.
I3	Lactuca serriola L.
I3	Lamium purpureum L. var. purpureum
I3	Leonurus cardiaca L. var. cardiaca
I3	Lepidium campestre (L.) Ait. f.
I3	Lepidium densiflorum Schrad. var. densiflorum
I3	Lespedeza thunbergii (DC.) Nakai

I3	Liatris pycnostachya Michx. var. pycnostachya
I3	Ligustrum obtusifolium Sieb. & Zucc.
I3	Ligustrum ovalifolium Hassk.
I3	Lobelia chinensis Lour.
I3	Lolium perenne L. var. aristatum Willd.
I3	Lolium perenne L. var. perenne
I3	Lolium pratense (Huds.) S.J. Darbyshire
I3	Lonicera tatarica L.
I3	Lonicera x bella Zabel
I3	Lotus corniculatus L.
I3	Lychnis flos-cuculi L.
I3	Lycium barbarum L.
I3	Lysimachia punctata L.
I3	Lysimachia vulgaris L.
I3	Maclura pomifera (Raf.) Schneid.
I3	Malus ioensis (Wood) Britt. var. ioensis
I3	Marsilea quadrifolia L.
I3	Medicago lupulina L.
I3	Medicago sativa L. ssp. sativa
I3	Mentha spicata L.
I3	Mentha x piperita L. (pro sp.)
I3	Mirabilis nyctaginea (Michx.) MacM.
I3	Molinia caerulea (L.) Moench
I3	Mollugo verticillata L.
I3	Myriophyllum aquaticum (Vell.) Verdc.
I3	Nepeta cataria L.
I3	Nymphoides peltata (Gmel.) Kuntze
I3	Oenothera clelandii W. Dietr., Raven & W.L. Wagner
I3	Ornithogalum umbellatum L.
I3	Oxalis corniculata L.
I3	Pennisetum glaucum (L.) R. Br.
I3	Perilla frutescens (L.) Britt. var. frutescens
I3	Philadelphus coronarius L.
I3	Philadelphus inodorus L.
I3	Pinus sylvestris L.
I3	Plantago aristata Michx.
I3	Poa annua L.
I3	Poa compressa L.
I3	Poa nemoralis L. var. nemoralis
I3	Poa pratensis L. ssp. pratensis
I3	Poa trivialis L.
I3	Polygonum aviculare L.
I3	Polygonum caespitosum Blume var. longisetum (de Bruyn) A.N. Steward
I3	Polygonum convolvulus L. var. convolvulus
I3	Polygonum persicaria L.
I3	Polygonum scandens var. dumetorum (L.) Gleason
I3	Potentilla argentea L. var. argentea

I3	Potentilla recta L.
I3	Prunus avium (L.) L.
I3	Prunus munsoniana W. Wight & Hedrick
I3	Pseudosasa japonica (Sieb. & Zucc. ex Steud.) Makino ex Nakai
I3	Puccinellia distans (Jacq.) Parl. ssp. distans
I3	Ribes uva-crispa L. var. sativum DC.
I3	Robinia hispida L. var. hispida
I3	Rorippa sylvestris (L.) Bess.
I3	Rosa canina L.
I3	Rosa eglanteria L.
I3	Rumex altissimus Wood
I3	Sagina apetala Ard.
I3	Salix alba L.
I3	Salsola kali L. ssp. kali
I3	Saponaria officinalis L.
I3	Sedum acre L.
I3	Sedum sarmentosum Bunge
I3	Sedum telephium L.
I3	Setaria faberi Herrm.
I3	Setaria viridis (L.) Beauv. var. major (Gaudin) Pospichal
I3	Silene vulgaris (Moench) Garcke
I3	Sinapis arvensis L.
I3	Sisymbrium altissimum L.
I3	Sisymbrium officinale (L.) Scop.
I3	Sonchus arvensis L. ssp. arvensis
I3	Sonchus asper (L.) Hill
I3	Sorghum halepense (L.) Pers.
I3	Spergula morisonii Boreau
I3	Spergularia rubra (L.) J.& K. Presl
I3	Spergularia salina J.& K. Presl
I3	Strophostyles leiosperma (Torr. & Gray) Piper
I3	Taxodium distichum (L.) L.C. Rich.
I3	Tragopogon dubius Scop.
I3	Tragopogon pratensis L.
I3	Trifolium arvense L.
I3	Trifolium aureum Pollich
I3	Trifolium campestre Schreb.
I3	Trifolium dubium Sibthorp
I3	Trifolium hybridum L.
I3	Trifolium pratense L.
I3	Trifolium repens L.
I3	Tussilago farfara L.
I3	Urtica dioica L. var. dioica
I3	Valerianella locusta (L.) Lat.
I3	Verbascum blattaria L.
I3	Verbena stricta Vent.
I3	Viburnum opulus var. opulus

I3	Vicia cracca L. ssp. cracca
I3	Vicia grandiflora Scop.
I3	Vicia hirsuta (L.) S.F. Gray
I3	Vicia sativa L. ssp. sativa
I3	Vicia tetrasperma (L.) Schreb.
I3	Vicia villosa Roth ssp. varia (Host) Corb.
I3	Vicia villosa Roth ssp. villosa
I3	Yucca filamentosa L.
I3I4	Artemisia absinthium L.
I3I4	Hibiscus trionum L.
I3I4	Myosoton aquaticum (L.) Moench
I3I4	Rorippa prostrata (Bergeret) Schinz & Thellung
I3I4	Sonchus oleraceus L.
I3I4	Thlaspi arvense L.
I4	Abutilon theophrasti Medik.
I4	Acalypha australis L.
I4	Acalypha ostryifolia Riddell
I4	Acalypha poiretii Spreng.
I4	Acer pseudoplatanus L.
I4	Achillea ptarmica L.
I4	Acicarpha tribuloides Juss.
I4	Acinos arvensis (Lam.) Dandy
I4	Aesculus glabra Willd. var. glabra
I4	Aesculus hippocastanum L.
I4	Aethusa cynapium L.
I4	Agrostemma githago L.
I4	Agrostis canina L.
I4	Ajuga genevensis L.
I4	Ajuga reptans L.
I4	Alcea rosea L.
I4	Alopecurus geniculatus L. var. geniculatus
I4	Alopecurus myosuroides Huds.
I4	Alternanthera paronichyoides St.-Hil. var. paronichyoides
I4	Althaea officinalis L.
I4	Alyssum alyssoides (L.) L.
I4	Amaranthus arenicola I. M. Johnston
I4	Amaranthus blitum L.
I4	Amaranthus crispus (Lesp. & Thev.) N. Terracc.
I4	Amaranthus palmeri S. Wats.
I4	Amaranthus powellii S. Wats.
I4	Amaranthus rudis Sauer
I4	Ambrosia bidentata Michx
I4	Ammannia coccinea Rottb.
I4	Ammannia robusta Heer & Regel
I4	Amsonia tabernaemontana Walt. var. tabernaemontana
I4	Anagallis arvensis L. var. arvensis
I4	Anchusa arvensis (L.) Bieb.

I4	Anchusa officinalis L.
I4	Anethum graveolens L.
I4	Anoda cristata (L.) Schlecht.
I4	Anthemis tinctoria L.
I4	Anthoxanthum aristatum Boiss.
I4	Anthyllis vulneraria L.
I4	Apera interrupta (L.) Beauv.
I4	Aphanes arvensis L.
I4	Apium graveolens L. var. dulce (P. Mill.) DC.
I4	Apium nodiflorum (L.) Lag.
I4	Aquilegia vulgaris L.
I4	Arachis hypogaea L.
I4	Arctium tomentosum P. Mill.
I4	Argemone mexicana L.
I4	Argentina anserina (L.) Rydb.
I4	Armoracia rusticana P.G. Gaertn., B. Mey. & Scherb.
I4	Artemisia biennis Willd. var. biennis
I4	Artemisia pontica L.
I4	Asperugo procumbens L.
I4	Asplenium scolopendrium L. var. americanum (Fern.) Kartesz & Gandhi
I4	Aster tataricus L. f.
I4	Astragalus glycyphyllos L.
I4	Atriplex nitens Schkuhr
I4	Atriplex patula L.
I4	Atriplex rosea L.
I4	Atriplex tatarica L.
I4	Atropa bella-donna L.
I4	Avena fatua L.
I4	Avena sativa L.
I4	Avena sterilis L.
I4	Ballota nigra L. var. nigra
I4	Baptisia australis (L.) R. Br. ex Ait. f. var. australis
I4	Baptisia bracteata Muhl. ex Ell. var. leucophaea (Nutt.) Kartesz & Gandhi
I4	Bassia hyssopifolia (Pallas) Kuntz
I4	Belamcanda chinensis (L.) DC.
I4	Bellis perennis L.
I4	Betula pendula Roth
I4	Betula pubescens Ehrh. ssp. pubescens
I4	Betula x caerulea Blanch. (pro sp.)
I4	Bifora radians Bieb.
I4	Boltonia asteroides (L.) L'Her. var. recognita (Fern. & Grisc.) Cronq.
I4	Borago officinalis L.
I4	Brassica napus L.
I4	Briza maxima L.
I4	Briza minor L.
I4	Bromus arvensis L.
I4	Bromus briziformis Fisch. & C.A. Mey.

I4	Bromus catharticus Vahl
I4	Bromus hordeaceus L. ssp. hordeaceus
I4	Bromus rigidus Roth
I4	Bromus squarrosus L.
I4	Bunias orientalis L.
I4	Bupleurum rotundifolium L.
I4	Cakile maritima Scop. ssp. maritima
I4	Calamagrostis epigeios (L.) Roth var. epigeios
I4	Calamintha nepeta (L.) Savi ssp. nepeta
I4	Calibrachoa parviflora (Juss.) D'Arcy
I4	Camelina microcarpa DC.
I4	Camelina sativa (L.) Crantz ssp. sativa
I4	Campanula rapunculoides L.
I4	Cannabis sativa L. ssp. sativa var. sativa
I4	Cardamine hirsuta L.
I4	Cardamine pratensis L. var. pratensis
I4	Cardiospermum halicacabum L.
I4	Carduus crispus L.
I4	Carduus tenuiflorus W. Curtis
I4	Carex hirta L.
I4	Carex texensis (Torr.) Bailey
I4	Carum carvi L.
I4	Celosia argentea L.
I4	Centaurea calcitrapa L.
I4	Centaurea cyanus L.
I4	Centaurea diffusa Lam.
I4	Centaurea melitensis L.
I4	Centaurea scabiosa L.
I4	Centaurea solstitialis L.
I4	Cerastium glomeratum Thuill.
I4	Cerastium pumilum W. Curtis
I4	Chaerophyllum temulum L.
I4	Chaiturus marrubiastrum (L.) Reichenb.
I4	Chamaemelum mixtum (L.) All.
I4	Chamaemelum nobile (L.) All.
I4	Chamaesyce serpens (Kunth) Small
I4	Chenopodium botrys L.
I4	Chenopodium capitatum (L.) Ambrosi
I4	Chenopodium glaucum L.
I4	Chenopodium humile Hook.
I4	Chenopodium multifidum L.
I4	Chenopodium murale L.
I4	Chenopodium opulifolium Schrad. ex Koch & Ziz
I4	Chenopodium polyspermum L. var. obtusifolium Gaud.
I4	Citrullus lanatus (Thunb.) Matsumura & Nakai var. lanatus
I4	Cleome hassleriana Chod.
I4	Cleome viscosa L.

I4	Clintonia umbellulata (Michx.) Morong
I4	Coix lacryma-jobi L.
I4	Collomia linearis Nutt.
I4	Colutea arborescens L.
I4	Commelina diffusa Burm. f. var. diffusa
I4	Commelina virginica L.
I4	Conringia orientalis (L.) Dumort.
I4	Consolida ajacis (L.) Schur
I4	Consolida regalis S.F. Gray
I4	Convallaria majalis L.
I4	Convolvulus arvensis L.
I4	Corchorus tridens L.
I4	Coreopsis grandiflora Hogg ex Sweet var. harveyana (Gray) Sherff
I4	Coreopsis tinctoria Nutt. var. tinctoria
I4	Coreopsis verticillata L.
I4	Coriandrum sativum L.
I4	Coronopus didymus (L.) Sm
I4	Coronopus squamatus (Forsk.) Aschers.
I4	Corynephorus canescens (L.) Beauv.
I4	Cosmos sulphureus Cav.
I4	Cotinus coggygria Scop.
I4	Crataegus monogyna Jacq.
I4	Crepis capillaris (L.) Wallr.
I4	Crepis tectorum L.
I4	Crotalaria retusa L.
I4	Crypsis schoenoides (L.) Lam.
I4	Cuscuta epithymum (L.) L.
I4	Cymbalaria muralis P.G. Gaertn., B. Mey. & Scherb.
I4	Cynanchum rossicum (Kleopov) Barbarich
I4	Cynosurus cristatus L.
I4	Cynosurus echinatus L.
I4	Cyperus aggregatus (Willd.) Endl.
I4	Cyperus compressus L.
I4	Cyperus croceus Vahl
I4	Cyperus eragrostis Lam.
I4	Cyperus fuscus L.
I4	Cyperus rotundus L.
I4	Cyperus schweinitzii Torr.
I4	Cyperus serotinus Rottb.
I4	Cyperus virens Michx.
I4	Dactyloctenium aegyptium (L.) Willd.
I4	Datura inoxia P. Mill.
I4	Datura wrightii Regel
I4	Descurainia pinnata (Walt.) Britt. var. brachycarpa (Richards.) Fern.
I4	Desmazeria rigida (L.) Tutin
I4	Deutzia scabra Thunb.
I4	Dianthus barbatus L.

I4	Dianthus deltoides L.
I4	Digitalis purpurea L. var. purpurea
I4	Digitaria ciliaris (Retz.) Koel.
I4	Dionaea muscipula Ellis
I4	Diplotaxis erucoides (L.) DC.
I4	Diplotaxis muralis (L.) DC.
I4	Diplotaxis tenuifolia (L.) DC.
I4	Dittrichia graveolens (L.) W. Greuter
I4	Dracocephalum parviflorum Nutt.
I4	Echinochloa colona (L.) Link
I4	Echium pustulatum Sibthorp & Sm.
I4	Egeria densa Planch.
I4	Eleusine tristachya (Lam.) Lam.
I4	Elymus repens (L.) Gould
I4	Emex spinosa (L.) Campd.
I4	Eragrostis cumingii Steud.
I4	Eranthis hyemalis (L.) Salisb.
I4	Erodium moschatum (L.) L'H?r. ex Ait. var. moschatum
I4	Eryngium campestre L.
I4	Eryngium maritimum L.
I4	Erysimum repandum L.
I4	Euphorbia exigua L.
I4	Euphorbia helioscopia L.
I4	Euphorbia lathyris L.
I4	Euphorbia marginata Pursh
I4	Euphorbia peplus L.
I4	Euphorbia segetalis L.
I4	Fagopyrum esculentum Moench
I4	Festuca filiformis Pourret
I4	Filago vulgaris Lam.
I4	Filipendula ulmaria (L.) Maxim. ssp. ulmaria
I4	Fimbristylis vahlii (Lam.) Link
I4	Foeniculum vulgare P. Mill.
I4	Fragaria x ananassa Duchesne (pro sp.) var. ananassa
I4	Frangula alnus P. Mill.
I4	Fumaria officinalis L. ssp. officinalis
I4	Galeopsis ladanum L. var. ladanum
I4	Galinsoga parviflora Cav.
I4	Galium odoratum (L.) Scop.
I4	Galium tricornutum Dandy
I4	Gaura villosa Torr. ssp. villosa
I4	Geranium columbinum L.
I4	Geranium dissectum L.
I4	Geranium ibericum Cav.
I4	Geranium molle L.
I4	Geranium rotundifolium L.
I4	Geranium sanguineum L.

I4	Glaucium flavum Crantz
I4	Glycine max (L.) Merr.
I4	Gossypium hirsutum L. var. hirsutum
I4	Grindelia squarrosa (Pursh) Dunal var. squarrosa
I4	Guizotia abyssinica (L. f.) Cass.
I4	Gymnocladus dioicus (L.) K. Koch
I4	Gypsophila muralis L.
I4	Halesia tetraptera Ellis var. tetraptera
I4	Helianthus grosseserratus Martens
I4	Helianthus maximiliani Schrad.
I4	Helianthus occidentalis Riddell ssp. occidentalis
I4	Helianthus pauciflorus Nutt. ssp. pauciflorus
I4	Helianthus x doronicoides Lam. (pro sp.)
I4	Helianthus x luxurians E.E. Wats. (pro sp.)
I4	Heliotropium amplexicaule Vahl
I4	Heliotropium curassavicum L. var. curassavicum
I4	Heliotropium europaeum L.
I4	Helleborus viridis L.
I4	Hemerocallis lilioasphodelus L.
I4	Herniaria glabra L.
I4	Heterotheca camporum (Greene) Shinners var. camporum
I4	Hibiscus syriacus L.
I4	Hieracium aurantiacum L.
I4	Hieracium lachenalii K.C. Gmel.
I4	Hieracium murorum L.
I4	Hieracium x floribundum Wimmer & Grab. (pro sp.)
I4	Holcus mollis L.
I4	Holosteum umbellatum L.
I4	Hordeum brachyantherum Nevski ssp. brachyantherum
I4	Hordeum marinum Huds. ssp. gussonianum (Parl.) Thellung
I4	Hordeum marinum Huds. ssp. marinum
I4	Hordeum murinum L. ssp. leporinum (Link) Arcang.
I4	Hordeum pusillum Nutt.
I4	Hordeum vulgare L.
I4	Hosta lancifolia Engl.
I4	Hyoscyamus albus L.
I4	Hyoscyamus niger L.
I4	Hyssopus officinalis L.
I4	Ipomoea lacunosa L.
I4	Ipomopsis rubra (L.) Wherry
I4	Iris germanica L.
I4	Isatis tinctoria L.
I4	Iva xanthifolia Nutt.
I4	Jasminum nudiflorum Lindl.
I4	Kerria japonica (L.) DC.
I4	Kickxia elatine (L.) Dumort.
I4	Kickxia spuria (L.) Dumort.

I4	Knautia arvensis (L.) Coult.
I4	Kummerowia stipulacea (Maxim.) Makino
I4	Kummerowia striata (Thunb.) Schindl.
I4	Lablab purpureus (L.) Sweet
I4	Lactuca sativa L.
I4	Lagurus ovatus L.
I4	Lamium album L.
I4	Lamium maculatum L.
I4	Lamium purpureum L. var. incisum (Willd.) Pers.
I4	Lappula squarrosa (Retz.) Dumort.
I4	Lapsana communis L.
I4	Larix decidua P. Mill.
I4	Lathyrus latifolius L.
I4	Lathyrus pratensis L.
I4	Lathyrus tuberosus L.
I4	Lens culinaris Medik.
I4	Leontodon autumnalis L. ssp. autumnalis
I4	Leontodon taraxacoides (Vill.) M?rat ssp. taraxacoides
I4	Lepidium graminifolium L.
I4	Lepidium ruderale L.
I4	Lepidium sativum L.
I4	Leptochloa fusca (L.) Kunth ssp. uninervia (J. Presl) N. Snow, comb. nov. ined.
I4	Leptochloa panicea (Retz.) Ohwi ssp. brachiata (Steudl.) N. Snow, comb. nov. ined.
I4	Lespedeza bicolor Turcz.
I4	Leucospora multifida (Michx.) Nutt.
I4	Levisticum officinale W. D. J. Koch
I4	Ligustrum amurense Carr.
I4	Lilium lancifolium Thunb.
I4	Linaria dalmatica (L.) P. Mill. ssp. dalmatica
I4	Linaria repens (L.) P. Mill.
I4	Linaria supina (L.) Chaz.
I4	Linum usitatissimum L.
I4	Lipocarpha maculata (Michx.) Torr.
I4	Lithospermum officinale L.
I4	Lobularia maritima (L.) Desv.
I4	Lolium temulentum L. ssp. temulentum
I4	Lonicera xylosteum L.
I4	Ludwigia grandiflora (M. Micheli) Greuter & Burdet
I4	Lychnis coronaria (L.) Desr.
I4	Lythrum hyssopifolia L.
I4	Magnolia acuminata (L.) L.
I4	Mahonia aquifolium (Pursh) Nutt.
I4	Malus pumila P. Mill.
I4	Malva alcea L.
I4	Malva moschata L.
I4	Malva neglecta Wallr.
I4	Malva nicaeensis All.

I4	Malva parviflora L.
I4	Malva sylvestris L.
I4	Malva verticillata L.
I4	Malvastrum coromandelianum (L.) Garcke
I4	Marrubium vulgare L.
I4	Matricaria discoidea DC.
I4	Matricaria recutita L.
I4	Mazus pumilus (Burm. f.) Steenis
I4	Medicago arabica (L.) Huds.
I4	Medicago littoralis Rhode ex Loisel.
I4	Medicago minima (L.) L.
I4	Medicago orbicularis (L.) Bartalini
I4	Medicago polymorpha L.
I4	Medicago sativa L. ssp. falcata (L.) Arcang.
I4	Melilotus altissimus Thuill.
I4	Melilotus indicus (L.) All.
I4	Melilotus neapolitanus Ten.
I4	Melilotus sulcatus Desf.
I4	Melissa officinalis L.
I4	Mentha aquatica L.
I4	Mentha arvensis L. var. arvensis
I4	Mentha longifolia (L.) L.
I4	Mentha pulegium L.
I4	Mentha suaveolens Ehrh.
I4	Mentha x gracilis Sole (pro sp.)
I4	Mentha x rotundifolia (L.) Huds. (pro sp.)
I4	Mentha x verticillata L.
I4	Mentha x villosa Huds. (pro sp.)
I4	Mercurialis annua L.
I4	Mirabilis hirsuta (Pursh) MacM.
I4	Mirabilis linearis (Pursh) Heimerl
I4	Misopates orontium (L.) Raf.
I4	Muscari botryoides (L.) P. Mill.
I4	Myosotis arvensis (L.) Hill
I4	Myosotis discolor Pers.
I4	Myosotis stricta Link ex Roemer & J.A. Schultes
I4	Narcissus pseudonarcissus L.
I4	Nelumbo nucifera Gaertn.
I4	Neslia paniculata (L.) Desv.
I4	Nicandra physalodes (L.) Gaertn.
I4	Nicotiana glauca Graham
I4	Nicotiana longiflora Cav.
I4	Nicotiana tabacum L.
I4	Oenothera glazioviana Micheli
I4	Oenothera grandiflora L'H?r. ex Ait.
I4	Oenothera grandis (Britt.) Smyth
I4	Oenothera mollissima L.

I4	Oenothera pilosella Raf. ssp. pilosella
I4	Onopordum acanthium L.
I4	Orobanche minor Sm.
I4	Oryzopsis miliacea (L.) Benth. & Hook. f. ex Aschers. & Schweinf.
I4	Panicum miliaceum L. ssp. miliaceum
I4	Papaver dubium L.
I4	Papaver somniferum L.
I4	Parapholis incurva (L.) C.E. Hubbard
I4	Parietaria judaica L.
I4	Parthenium hysterophorus L.
I4	Paspalum distichum L.
I4	Paspalum notatum Fluegg? var. notatum
I4	Paspalum scrobiculatum L.
I4	Penstemon calycosus Small
I4	Penstemon pallidus Small
I4	Petasites hybridus (L.) P.G. Gaertn., B. Mey. & Scherb.
I4	Petrorhagia prolifera (L.) P.W. Ball & Heywood
I4	Petrorhagia saxifraga (L.) Link
I4	Petunia axillaris (Lam.) B.S.P.
I4	Petunia integrifolia (Hook.) Schinz & Thellung
I4	Petunia x atkinsiana D. Don ex Loud.
I4	Phalaris minor Retz.
I4	Phalaris paradoxa L.
I4	Phleum arenarium L.
I4	Phlox paniculata L.
I4	Phyla nodiflora (L.) Greene
I4	Physalis alkekengi L.
I4	Physalis angulata L.
I4	Physalis peruviana L.
I4	Physalis philadelphica Lam. var. immaculata Waterfall
I4	Physostegia virginiana (L.) Benth. var. virginiana
I4	Picea abies (L.) Karst.
I4	Picris echioides L.
I4	Picris hieracioides L. ssp. hieracioides
I4	Pimpinella saxifraga L. ssp. saxifraga
I4	Pinellia ternata (Thunb.) Makino ex Breitenbach
I4	Pinus nigra Arnold
I4	Plantago coronopus L.
I4	Plantago media L.
I4	Plantago patagonica Jacq.
I4	Plantago psyllium L.
I4	Poa bulbosa L.
I4	Polemonium caeruleum L.
I4	Polygonum bellardii All.
I4	Polygonum plebeium R. Br.
I4	Polypogon monspeliensis (L.) Desf.
I4	Polypogon viridis (Gouan) Breistr.

I4	Populus nigra L.
I4	Populus x canescens (Ait.) Sm. (pro sp.)
I4	Populus x jackii Sarg.
I4	Portulaca grandiflora Hook.
I4	Portulaca oleracea L.
I4	Portulaca pilosa L.
I4	Potentilla intermedia L.
I4	Potentilla reptans L.
I4	Proboscidea louisianica (P. Mill.) Thellung ssp. louisianica
I4	Prunus cerasifera Ehrh.
I4	Prunus cerasus L.
I4	Prunus domestica L. var. domestica
I4	Prunus domestica L. var. insititia (L.) Fiori & Paoletti
I4	Prunus mahaleb L.
I4	Prunus padus L.
I4	Prunus persica (L.) Batsch
I4	Puccinellia americana Sorensen
I4	Puccinellia distans (Jacq.) Parl. ssp. borealis (Holmb.) W.E. Hughes
I4	Puccinellia rupestris (With.) Fern. & Weatherby
I4	Pyrus communis L.
I4	Ranunculus arvensis L.
I4	Ranunculus repens L.
I4	Ranunculus sardous Crantz
I4	Raphanus raphanistrum L.
I4	Rapistrum rugosum (L.) All. ssp. rugosum
I4	Ratibida columnifera (Nutt.) Woot. & Standl.
I4	Reseda alba L.
I4	Reseda lutea L.
I4	Reseda odorata L.
I4	Rhododendron japonicum (Gray) Sur.
I4	Richardia brasiliensis Gomes
I4	Richardia humistrata (Cham. & Schlecht.) J.A. & J.H. Schultes
I4	Ricinus communis L.
I4	Robinia viscosa Vent. var. viscosa
I4	Rorippa austriaca (Crantz) Bess.
I4	Rorippa palustris (L.) Bess. var. palustris
I4	Rosa centifolia L.
I4	Rosa gallica L.
I4	Rosa setigera Michx. var. tomentosa Torr. & Gray
I4	Rosa spinosissima L.
I4	Rubus ulmifolius Schott var. inermis (Willd.) Focke
I4	Rumex acetosa L. ssp. acetosa
I4	Rumex conglomeratus Murr.
I4	Rumex maritimus L.
I4	Rumex patientia L.
I4	Rumex pulcher L.
I4	Rumex salicifolius Weinm. var. mexicanus (Meisn.) C.L. Hitchc.

I4	Rumex sanguineus L.
I4	Sagina procumbens L.
I4	Salix babylonica L.
I4	Salix pentandra L.
I4	Salix purpurea L.
I4	Salix viminalis L.
I4	Salix x rubens Schrank (pro sp.)
I4	Salsola tragus L.
I4	Salvia pratensis L.
I4	Salvia reflexa Hornem.
I4	Salvia verticillata L.
I4	Sambucus ebulus L.
I4	Sanguisorba minor Scop. ssp. muricata (Spach) Nordborg
I4	Sarracenia flava L.
I4	Satureja hortensis L.
I4	Scabiosa columbaria L.
I4	Scandix pecten-veneris L.
I4	Schoenoplectus lacustris (L.) Palla
I4	Schoenoplectus mucronatus (L.) Palla
I4	Scilla siberica Haw.
I4	Scleranthus annuus L.
I4	Scleria oligantha Michx.
I4	Scoparia flava Cham. & Schlecht.
I4	Scrophularia canina L. ssp. canina
I4	Scrophularia canina L. ssp. hoppii (Koch) Fourn.
I4	Scrophularia nodosa L.
I4	Scrophularia umbrosa Dumort.
I4	Secale cereale L.
I4	Sedum alboroseum Baker
I4	Sedum album L.
I4	Sedum reflexum L.
I4	Sedum spurium Bieb.
I4	Senecio jacobaea L.
I4	Senecio viscosus L.
I4	Senecio vulgaris L.
I4	Setaria italica (L.) Beauv.
I4	Setaria setosa (Sw.) Beauv. var. setosa
I4	Setaria verticillata (L.) Beauv.
I4	Setaria verticilliformis Dunart.
I4	Setaria viridis (L.) Beauv. var. viridis
I4	Sherardia arvensis L.
I4	Sida rhombifolia L.
I4	Sida spinosa L
I4	Sida stipularis Cav.
I4	Silene armeria L.
I4	Silene conica L.
I4	Silene csereii Baumg.

I4	Silene dichotoma Ehrh.
I4	Silene dioica (L.) Clairville
I4	Silene gallica L.
I4	Silene latifolia Poir. ssp. alba (P. Mill.) Greuter & Burdet
I4	Silene noctiflora L.
I4	Sinapis alba L.
I4	Solanum americanum P. Mill.
I4	Solanum physalifolium Rusby
I4	Solanum rostratum Dunal
I4	Solanum sisymbriifolium Lam.
I4	Solidago missouriensis Nutt. var. missouriensis
I4	Sonchus arvensis L. ssp. uliginosus (Bieb.) Nyman
I4	Sorghum bicolor (L.) Moench var. bicolor
I4	Spergula arvensis L.
I4	Spergula pentandra L.
I4	Spermolepis divaricata (Walt.) Raf. ex Ser.
I4	Spiraea prunifolia Sieb. & Zucc.
I4	Spiraea x billiardii Herincq. (pro sp.)
I4	Sporobolus contractus A.S. Hitchc.
I4	Sporobolus cryptandrus (Torr.) Gray
I4	Sporobolus indicus (L.) R. Br. var. indicus
I4	Stachys annua (L.) L.
I4	Stachys arvensis (L.) L.
I4	Stachys germanica L.
I4	Stachys ocymastrum (L.) Brig.
I4	Stachys palustris L.
I4	Stachys sylvatica L.
I4	Stellaria graminea L.
I4	Symphytum officinale L.
I4	Syringa vulgaris L.
I4	Tanacetum parthenium (L.) Schultz-Bip.
I4	Tanacetum vulgare L.
I4	Teesdalia nudicaulis (L.) Ait. f.
I4	Thermopsis villosa (Walt.) Fern. & Schub.
I4	Thinopyrum intermedium (Host) Barkworth & D.R. Dewey
I4	Thymus praecox Opiz ssp. arcticus (Dur.) Jalas
I4	Torilis arvensis (Huds.) Link
I4	Torilis nodosa (L.) Gaertn.
I4	Tragopogon porrifolius L.
I4	Tragus racemosus (L.) All.
I4	Trianthema portulacastrum L.
I4	Tribulus terrestris L.
I4	Trifolium fragiferum L.
I4	Trifolium incarnatum L.
I4	Trifolium lappaceum L.
I4	Trifolium scabrum L.
I4	Trifolium squamosum L.

I4	Trifolium striatum L.
I4	Trifolium subterraneum L.
I4	Trillium grandiflorum (Michx.) Salisb.
I4	Trisetum flavescens (L.) Beauv.
I4	Triticum aestivum L.
I4	Urochloa adspersa (Trin.) R. Webster
I4	Urochloa plantaginea (Link) R. Webster
I4	Urtica urens L.
I4	Vaccaria hispanica (P. Mill.) Rauschert
I4	Valeriana officinalis L.
I4	Verbascum lychnitis L.
I4	Verbascum phlomoides L.
I4	Verbascum sinuatum L.
I4	Verbena bonariensis L. var. bonariensis
I4	Verbena bracteata Lag. & Rodr.
I4	Verbena officinalis L. var. officinalis
I4	Veronica agrestis L.
I4	Veronica arvensis L.
I4	Veronica austriaca L. ssp. teucrium (L.) D.A. Webb
I4	Veronica chamaedrys L.
I4	Veronica longifolia L.
I4	Veronica persica Poir.
I4	Veronica serpyllifolia L. var. serpyllifolia
I4	Vicia monantha Retz.
I4	Vicia sativa L. ssp. nigra (L.) Ehrh.
I4	Viola arvensis Murr.
I4	Viola odorata L.
I4	Viola tricolor L.
I4	Wisteria frutescens (L.) Poir.
I4	Xanthium spinosum L.
I4	Xanthium strumarium L. var. strumarium
I4	Zea mays L. ssp. mays

Appendix 3
List of Agricultural Weeds in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Source: Meade 2007

Scientific Name	Common Name	New Jersey Nativity
Abutilon theophrasti	velvet leaf	Non-Native
Ailanthus altissima	tree-of-heaven	Non-Native
Alliaria petiolata	garlic mustard	Non-Native
Allium vineale	wild garlic	Non-Native
Alopecurus pratensis	meadow foxtail	Non-Native
Amaranthus hybridus	smooth pigweed	Non-Native
Amaranthus lividus (blitum)	prostrate pigweed	Non-Native
Amaranthus retroflexus	redroot pigweed	Non-Native
Amaranthus spinosus	spiny pigweed	Non-Native
Anagallis arvensis	scarlet pimpernel	Non-Native
Anoda cristata	spurred anoda	Non-Native
Anthemis arvensis	corn chamomile	Non-Native
Anthemis cotula	mayweed	Non-Native
Anthoxanthum odoratum	sweet vernal grass	Non-Native
Arctium spp. (minus)	burdock species	Non-Native
Artemisia vulgaris	common mugwort	Non-Native
Bambusa spp.	bamboo grass species	Non-Native
Barbarea vulgaris	yellow rocket	Non-Native
Berberis thunbergi	Japanese barberry	Non-Native
Brassica napus (rapa)	wild turnip	Non-Native
Calystegia sepium	hedge bindweed	Non-Native
Capsella bursa-pastoris	Shepard's purse	Non-Native
Cardamine spp. (hirsuta)	bittercress species	Non-Native
Carduus nutans	musk thistle	Non-Native
Centaurea maculosa	spotted knapweed	Non-Native
Cerastium vulgatum	mouse-ear chickweed	Non-Native
Chenopodium album	lamb's quarters	Non-Native
Chrysanthemum leucanthemum	oxeye daisy	Non-Native
Cichorium intybus	chicory	Non-Native
Cirsium arvense	Canada thistle	Non-Native
Cirsium vulgare	bull thistle	Non-Native
Convolvulus arvensis	field bindweed	Non-Native
Daucus carota	Queen Anne's lace	Non-Native
Digitaria spp.	crabgrass species	Non-Native
Dipsacus sylvestris	teasel	Non-Native
Draba verna	whitlow grass	Non-Native
Duchesnea indica	Indian strawberry	Non-Native
Echinochloa crusgalli	barnyard grass	Non-Native
Eleusine indica	goosegrass	Non-Native
Elytrigia repens	quackgrass	Non-Native
Erodium cicutarium	redstem filaree	Non-Native
Galinsoga spp.	galinsoga species	Non-Native
Glechoma hederacea	ground ivy	Non-Native
Helianthus tuberosus	Jerusalem artichoke	Non-Native
Hypochoeris radicata	false dandelion	Non-Native
Ipomoea hederacea	ivy-leafed morning glory	Non-Native
Lactuca serriola	prickly lettuce	Non-Native
Lamium amplexicaule	henbit	Non-Native
Lamium purpureum	purple dead nettle	Non-Native
Leontodon autumnalis	fall dandelion	Non-Native
Lonicera japonica	Japanese honeysuckle	Non-Native
Lysimachia nummularia	moneywort	Non-Native
Malva neglecta	roundleaf mallow	Non-Native
Matricaria matricarioides	pineapple weed	Non-Native
Medicago lupulina	black medic	Non-Native
Melilotus officinalis	white sweet clover	Non-Native
Microstegium vimineum	Japanese stiltgrass	Non-Native
Mollugo verticillata	carpet weed	Non-Native
Ornithogalum umbellatum	star-of-bethlehem	Non-Native
Phleum pratense	timothy	Non-Native
Phragmites australis	common reed	Non-Native

Appendix 3
List of Agricultural Weeds in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Source: Meade 2007

Scientific Name	Common Name	New Jersey Nativity
Plantago lanceolata	English plantain	Non-Native
Plantago major	broad leaf plantain	Non-Native
Polygonum cuspidatum	Japanese knotweed	Non-Native
Polygonum perfoliatum	mile-a-minute weed	Non-Native
Portulacca oleracea	purslane	Non-Native
Pueraria lobata	kudzu	Non-Native
Rosa multiflora	multifloral rose	Non-Native
Rumex acetosella	sheep sorrel	Non-Native
Rumex crispus	curly dock	Non-Native
Senecio vulgaris	common groundsel	Non-Native
Setaria faberii	giant foxtail	Non-Native
Setaria glauca	yellow foxtail	Non-Native
Sida spinosa	prickly sida	Non-Native
Silene alba (latifolia)	white campion	Non-Native
Sonchus asper	sow thistle	Non-Native
Sorghum halepense	Johnson grass	Non-Native
Taraxacum officinale	dandelion	Non-Native
Thlaspi arvense	pennycress	Non-Native
Tragopogon dubius	salsify	Non-Native
Trifolium arvense	rabbitfoot clover	Non-Native
Trifolium repens	white clover	Non-Native
Verbascum blattaria	moth mullein	Non-Native
Verbascum thapsis	common mullein	Non-Native
Achillea millefolium	yarrow	Native
Ambrosia artemisifolia	common ragweed	Native
Ambrosia trifida	giant ragweed	Native
Andropogon virginicus	broom grass	Native
Apocynum cannabinum	hemp dogbane	Native
Aristida spp.	three-awn grass species	Native
Asclepias spp.	milkweed species	Native
Aster spp.	aster species	Native
Campsis radicans	trumpet creeper	Native
Cenchrus spp.	sandbur species	Native
Conyza canadensis	horseweed	Native
Cyperus esculentus	yellow nutsedge	Native
Datura stramonium	jimsonweed	Native
Desmodium spp.	tick trefoil species	Native
Echinocystis lobata	wild cucumber	Native
Equisetum spp.	horsetail species	Native
Erigeron annuus	daisy fleabane	Native
Euphorbia maculata (supina)	spotted spurge	Native
Muhlenbergia frondosa	wirestem muhly	Native
Muhlenbergia schreberi	nimblewill	Native
Oenothera biennis	evening primrose	Native
Oenothera laciniata	cut-leaved evening primrose	Native
Opuntia humifusa	prickly pear cactus	Native
Panicum spp.	panic grass species	Native
Parthenocissus quinquefolia	Virginia creeper	Native
Paspalum laeve	field paspalum	Native
Paspalum spp.	paspalum species	Native
Polygonum aviculare	knotweed	Native
Sicyos angulatus	one-seeded bur cucumber	Native
Smilax spp.	catbriar species	Native
Solanum carolinense	horsenettle	Native
Solidago spp.	goldenrod species	Native
Stellaria graminea (longifolia)	grass leaved stichwort	Native
Triodanis perfoliata	venus looking glass	Native
Tripsacum dactyloides	Eastern gamma-grass	Native
Viola rafinesquii	field pansy	Native
Vitis spp.	grape species	Native
Xanthium strumarium	cocklebur	Native

Appendix 3
List of Agricultural Weeds in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Source: Meade 2007

Scientific Name	Common Name	New Jersey Nativity
Amaranthus spp.	pigweed species	Both
Cuscuta spp.	dodder species	Both
Galium spp.	bedstraw	Both
Hieracium spp.	hawkweed species	Both
Lactuca spp.	wild lettuce species	Both
Lepidium spp.	pepperweed species	Both
Oxalis spp.	wood sorrel species	Both
Polygonum spp.	knotweed species	Both
Potentilla spp.	cinquefoil species	Both
Rubus species	blackberry species	Both
Veronica spp.	speedwell species	Both
Vicia spp.	vetch species	Both
Viola spp.	violet species	Both

Appendix 4
List of Non-Native Animals in New Jersey
New Jersey Strategic Management Plan for Invasive Species
(only includes fish species that are entirely freshwater)
Sources: Ehrlich et al. 1988, GISP 2007, NJDEP 2007, Steves et al. 2007, USGS-NAS 2007

Scientific Name	Common Name	Taxa	Origin	Status	Current Impact	Notes
Ambloplites rupestris	rock bass	freshwater fish	North America	Unknown	Unknown	introduced game species, competition for food with similar species
Ameiurus melas	black bullhead	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter fish communities through predation
Amia calva	bowfin	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter fish communities through predation
Aporrectodea limicola	earthworm (Lumbricidae)	invertebrate	Europe	Invasive	Unknown	may dramatically alter forest soils leading to soil erosion and changes in nutrient availability; often associated with infestations of invasive plant species
Astronotus ocellatus	oscar	freshwater fish	South America	Unknown	Unknown	introduced from aquarium releases, may compete with other sunfish for food and nesting locations
Bithynia tentaculata	mud bithynia	snail	Europe	Unknown	Unknown	Records for Sussex County
Carassius auratus	goldfish	freshwater fish	North America	Unknown	Unknown	introduced ornamental species, may alter aquatic vegetation and substrate
Carpodacus mexicanus	house finch	bird	North America	Invasive	Moderate	primarily associated with human habitations and agricultural fields; populations are large and may compete with native birds for food and nesting sites; introduced to the eastern U.S. in 1940's
Cipangopaludina chinensis malleata	Chinese mystery snail	snail	Asia	Unknown	Unknown	
Columba livia	rock dove	bird	Europe	Invasive	High	primarily associated with human habitations and agricultural operations; may be considered a risk to human health; foul structures
Corbicula fulminea	Asiatic clam	mussel	Asia	Invasive	Unknown	widespread outside of Pine Barrens; species may produce 'biofouling' of intake pipes in the U.S.; ecological impacts unknown; tolerant of human-caused impacts (silting, nutrient loads, etc.)
Craspedacusta sowerbyi	freshwater jellyfish	hydrozoan	Asia	Unknown	Unknown	widespread distribution
Ctenopharyngodon idella	grass carp	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter aquatic vegetation and substrate
Cygnus olor	mute swan	bird	Eurasia	Invasive	Low, Locally High	population growth rate very high in New Jersey, localized damage observed (e.g., Great Swamp National Wildlife Reguge); often associated with ponds in developed parks; may harass or displace native birds; occassionally aggressive toward humans especially while nesting

Appendix 4
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New Jersey Strategic Management Plan for Invasive Species
(only includes fish species that are entirely freshwater)
Sources: Ehrlich et al. 1988, GISP 2007, NJDEP 2007, Steves et al. 2007, USGS-NAS 2007

Scientific Name	Common Name	Taxa	Origin	Status	Current Impact	Notes
Cyprinus carpio	common carp	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter aquatic vegetation and substrate
Dendrobaena octaedra	earthworm (Lumbricidae)	invertebrate	Europe	Invasive	Unknown	may dramatically alter forest soils leading to soil erosion and changes in nutrient availability; often associated with infestations of invasive plant species
Eisenia rosea	earthworm (Lumbricidae)	invertebrate	Europe	Invasive	Unknown	may dramatically alter forest soils leading to soil erosion and changes in nutrient availability; often associated with infestations of invasive plant species
Esox lucius	Northern pike	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter fish community composition through predation, may elimate smaller native fish species
Esox lucius x masquinongy	tiger muskellunge	freshwater fish	Artificial hybrid	Unknown	Unknown	introduced game species, may alter fish community composition through predation, may elimate smaller native fish species
Esox masquinongy	muskellunge	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter fish community composition through predation, may elimate smaller native fish species
Felis domesticus	feral cats	mammal	Africa (but with significant selection for domestication)	Invasive	High	Primarily associated with human habitations; estimated to result in the death of nearly 240 million birds per year in the U.S.
Gambusia affinis	mosquitofish	freshwater fish	North America	Unknown	Unknown	introduced for mosquito control, may impact fish species through egg predation and composition of invertebrate communities -- may not be effective at controlling mosquitos
Ictalurus furcatus	blue catfish	freshwater fish	North America	Unknown	Unknown	introduced game species, may hybridize with other catfish, may alter fish species composition through predation
Ictalurus punctatus	channel catfish	freshwater fish	North America	Unknown	Unknown	introduced game species, may hybridize with other catfish, may alter fish species composition through predation
Lepomis cyanellus	green sunfish	freshwater fish	North America	Unknown	Unknown	introduced game and bait species, may alter fish communities through competition and predation
Lepomis gulosus	warmouth	freshwater fish	North America	Unknown	Unknown	introduced game and bait species, may alter fish communities through competition and predation, may hybridize with other sunfish

Appendix 4
List of Non-Native Animals in New Jersey
New Jersey Strategic Management Plan for Invasive Species
(only includes fish species that are entirely freshwater)
Sources: Ehrlich et al. 1988, GISP 2007, NJDEP 2007, Steves et al. 2007, USGS-NAS 2007

Scientific Name	Common Name	Taxa	Origin	Status	Current Impact	Notes
Lepomis macrochirus	bluegill	freshwater fish	North America	Unknown	Unknown	introduced game and bait species, may alter fish communities through competition and predation
Lepus californicus	black-tailed jackrabbit	mammal	North America	Non-Invasive	Unknown	introduced game species
Lepus capensis	European hare	mammal	Europe	Non-Invasive	Unknown	introduced game species
Lepus townsendii	white-tailed jackrabbit	mammal	North America	Non-Invasive	Unknown	introduced game species
Leuciscus idus	ide	freshwater fish	Europe	Unknown	Unknown	introduced game species, may behavior similarly to goldfish and carp
Lumbricus rubellus	earthworm (Lumbricidae)	invertebrate	Europe	Invasive	Unknown	may dramatically alter forest soils leading to soil erosion and changes in nutrient availability; often associated with infestations of invasive plant species
Lumbricus terrestris	earthworm (Lumbricidae)	invertebrate	Europe	Invasive	Unknown	may dramatically alter forest soils leading to soil erosion and changes in nutrient availability; often associated with infestations of invasive plant species
Micropterus dolomieu	smallmouth bass	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter fish community composition through predation, may elimate smaller native fish species
Micropterus salmoides	largemouth bass	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter fish community composition through predation, may elimate smaller native fish species
Misgurnus anguillicaudatus	Oriental weatherfish	freshwater fish	Asia	Unknown	Unknown	introduced aquarium species
Molothrus ater	brown-headed cowbird	bird	North America	Invasive	High	primarily associated with small forest patches, edges, grasslands, and agricultural operations; parasitize nests of native birds and kill nestlings; range expanded toward New Jersey with forest clearing for agriculture
Mus musculus	house mouse	mammal	Eurasia	Invasive	Unknown	primarily associated with human habitations, may be considered an agricultural problem and risk to human health; may compete with native small mammals
Myiopsitta monachus	monk parakeet	bird	South America	Invasive	Low	Currently known from a few isolated, but persistant breeding populations associated with urban areas. Current property damage to utility poles, but species is an agricultural pest in its native range.
Myocastor coypus	nutria	mammal	South America	Non-Invasive	Unknown	limited distribution and abundance

Appendix 4
List of Non-Native Animals in New Jersey
New Jersey Strategic Management Plan for Invasive Species
(only includes fish species that are entirely freshwater)
Sources: Ehrlich et al. 1988, GISP 2007, NJDEP 2007, Steves et al. 2007, USGS-NAS 2007

Scientific Name	Common Name	Taxa	Origin	Status	Current Impact	Notes
Oncorhynchus mykiss	rainbow trout	freshwater fish	North America	Unknown	Unknown	introduced game species, may alter fish community composition through predation, may elimate smaller native fish species
Orconectes rusticus	rusty crayfish	crustacean	North America	Unknown	Unknown	can reduce native crayfish and alter fish species composition
Orconectes virilis	virile crayfish	crustacean	North America	Unknown	Unknown	create damage to levees

Appendix 5
List of Non-Native Pests and Pathogens in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Sources: Campbell 2007, NJDA 2007

Common Name	Scientific Name	Type	Invasive Species Status	North America Occurrence Status[1]	Risk of Introduction to New Jersey[2]	New Jersey Current Distribution Status[3]	New Jersey Current or (Potential) Damage Risk[4]	Species at Risk	Comments
Africanized honey bee	*Apis mellifera scutellata*	insect	Invasive	Absent	Unknown	Absent	(Moderate)	European honey bee (Apis mellifera)	NJDA considers species to be dangerously injurious to European honey bees important for pollinating various commodities
ambrosia beetle	*Xylosandrus mutilatus*	insect	Non-Invasive	recently introduced	Moderate	Absent	(Unknown)	broad host range - hardwood trees and shrubs	Found in Mississippi
ambrosia beetle	*Xylosandrus crassiusculus*	insect	Non-Invasive	recently introduced	Low	Absent	(Unknown)	Fruit trees and nursery stock, so far	Found in South Carolina
Asian gypsy moth	*Lymantria dispar*	insect	Invasive	potential threat	High	Absent	(High)	broad host range - 500 species in native range	Repeatedly found at ports; Worse than European variety because females can disperse great distances
Asian longhorned beetle	*Anoplophora glabripennis*	insect	Invasive	recently introduced	Already Present	Limited	Low, (Moderate)	maples (*Acer* spp.), poplars (*Populus* spp.), birches (*Betula* spp.), elms (*Ulmus* spp.)	Risk map shows New Jersey as largely non-susceptible, but beetles show preference for sugar maple (these forest types in NJ include globally rare limestone forest communities); Eradication programs in urban areas - New York City, Jersey City, Carteret, Woodbridge, and Rahway have occurred
Asian soybean rust	*Phakopsora pachyrhizi*	pathogen	Invasive	established	Moderate	Absent	(Moderate)	Soybeans (*Glycine max*) and other species in the bean family	Discovered in North America in 2004; Currently spreading through southern states; may be restricted in colder climates; species is being carefully monitored and treated by USDA-APHIS
Asian tiger mosquito	*Aedes albopictus*	insect	invasive	established	Already Present	Widespread	(High)	Humans and their pets	Native to southeast Asia, Asian tiger mosquito was first found in North American in tires in the Houston area in 1985 and is now reported as far north as Maine. It can transmit pathogens and viruses including West Nile Virus, yellow fever and St. Louis encepahlitis.

Appendix 5
List of Non-Native Pests and Pathogens in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Sources: Campbell 2007, NJDA 2007

Common Name	Scientific Name	Type	Invasive Species Status	North America Occurrence Status[1]	Risk of Introduction to New Jersey[2]	New Jersey Current Distribution Status[3]	New Jersey Current or (Potential) Damage Risk[4]	Species at Risk	Comments
bacterial leaf scorch	*Xylella fastidiosa*	pathogen	Invasive	established, Native to southeast U.S.	Already Present	Widespread	Low, (Moderate)	red oak group (*Quercus* spp.)	Currently, BLS is associated with street trees and other ornamental plantings (40% of tested trees were infested across the state), but spread into more natural settings appears to be occurring (J. Arsenault, personal communication).
banded elm bark beetle	*Scolytus schevyrewi*	insect	Non-Invasive	recently introduced	Moderate	Absent	(Unknown)	Elm (*Ulmus* spp.), Cherries (*Prunus* spp.)	Currently found from California to Michigan
beech bark disease	*Nectria coccinea* var. *faginata* (pathogen) with *Cryptococcus fagisuga* (insect)	pathogen / insect	Invasive	established	Already Present	Widespread	Low, (Moderate)	American beech (*Fagus grandifolia*)	Found throughout the state, but damage is not currently severe
brown longhorned spruce beetle	*Tetropium fuscum*	insect	Non-Invasive	recently introduced	Low	Absent	(Low)	Red spruce (*Picea rubens*), white spruce (*Picea glauca*), potentially pines (*Pinus* spp.), fir (*Abies* spp.), larch (*Larix* spp.)	Found in Nova Scotia, primarily a risk to conifer forests
butternut canker	*Sirococcus clavigignentii-juglandacearum*	pathogen	Invasive	established	Already Present	Widespread	Moderate, (High)	Butternut (*Juglans cinerea*)	butternut relatively uncommon in NJ
chestnut blight (bark disease)	*Cryphonectria parasitica*	pathogen	Invasive	established	Already Present	Widespread	High	American chestnut (*Castanea dentata*), Allegheny chinkapin (*Castanea pumila*)	Chestnuts have been reduced to short-lived sprouts. There are efforts to produce plants with resistance for future reintroduction.
chestnut gall wasp	*Dryocosmus kuriphilus*	pathogen	Non-Invasive	established	Low	Absent	(Low)	American chestnut (*Castanea dentata*)	Found in Georgia, chinkapins are resistant
Chilean carpenter worm	*Chilecomadia valdiviana*	insect	Non-Invasive	potential threat	Low	Absent	(Low)	broad host range - hardwoods and fruit trees	Moderate risk of importation

Appendix 5
List of Non-Native Pests and Pathogens in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Sources: Campbell 2007, NJDA 2007

Common Name	Scientific Name	Type	Invasive Species Status	North America Occurrence Status[1]	Risk of Introduction to New Jersey[2]	New Jersey Current Distribution Status[3]	New Jersey Current or (Potential) Damage Risk[4]	Species at Risk	Comments
citrus longhorned beetle	*Anoplophora chinensis*	insect	Non-Invasive	eradicated	Low	Absent	(Unknown)	maple (*Acer* spp.), oak (*Quercus* spp.), willow (*Salix* spp.), poplar (*Populus* spp.), apple (*Malus* spp.)	Hopefully eradicated…
common pine shoot beetle	*Tomicus piniperda*	insect	Invasive	recently introduced	Already Present	Limited	(Low)	Scotch pine (Pinus sylvestris) and other Pines (*Pinus* spp.)	Discovered in North America in 1992 (Ohio) and now known from 12 states; May cause damage to Christmas tree farms; may cause severe decline in the health of the trees; APHIS-PPQ is limit its artificial spread beyond the infested area through quarantine, an active regulatory program and control of infestation impacts
corn earworm	*Helicoverpa zea*	insect	Invasive	established	Already Present	Widespread	Low	Corn, tomato, and a variety of other crops	Established in North America; New Jersey represents the northern boundary due to cold tolerance (more prevalent in Southern New Jersey); species may be controlled with insecticides or biocontrol agents (Btk) or other cultural methods
dogwood anthracnose disease	*Discula destructiva*	pathogen	Invasive	established	Already Present	Widespread	Moderate, (High)	Flowering dogwood (*Cornus florida*)	Resistance found in non-native ornamental (*Cornus kousa*), but is rare or absent in the native *C. florida;* acid deposition increases susceptibility, more prevalent in southeast U.S.
Dutch elm disease	*Ophiostoma ulmi* (pathogen) vectored by native elm bark beetle (*Hylurgopinus rufipes*) and the European bark beetle (*Scolytus multistriatus*)	pathogen / insect	Invasive	established	Already Present	Widespread	High	American elm (*Ulmus americana*)	mostly street trees infected - still spreading in forests, slippery elm (*Ulmus rubra*) has some reistance
Dutch elm disease 2	*Ophiostoma novo-ulmi*	pathogen	Unknown	recently introduced	Unknown	Unknown	(High)	Elm (*Ulmus* spp.)	unknown origin - native?, more damaging than *O. ulmi*

Appendix 5
List of Non-Native Pests and Pathogens in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Sources: Campbell 2007, NJDA 2007

Common Name	Scientific Name	Type	Invasive Species Status	North America Occurrence Status[1]	Risk of Introduction to New Jersey[2]	New Jersey Current Distribution Status[3]	New Jersey Current or (Potential) Damage Risk[4]	Species at Risk	Comments
Eurasian nun moth	*Lymantria monacha*	insect	Invasive	potential threat	High	Absent	(High)	broad host range - hardwoods and conifers	Serious pest in its native range, entry potential high
European corn borer	*Ostrinia nubilalis*	insect	Invasive	established	Already Present	Widespread	Low	Corn and other crops	Established in North America since 1917, widely controlled through pesticides and a range of introduced biocontrol agents
European gypsy moth	*Lymatria dispar*	insect	Invasive	established	Already Present	Widespread	Moderate, (High)	Primarily Oak species (*Quercus* spp.)	periodic severe defoliations occur, perennial low level infestations. Last serious defoliations occurred over 20 years ago. Species is currently controlled by a native pathogen and aerial application of Bt
European larch canker	*Lachnellula willkommii*	pathogen	Non-Invasive	established	Low	Absent	(Low)	American larch (*Larix laricina*)	reported infections to our north, larch found in small, but globally rare communities in NJ (spread rate would be low?)
European oak bark beetle	*Scolytus intricatus*	insect	Invasive	potential threat	High	Absent	(High)	Oaks (*Quercus* spp.), chestnuts (*Castanea* spp.), beech (*Fagus* spp.), birch (*Betula* spp.), poplars (*Populus* spp.), willows (*Salix* spp.), elms (*Ulmus* spp.)	Serious pest in its native range, entry potential high. Carries pathogenic fungi. Insect would probably have its greatest impact on eastern hardwood dominated forests.
European spruce beetle	*Ips typographus*	insect	Non-Invasive	potential threat	Low	Absent	(Low)	Spruce (Picea spp.)	Repeatedly found at ports, entry potential high. Carries extremely pathogenic fungi; spruce uncommon in NJ, but found in rare plant communities and could impact nursery industry
golden nematode	*Globodera rostochiensis*	invertebrate	Invasive	established	High	Absent	(Moderate)	Primary host is potato (*Solanum tuberosum*), but may impact related species including tomato	NJDA considers species to pose a serious threat to potatoes and tomatoes

Appendix 5
List of Non-Native Pests and Pathogens in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Sources: Campbell 2007, NJDA 2007

Common Name	Scientific Name	Type	Invasive Species Status	North America Occurrence Status[1]	Risk of Introduction to New Jersey[2]	New Jersey Current Distribution Status[3]	New Jersey Current or (Potential) Damage Risk[4]	Species at Risk	Comments
hemlock woolly adelgid	*Adelges tsugae*	insect	Invasive	established	Already Present	Widespread	High	eastern hemlock (*Tsuga canadensis*), Carolina hemlock (*Tsuga caroliniana*)	biocontrol agent of unknown efficacy, much of NJ hemlocks killed and nearly all wounded
Japanese beetle	*Popillia japonica*	insect	Invasive	established	Already Present	Widespread	High	Primarily landscape plants and lawns	species may be controlled through a variety of techniques
Japanese wax scale	*Ceroplastes ceriferus*	insect	Invasive	established	Already Present	Widespread	Unknown	Ornamental shrubs and trees; may spread to nearby natural areas	NJDA considers species to be dangerously injurious to nursery/landscape trees and shrubs; possibly observed at Duke Farms in Hillsborough, NJ infesting naturalized shrubs (identification of pest not confirmed)
khapra beetle	*Torgoderma granarium*	insect	Invasive	Absent	Unknown	Absent	(Moderate)	Food and grain stocks, especialy wheat	NJDA considers species to be dangerously injurious to food and grain stocks
larch casebearer	*Coleophora laricella*	insect	Non-Invasive	established	Low	Absent	(Low)	American larch (*Larix laricina*)	larch found in small, but globally rare communities in NJ (spread rate would be low?); introduced parasitoids released
Mediterranean pine engraver beetle	*Orthotomicus erosus*	insect	Non-Invasive	potential threat	Low	Absent	(Low)	Pine (*Pinus* spp.), douglas-fir (*Pseudotsuga menziesii*), spruce (*Picea* spp.), fir (*Abies* spp.)	Repeatedly found at ports, entry potential high.
Mexican bean beetle	*Epilachna varivestis*	insect	Invasive	established	Already Present	Widespread	Low	Primarily soybean, snapbean, and lima bean	NJDA beneficial insect lab has been releasing a biocontrol agent since 1980 (parasitic wasp - Pediobius foveolatus) that has been very effective at reducing damage caused by the pest. Annual releases of the biocontrol agent are required because it is not able to tolerate winter temperatures in New Jersey.
oriental beetle	*Exomala orientalis*	insect	Invasive	established	Already Present	Widespread	Moderate	Primarily landscape plants and lawns	species may be controlled through a variety of techniques

Appendix 5
List of Non-Native Pests and Pathogens in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Sources: Campbell 2007, NJDA 2007

Common Name	Scientific Name	Type	Invasive Species Status	North America Occurrence Status[1]	Risk of Introduction to New Jersey[2]	New Jersey Current Distribution Status[3]	New Jersey Current or (Potential) Damage Risk[4]	Species at Risk	Comments
Phytophthora root rot	*Phytophthora cinnamomi*	pathogen	Invasive	established	High	Absent	(High)	American chestnut (*Castanea dentata*), Allegheny chinkapin (*Castanea pumila*)	potential threat to oaks, which are attacked by this pathogen in Europe
pine flat bug	*Aradus cinnamomeus*	insect	Invasive	potential threat	High	Absent	(High)	broad host range - hardwoods and conifers	Serious pest in its native range, entry potential high
red-haired pine bark beetle	*Hylurgus ligniperda*	insect	Unknown	recently introduced	Unknown	Unknown	(Low)	Conifers	Found in Christmas tree plantation in Rochester, NY (and two other sites in the county)
shot-hole borer	*Xyleborus similis*	insect	Non-Invasive	recently introduced	Low	Absent	(Low)	broad host range - trees	Found in Texas - native to tropical areas
Sirex woodwasp	*Sirex noctilio* (insect) with *Amylostereum areolatium* (pathogen)	insect / pathogen	Non-Invasive	recently introduced	High	Absent	(Moderate)	Pines (*Pinus* spp.)	Discovered in New York in 2004. Primarily a threat to pine plantations.
sudden oak death syndrome	*Phytophthora ramorum*	pathogen	Invasive	recently introduced	High	Absent	(High)	red oak group (*Quercus* spp.), mountain laurel (*Kalmia angustifolia*), great bay (*Rhododendron maximum*)	found in nursery stock in Long Island and Cape May; risk maps show New Jersey as "moderate risk", however, there is a margin of error in the risk designation for our area and this pest has huge destructive potential. 2.1 million plants from contaminated nurseries were shipped to 21 states since 2003. 1.5 million of the potentially infected plants were not recovered (infected stock installed as landscape plantings). Searches are being conducted near affected nurseries and only one infection has been confirmed.
tarnished plant bug	*Lygus lineolaris*	insect	Invasive	established	Already Present	Widespread	Low	Primarily alfalfa and other agricultural commodities located near alfalfa	Biocontrol agent (parasitic wasp - Peristenus digoneutis) was released in 1979 and had a 50% parasitizing rate on the pest by 1992. The biocontrol agent is spreading throughout the northeast.

Appendix 5
List of Non-Native Pests and Pathogens in New Jersey
New Jersey Strategic Management Plan for Invasive Species
Sources: Campbell 2007, NJDA 2007

Common Name	Scientific Name	Type	Invasive Species Status	North America Occurrence Status[1]	Risk of Introduction to New Jersey[2]	New Jersey Current Distribution Status[3]	New Jersey Current or (Potential) Damage Risk[4]	Species at Risk	Comments
white pine blister rust	*Cronartium ribicola*	pathogen	Invasive	established	Already Present	Present	Low, (Moderate)	Five needle pines (e.g., white pine - *Pinus strobus*)	NJDA considers species to be dangerous plant disease and is a nuisance. NJDA restricts importation and movement of infected white pine trees and currants (Ribes sp. and Grossularia sp.). Relatively small pockets of naturally occurring white pine in New Jersey, but could have large impacts to nursery industry

Notes

1 - The majority of this information in this table is derived from Faith Campbell's "Gallery of Pests". http://tncweeds.ucdavis.edu/gallery.html.

2 - Risk of Introduction to New Jersey: very coarse estimate of risk of establishing in NJ; values include 'Already Present', 'High', 'Moderate', 'Low', 'Unknown'

3 - New Jersey Current Distribution Status: very coarse estimate of current infestation status; values include 'Widespread', 'Limited', 'Absent', 'Unknown'

4 - New Jersey Current or (Potential) Damage Risk: very coarse estimate of damage; values include 'High', 'Moderate', 'Low', 'Unknown'; potential damage values are presented in parantheses

Appendix 6
List of Non-Native Marine Species in New Jersey
New Jersey Strategic Management Plan for Invasive Species
(includes fish species that are at least partially marine)
Sources: Pederson et al. 2003, GISP 2007, Fofonoff et al. 2007, NJDEP 2007, Steves et al. 2007, USGS-NAC 2007

Scientific Name	Common Name	Taxa	Invasive Species Status	Current Impact[1]	Current Distribution Status[1]	Origin	Notes
Barentsia benedini	entoproct	entoprocta	Unknown	Unknown	Established	Unknown-marine	
Blackfordia virginica	hydroid and jellyfish	cnidaria	Non-invasive	Low	Established	Black Sea	
Botrylloides violaceus	tunicate	tunicate	Invasive	Medium	Established	NW Pacific	Fouling organism- Local abundance unknown
Botryllus schlosseri	tunicate	tunicate	Invasive	Medium	Established	Unknown-marine	Fouling organism
Bowerbankia gracilis	creeping bryozoan	bryozoan	Unknown	Unknown	Established	Cryptogenic	
Bowerbankia imbricata	bryozoan	bryozoan	Unknown	Unknown	Established	Cryptogenic	
Carcinus maenas	European green crab	crab	Invasive	Medium	Invasive	NE Atlantic	may cause significant damage to commercial fisheries and native ecosystems through predation and competition, known from North America since 1817
Codium fragile ssp. *tomentosoides*	Green fleece	algae	Invasive	Unknown	Established	NW Pacific	Aesthetic impact on beaches, ship, dock, shellfish fouling
Cordylophora caspia	hydroid	cnidaria	Non-invasive	Low	Established	Black-Caspian Seas	Occasional fouler of powerplants, boats, and fishing gear
Coscinodiscus wailesii	diatom	algae	Non-invasive	Low	Established	Pacific Ocean	Caused fouling of fishnets, 1970s. Current imacts unknown.
Diadumense lineata	orange-striped anemone	cnidaria	Unknown	Unknown	Established	NW Pacific	
Ectopleura larynx	hydroid	cnidaria	Unknown	Unknown	Established	Cryptogenic	
Electra pilosa	hairy sea mat	bryozoan	Unknown	Unknown	Established	Cryptogenic	
Ficopomatus enigmaticus	tubeworm	polychaeta	Unknown	Unknown	Established	Unknown-marine	Recorded in Barnegat Bay (1976 and 1990s); potential foulling organism, but not abundant
Garveia franciscana	hydroid	cnidaria	Invasive	Medium	Established	Unknown-marine	Sometines a severe fouler of powerplants, fishing gear, etc.
Halichondria bowerbanki	sponge	sponge	Unknown	Unknown	Established	Cryptogenic	Fouling organism; found on both sides of Atlantic, origin uncertain
Haplosporidium nelsonii	MSX oyster disease	protozoan	Invasive	High	Established	NW Pacific	broght to the Delaware Bay with illegal planting of Japanese oysters in 1957; caused extensive mortality of eastern oysters
Harmothoe imbricata	scaleworm	polychaeta	Unknown	Unknown	Established	Cryptogenic	

Appendix 6
List of Non-Native Marine Species in New Jersey
New Jersey Strategic Management Plan for Invasive Species
(includes fish species that are at least partially marine)
Sources: Pederson et al. 2003, GISP 2007, Fofonoff et al. 2007, NJDEP 2007, Steves et al. 2007, USGS-NAC 2007

Scientific Name	Common Name	Taxa	Invasive Species Status	Current Impact[1]	Current Distribution Status[1]	Origin	Notes
Hemigrapsus sanguineus	Asian shore crab	crab	Invasive	High	Established	NW Pacific	may cause significant damage to native ecosystems through predation and competition, first discovered in North America by a college biology class at Cape May in 1987 and has rapidly spread north to Maine; probably introduced with ballast water; may compete with native crab species in rocky areas, may consume barncles and mussels
Lepidonotus squamatus	scaleworm	polychaeta	Unknown	Unknown	Established	Cryptogenic	
Ligia exotica	wharf roach	isopod	Non-invasive	Low	Established	Indo-Pacific	competition with similar species
Littorina littorea	common periwinkle	mollusk	Invasive	Medium	Established	NE Atlantic	may severely alter rocky intertidal communities through selective browsing of algae, first observed in New Jersey in the 1890's, grow densely to the exclusion of native species
Molgula manhattensis	tunicate	tunicate	Unknown	Unknown	Established	Cryptogenic	Fouling organism; found on both sides of Atlantic, origin uncertain
Morone chrysops	white bass	fish	Invasive	Medium	Established	North America	introduced game species, may alter fish community composition through predation, may elimate smaller native fish species, reached Hudson River in 1977, white bass-striped bass hybrids also widely stocked
Myosotella myosotis	salt-marsh snail	mollusk	Non-invasive	Low	Established	NE Atlantic	air-breathing snail of upper intertidal zone; first reported in 1865, earlier name was *Ovatella myosotis*
Neosiphonia harveyi	red seaweed	algae	Non-invasive	Low	Established	NW Pacific	
Obelia bidentata	hydroid	cnidaria	Unknown	Unknown	Established	Cryptogenic	
Obelia longissima	hydroid	cnidaria	Unknown	Unknown	Established	Cryptogenic	
Odontella sinensis	diatom	algae	Non-invasive	Low	Established	Indo-Pacific	
Perkinsus marinus	Dermo	protozoan	Invasive	High	Established	Gulf of Mexico	First documented in the Delaware Bay in the 1950's
Pterois volitans	red lion fish	fish	Invasive	Medium	Established	Indo-Pacific	introduced ornamental species

Appendix 6
List of Non-Native Marine Species in New Jersey
New Jersey Strategic Management Plan for Invasive Species
(includes fish species that are at least partially marine)
Sources: Pederson et al. 2003, GISP 2007, Fofonoff et al. 2007, NJDEP 2007, Steves et al. 2007, USGS-NAC 2007

Scientific Name	Common Name	Taxa	Invasive Species Status	Current Impact[1]	Current Distribution Status[1]	Origin	Notes
Rangia cuneata	Gulf wedge clam	mollusk	Invasive	Medium	Established	Gulf of Mexico	Northward expansion from Gulf of Mexico possibly with oyster transplants, or through canals, barges, and ballast water; established in brackish estuaries from 1950s to 1980s (Chesapeake - 1960, Delaware Bay (1971), Hudson (1988); impacts as filter-feeder, waterfowl food, may compete with natives species
Styela canopus	tunicate	tunicate	Invasive	Medium	Established	Indo-Pacific	Fouling organism
Styela clava	tunicate	tunicate	Invasive	Medium	Established	Indo-Pacific	Fouling organism; local abundance unknown; Found by McDermott near Cape May 1998, found washing ashore at Cape Henlopen by Fofonoff 2003. Serious pest ot aquaculture in some areas.
Synidotea laevidodorsalis	isopod species	isopod	Non-invasive	Low	Established	Indo-Pacific	newly discovered in Northeast in 2003
Tenellia adspersa	nudibranch	mollusk	Unknown	Unknown	Established	Cryptogenic	
Teredo bartschi	bartsh shipworm	mollusk	Non-invasive	Medium	Extirpated	Unknown-marine	may damage untreated wooden structures; known to occur in Barnegat Bay prior to 1993. Dependent on powerplant effluents. Now extirpated in NJ.
Teredo furcifera	deep-cleft shipworm	mollusk	Unknown	Unknown	Extirpated	Unknown-marine	may damage untreated wooden structures; known to occur in Barnegat Bay prior to 1974

[1]P. Fofonoff - personal communication (also provided origin and notes for many species)

Appendix 7
Federal Legal Authorities Related to Invasive Species
New Jersey Strategic Management Plan for Invasive Species
Source: Northwest Natural Resource Group 2004

Invasive Species Function	Authorities and Guidance	Agencies	Key Responsibilities
Prevention	Plant Protection Act, Animal quarantine laws, Lacey Act, Federal Seed Act, Non-indigenous Aquatic Nuisance Prevention and Control Act	USDA, particularly APHIS, U.S. Fish and Wildlife Service, NOAA, EPA, Departments of Defense, State, and Transportation (for aquatic weeds)	Prohibit or restrict imports or movements of plant pests including noxious weeds, Control interstate movement of invasive animals and those with communicable diseases, Control weed infested seed, Regulate the movement of injurious animals, Prevent and control noxious aquatic weeds
Early Detection and Rapid Response	Plant Protection Act, Animal quarantine laws, NEPA	Only USDA has the emergency authority to deal with incipient invasions	Seize, hold, quarantine and treat prohibited species imported into the U.S. or transported between states
Control, Management, and Restoration	Such organic acts as NFMA, FLPMA, and those that guide the management of lands or waters under various agency jurisdictions, Non-indigenous Aquatic Nuisance Prevention and Control Act, FIFRA, NEPA, Plant Protection Act, Emergency Watershed Program	Forest Service, Department of Interior, NOAA, Department of Defense, EPA, BOR, ACOE, NRCS, No single agency has overall responsibility	Control and manage invasive species and restore affected areas on federal lands and waters
Research and Monitoring	Cooperative Agriculture Pest Survey, various organic acts	USDA, NOAA, Department of Interior, EPA	Develop databases on various invasives, research invasive species and pathogens of concern to forests, agricultural lands, rangelands and wetlands. Research risks associated with invasive species
Information Management	International Plant Protection Convention, NAFTA, Convention on International Trade in Endangered Species of Wild Fauna and Flora, Convention on Biological Diversity, North American Agreement for Environmental Cooperation	USDA, Office of the U.S. Trade Representative, World Trade Organization, Departments of Interior, Transportation, State, and International Maritime Organization, EPA, U.S. AID	Develop strategies for international control of invasive species and share information, Capacity building in other countries, Treaty and trade negotiations, Ballast water management
Public Outreach and Partnership Efforts	Various organic acts	USDA, Department of Interior, Department of Commerce	Dissemination of public information, Cooperate with state, local, and tribal governments
Interagency Efforts	Various organic acts, Executive Order 13112	Aquatic Nuisance Species Task Force, Federal Interagency Committee on the Management of Noxious and Exotic Weeds, Committee on the Environment and Natural Resources of the National Science and Technology Council, National Invasive Species Council	Problem-specific cooperative efforts and the coordination of control and research efforts

Appendix 8
Existing and Potential New Jersey Legal Authorities Related to Invasive Species
New Jersey Strategic Management Plan for Invasive Species
Sources: ELI 2002, Michie's Legal Resources 2007, NJDA 2007

Invasive Species Function	Existing and Potential Authorities to address invasive species functions (see NJAC Code guide below)	Responsible Groups (existing and potential)	Existing and Potential Responsibilities
Prevention	NJAC Title 2 - Chapters 2, 3, 5, 9, 10, 16, 17, 18, 19, 20, 21, 72, 89 NJAC Title 7 - Chapters 2, 3, 5C, 12, 25-4, 25-10, 25-18, 25-22, 25-24, 38, 50	NJDA NJDEP NJISC	NJDA: There are a large number of NJDA chapters currently or potentially relevant to the prevention of new introductions of invasive species. Rule changes may be proposed to broaden inspection efforts to include more listed species and expand their mandate to non-agricultural pests. Prevention efforts could be strengthened through rule changes involving NJAC 2:18 and NJAC 2:72. In total, these rules can be used to prevent new introductions to New Jersey and prevent the continued sale of existing invasive species. NJDEP: NJDEP enforces NJAC 7:25-4 and 7:25-10 related to permitting and fines for listed animal species, marine activities, which could be expanded to reduce threats of invasive species. NJAC 7:2 and 7:3 can be modified to account for threats posed by invasive species. NJAC 7:25 and its subchapters can be strengthened to reduce impacts. NJAC 7:38 and 7:50 may be used to prevent the use of invasive species. NJAC 7:5C provides a model to conduct future listing protocols for invasive species. Aquatic and marine prevention could be strengthened through NJAC 7:12, 25-18, 25-22, and 25.24. NJISC: Assist with the development and implementation of proposed rule changes.
Early Detection and Rapid Response	NJAC Title 2 - Chapters 10, 16, 19, 89 NJAC Title 7 - Chapters 2, 3, 5	NJDA NJDEP NJISC	NJDA: NJDA performs a variety of functions that can be modified to specifically search for occurrences of new invasive species or range expansion of existing invasive species. NJDA has used ED/RR to respond to ALB and SOD in recent years, however, NJDA does not have the resources to respond to invasive species that do not provide a direct link to agriculture or forestry (e.g. water chestnut, black swallowwort, etc.). NJDEP: NJAC 7:2, 7:3, and 7:5 could be strengthened to improve ED/RR on NJDEP lands. NJISC: Assist with the development and implementation of proposed rule changes.
Control and Restoration	NJAC Title 2 - Chapters 2, 23, 72 NJAC Title 7 - Chapters 2, 3, 5, 5A, 6, 6A, 23, 25-5, 25-23, 30 NJAC Title 8 - 23A	NJDA NJDEP NJDHSS NJISC	NJDA: The only extensive control program in New Jersey involves gypsy moth and a variety of agricultural pests. This represents a significant deficiency that may be addressed through rule changes or greater authority to NJDEP. Bonding requirements may be subject to rule changes to provide funding for control and restoration. NJDEP: NJDEP can greatly increase its efforts on particular parks, forests, and natural areas through modification of various rules; NJAC 7:6 and NJAC 7:6A could be used to improve invasive species programs at the local level. NJAC 7:25-5 and 25-23 could provide additional support to reduce deer populations to prevent serious impacts on native flora that allow invasive species to establish. NJAC 7:23 could provide additional support for control of aquatic species. NJAC 7:30 could be modified to allow expansion of herbicide label uses to control invasive species. NJDHSS: NJAC 8:23A could involve a more active spay/neuter program to mitigate the impacts of feral cats. NJISC: Assist with the development and implementation of proposed rule changes.
Research and Monitoring	NJAC Title 2 - Chapter 10 NJAC Title 7 - Chapters 2, 3, 5, 5A	NJDA NJDEP NJISC	NJDA: NJDA laboratory services and the beneficial insect lab currently play a role, which should be expanded to increase capacity to provide biocontrol agents. State universities and RCE, if provided additional funding, could contribute significantly to our understanding of invasive species. NJDEP: There are a variety of NJDEP programs that can become involved with research and monitoring (mapping) of invasive species to prioritize control programs. NJISC: Assist with the development and implementation of proposed rule changes.

Invasive Species Function	**Existing and Potential Authorities to address invasive species functions (see NJAC Code guide below)**	**Responsible Groups (existing and potential)**	**Existing and Potential Responsibilities**
Public Outreach and Partnership Efforts	NJAC Title 7 - Chapters 6, 6A NJAC Title 7 - Chapters 2, 3, 5, 5A, 6, 6A Executive Order #97 (temporarily)	NJDA NJDEP NJISC	Programs specifically designed to provide and share information with a variety of stakeholders is essential (see Appendix 13). Outreach and partnerships can be conducted through NJDA, NJDEP, RCE, and a permanent NJISC. NJDEP: NJAC 7:6 and NJAC 7:6A could be used to improve outreach programs at the local level. NJISC: Assist with the development and implementation of proposed rule changes.
Interagency Efforts	Executive Order #97 (temporarily)	NJDA NJDEP NJDOT NJ Commerce NJISC	All current members of the NJISC will lobby for a permanent council, which would be the primary interagency effort in New Jersey. The NJISC would also include representatives from federal agencies and communicate with invasive species programs of neighboring states and regional groups.

Guide to New Jersey Administrative Code - Includes all potentially relevant chapters and sub-chapters

Department	Division	Title	Chapter	Sub-Chapter	Chapter or Sub-Chapter Name
Agriculture	N/A	2	2	N/A	Disease Control Program
Agriculture	N/A	2	3	N/A	Livestock and Poultry Importation
Agriculture	N/A	2	5	N/A	Quarantines and Embargoes on Animals
Agriculture	N/A	2	9	N/A	Avian Influenza
Agriculture	N/A	2	10	N/A	Laboratory Services
Agriculture	N/A	2	16	N/A	Certification
Agriculture	N/A	2	17	N/A	Importation of Plants and Plant Material
Agriculture	N/A	2	18	N/A	Nursery Inspection Fees
Agriculture	N/A	2	19	N/A	Sale and Distribution of Plants and Plant Material
Agriculture	N/A	2	20	N/A	Quarantines
Agriculture	N/A	2	21	N/A	Seed Control
Agriculture	N/A	2	23	N/A	Gypsy Moth
Agriculture	N/A	2	72	N/A	Bonding Requirements of Commission Merchants, Dealers, Brokers and Agents
Agriculture	N/A	2	89	N/A	Aquaculture Development
Environmental Protection	Parks & Forestry	7	2	N/A	State Park Service Code
Environmental Protection	Parks & Forestry	7	3	N/A	Forestry
Environmental Protection	N/A	7	5	N/A	Conserve Wildlife Matching Grants Program
Environmental Protection	Parks & Forestry	7	5A	N/A	Natural Areas and the Natural Areas System
Environmental Protection	Parks & Forestry	7	5C	N/A	Endangered Plant Species Program
Environmental Protection	N/A	7	6	N/A	Office of Environmental Services Matching Grants Program for Local Environmental Agencies
Environmental Protection	N/A	7	6A	N/A	Aid for Urban Environmental Concerns Matching Grants Program for Environmental Agencies
Environmental Protection	N/A	7	12	N/A	Shellfish Growing Water Classification
Environmental Protection	N/A	7	23	N/A	Administration of Lake Restoration Projects
Environmental Protection	Fish & Wildlife	7	25	4	Endangered, Nongame and Exotic Wildlife
Environmental Protection	Fish & Wildlife	7	25	5	2005-2006 Game Code
Environmental Protection	Fish & Wildlife	7	25	6	2005-2006 Fish Code
Environmental Protection	Fish & Wildlife	7	25	10	Possession, Propagation, Liberation, Sale and Importation of Game Animals and Game Birds
Environmental Protection	Fish & Wildlife	7	25	18	Marine Fisheries
Environmental Protection	Fish & Wildlife	7	25	22	Fishery Management in New Jersey
Environmental Protection	Fish & Wildlife	7	25	23	Permit to Kill Wild Deer
Environmental Protection	Fish & Wildlife	7	25	24	Leasing of Atlantic Coast Bottom for Aquaculture
Environmental Protection	N/A	7	30	N/A	Pesticide Control Program
Environmental Protection	N/A	7	38	N/A	Highlands Water Protection and Planning Act Rules
Environmental Protection	N/A	7	50	N/A	Pinelands Comprehensive Management Plan
Health and Senior Services	N/A	8	23A	N/A	Animal Facility Operation; Animal Control Officer Certification; Pilot Spay/Neuter Clinic Fees

Appendix 9

St. Louis Declaration Voluntary Codes of Conduct

New Jersey Strategic Management Plan for Invasive Species

"The Workshop on Linking Ecology and Horticulture To Prevent Plant Invasions"

December 2001
St. Louis, Missouri

STATEMENT OF PURPOSE

In December 2001, experts from across the globe met in St. Louis, Missouri to explore and develop workable voluntary approaches for reducing the introduction and spread of non-native invasive plants, which are serious threats to protecting biodiversity and ecosystems in the United States and other countries. *The Workshop on Linking Ecology and Horticulture to Prevent Plant Invasions* was convened by the Missouri Botanical Garden and the Royal Botanic Gardens, Kew; and brought together some of the most respected leaders in their fields for the first time (see attached list). [1]

This landmark three-day gathering yielded the ***Saint Louis Declaration***, which consists of two major components:

1. **Overarching Findings and Principles** that frame the invasive species problem and present the underlying basis for successful efforts to address it; and,

2. **Draft Voluntary Codes of Conduct** that help govern decisions made by commercial, professional and government groups whose actions affect the spread of invasive plant species including government agencies, nursery professionals, the gardening public, landscape architects and botanic gardens and arboreta.

The draft voluntary codes offer professional codes of conduct designed to curb the use and distribution of invasive plant species through self-governance and self-regulation by the groups concerned. This approach has been used successfully to ameliorate other problems but its application to invasive plant threats is novel and innovative. Importantly, the draft Voluntary

[1] Sponsors and/or financial supporters included: The American Association of Botanical Gardens and Arboreta, American Nursery & Landscape Association, American Society of Landscape Architects, Botanic Gardens Conservation International, Center for Plant Conservation, Chicago Botanic Garden, Global Invasive Species Programme, Agricultural Research Service (USDA), Environmental Defense, Missouri Botanical Garden, National Science Foundation, Turner Foundation, Inc, and Winslow Foundation.

Codes of Conduct were developed recognizing that education must accompany all efforts to address the problem and that some future government regulation may perhaps be needed if such efforts prove insufficient. These codes, which are attached, are now being considered for endorsement by the major professional societies and organizations representing each of the groups covered. If endorsed they will be 'tested' and revised as necessary to improve their utility and effectiveness.

Workshop participants also discussed key topics and activities that drive concerns about invasive plant species worldwide. Among them were:

- Economic and environmental impacts presented by the spread of invasive plants
- How horticulture contributes to the spread of invasive plants
- The nursery industry's view of the problem and its efforts to respond to it
- Government responses to concerns about invasive plants (the focus here was on US Government response with selected examples of how Australia, South Africa and Britain have responded in different ways)
- Risk assessment and how it can be used to evaluate whether a new plant species proposed for introduction is likely to become an invasive pest
- Educational tools available for helping the public become more aware of the problem
- Plant species that might be acceptable alternatives to those invasive plants identified as harmful

Proceedings and plans for additional activities by the ***"Workshop Linking Ecology and Horticulture to Prevent Plant Invasions"*** will be released in late March. You are encouraged to direct any questions or comments to invasivespecies@mobot.org. Thank you for your interest.

The St. Louis Declaration on Invasive Plant Species

A Product of:
"The Workshop on Linking Ecology and Horticulture To Prevent Plant Invasions"

FINDINGS AND OVERARCHING PRINCIPLES

February 2002

Findings:

People are major dispersers of plants. The magnitude of this dispersal is unprecedented and has allowed dispersal of species that manifest aggressive traits in new areas.

Plant introduction and improvement are the foundation of modern agriculture and horticulture, yielding diversity to our supply of plants used for food, forestry, landscapes and gardens, medicinal and other purposes.

A small proportion of introduced plant species become invasive and cause unwanted impacts to natural systems and biological diversity as well as economies, recreation, and health.

Plant species can be invasive in some regions, but not in others. The impacts of invasive plant species can occur at times and places far removed from the site of introduction.

Principles (a.k.a. *The St. Louis Six*)

1. Plant introduction should be pursued in a manner that both acknowledges and minimizes unintended harm.

2. Efforts to address invasive plant species prevention and management should be implemented consistent with national goals or standards, while considering regional differences to the fullest extent possible.

3. Prevention and early detection are the most cost effective techniques that can be used against invasive plants.

4. Research, public education and professional training are essential to more fully understanding the invasive plant issue and positively affecting consumer demand, proper plant use, development of non-invasive alternatives, and other solutions.

5. Individuals from many fields must come together to undertake a broad-based and collaborative effort to address the challenge, including leaders in horticulture, retail and wholesale nurseries, weed science, ecology, conservation groups, botanical gardens, garden clubs, garden writers, educational institutions, landscape architects, foundations and government.

6. A successful invasive plant species strategy will make use of all available tools including voluntary codes of conduct, best management practices, and appropriate regulation. Codes of conduct for specific communities of interest are an essential first step in that they encourage voluntary initiative, foster information exchange, and minimize the expense of regulation.

Draft
Voluntary Codes of Conduct
For Government
February 2002

1. Require risk assessment for government-led or financed plant introductions to ensure that no new harmful plant species are introduced, intentionally or unintentionally.

2. Do not distribute existing holdings of invasive plant species to areas where they can potentially do harm; eliminate these holdings or maintain new or existing holdings using appropriate safeguards.

3. Coordinate and facilitate collaboration in databases, early warning systems, monitoring, and other means of preventing invasive plant species problems.

4. Lead and fund (subject to budgetary considerations) the development of environmentally sound methods to control harmful invasive plant species, seek control of such species on public lands and promote their control on adjacent private lands.

5. Develop and promote the use of non-invasive plant species within all government units and to the public.

6. Facilitate, lead, coordinate and evaluate public outreach and education on harmful invasive plant species.

7. Encourage that employees and management participate in ongoing training programs on invasive plant species.

8. Foster international cooperation to minimize the risk of the import and export of potentially invasive plant species.

9. Develop partnerships and incentive programs to lessen the impact of invasive plant species and provide non-invasive restoration materials.

10. Provide a forum for regular evaluation of the effectiveness of these voluntary codes of conduct towards preventing the invasive plant species problem.

11. Enforce invasive plant species legislation at all levels.

Draft
Voluntary Codes of Conduct
For Nursery Professionals
February 2002

1. Ensure that invasive potential is assessed prior to introducing and marketing plant species new to North America. Invasive potential should be assessed by the introducer or qualified experts using emerging risk assessment methods that consider plant characteristics and prior observations or experience with the plant elsewhere in the world. Additional insights may be gained through extensive monitoring on the nursery site prior to further distribution.

2. Work with regional experts and stakeholders to determine which species in your region are either currently invasive or will become invasive. Identify plants that could be suitable alternatives in your region.

3. Develop and promote alternative plant material through plant selection and breeding.

4. Phase out existing stocks of invasive species in your region.

5. Follow all laws on importation and quarantine of plant materials across political boundaries.

6. Encourage customers to use, and garden writers to promote, non-invasive plants.

Draft
Voluntary Codes of Conduct
For The Gardening Public
February 2002

1. Ask for only non-invasive species when you acquire plants. Plant only environmentally safe species in your gardens. Work towards and promote new landscape design that is friendly to regional ecosystems.

2. Seek information on which species are invasive in your area. Sources could include botanical gardens, horticulturists, conservationists, and government agencies. Remove invasive species from your land and replace them with non-invasive species suited to your site and needs.

3. Do not trade plants with other gardeners if you know they are species with invasive characteristics.

4. Request that botanical gardens and nurseries promote, display and sell only non-invasive species.

5. Help educate your community and other gardeners in your area through personal contact, and in such settings as garden clubs and other civic groups.

6. Ask garden writers and other media to emphasize the problem of invasive species and provide information. Request that garden writers promote only non-invasive species.

7. Invite speakers knowledgeable on the invasive species issue to speak to garden clubs, master gardeners, schools and other community groups.

8. Seek the best information on control of invasive plant species and organize neighborhood work groups to remove invasive plant species under the guidance of knowledgeable professionals.

9. Volunteer at botanical gardens and natural areas to assist ongoing efforts to diminish the threat of invasive plants.

10. Participate in early warning systems by reporting invasive species you observe in your area. Determine which group or agency should be responsible for reports emanating from your area. If no 800 number exists for such reporting, request that one be established, citing the need for a clearinghouse with an 800 number and website links to information about invasive plant species.

11. Assist garden clubs to create policies regarding the use of invasive species not only in horticulture, but in activities such as flower shows. Urge florists and others to eliminate the use of invasive plant material.

Draft
Voluntary Codes of Conduct
For Landscape Architects
February 2002

1. Seek out education and information on invasive species issues:

    a. Work with local plant ecologists, horticulturists, nurseries, botanic gardens, conservation organizations and others to determine what species in your region either are currently highly invasive or show aggressive potential. Investigate species under consideration that may present a threat.
    b. Increase interaction with other professionals and non-professionals to identify alternative plant material and other solutions to problems caused by harmful invasive plants.
    c. Take advantage of continuing education opportunities to learn more about invasive species issues.

2. Identify and specify non-invasive species that are aesthetically and horticulturally suitable alternatives to invasive species in your region.

3. Eliminate specification of species that are invasive in your region.

4. Be aware of potential environmental impacts beyond the designed and managed area of the landscape plan (e.g. plants may spread to adjacent natural area or cropland).

5. Encourage nurseries and other suppliers to provide landscape contractors and the public with non-invasive plants.

6. Collaborate with other local experts and agencies in the development and revision of local landscape ordinances. Promote inclusion of invasive species issues in these ordinances.

Actions for the *American Society of Landscape Architects* (ASLA) Invasive Plants Species Task Force:

1. Encourage and work with Landscape Architecture degree programs to uniformly identify and address invasive species in plant materials courses.

    a. Work with Council of Educators in Landscape Architecture to conduct survey of Landscape Architecture programs to determine need for improvements (e.g., ecological concepts, invasiveness, and the use of alternatives). Bill Fountain, University of Kentucky, and the task force will create survey format and ASLA will facilitate communications with CELA president regarding implementation of survey and dissemination of results.
    b. Work with CELA to include issue of invasiveness in that organization's publications and/or within its annual conferences.

c. Include invasive species issues in continuing education opportunities for practicing Landscape Architects (e.g. annual meeting, workshops, continuing articles in LA Magazine, and further information sharing derived from interaction with nursery, arboretum, botanic garden, and conservation communities.

2. Include on ASLA website: links to sites discussing methods for risk assessment and other IS issues.

3. Work to include knowledge of invasive species and alternatives in existing certification systems for professionals. (e.g. LARE, International Society of Arboriculture Arborist Certification Program).

Draft
Voluntary Codes of Conduct
For Botanic Gardens and Arboreta
February 2002

1. Conduct an institution-wide review examining all departments and activities that provide opportunities to stem the proliferation of invasive species and inform visitors. For example, review or write a collections policy that addresses this issue; examine such activities as seed sales, plant sales, book store offerings, wreath-making workshops, etc.

2. Avoid introducing invasive plants by establishing an invasive plant assessment procedure. Predictive risk assessments are desirable, and should also include responsible monitoring on the garden site or through partnerships with other institutions. Institutions should be aware of both direct and indirect effects of plant introduction, such as biological interference in gene flow, disruption of pollinator relationships, etc.

3. Consider removing invasive species from plant collections. If a decision is made to retain an invasive plant, ensure its control and provide strong interpretation to the public explaining the risk and its function in the garden.

4. Seek to control harmful invasive species in natural areas managed by the garden and assist others in controlling them on their property, when possible.

5. Promote non-invasive alternative plants or, when possible, help develop non-invasive alternatives through plant selection or breeding.

6. If your institution participates in seed or plant distribution, including through Index Seminum, do not distribute known invasive plants except for bona-fide research purposes, and consider the consequences of distribution outside your biogeographic region. Consider a statement of caution attached to species that appear to be potentially invasive but have not been fully evaluated.

7. Increase public awareness about invasive plants. Inform why they are a problem, including the origin, mechanisms of harm, and need for prevention and control. Work with the local nursery and seed industries to assist the public in environmentally safe gardening and sales. Horticulture education programs, such as those at universities, should also be included in education and outreach efforts. Encourage the public to evaluate what they do in their own practices and gardens.

8. Participate in developing, implementing, or supporting national, regional, or local early warning systems for immediate reporting and control. Participate also in the creation of regional lists of concern.

9. Botanical gardens should try to become informed about invasiveness of their species in other

biogeographic regions, and this information should be compiled and shared in a manner accessible to all.

10. Become partners with other organizations in the management of harmful invasive species.

11. Follow all laws on importation, exportation, quarantine, and distribution of plant materials across political boundaries, including foreign countries. Be sensitive to conventions and treaties that deal with this issue, and encourage affiliated organizations (plant societies, garden clubs, etc.) to do the same.

"*The Workshop on Linking Ecology and Horticulture To Prevent Plant Invasions"*

December 2002

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Appendix 10

Standards from the Environmental Law Institute Annotated with NJISC Recommendations

New Jersey Strategic Management Plan for Invasive Species

Source: Environmental Law Institute 2004b

Item Number	Broad Function	Elements of Broad Functions or Activities	Additional Activities	Gold	Silver	Bronze	Explanation of Standards / NJ Status Notes and NJISC Recommendations
1	Definition of Invasive species	--	--	X	X	X	All non-native species are subject to regulation (encompasses all categories of species including wildlife, aquatic life, plants, insects, and microorganisms) and the definition should lead to the creation of a 'clean list'. / A definition is included with this Plan and the Council has proposed regulatory and non-regulatory strategies. Standard will be met if recommendations are adopted.
2	Coordination	Comprehensive invasive species council (interagency)	--	X	X	X	The Council and plan should benefit from formal state recognition and earmarked funding to ensure political backing and financial support. / This was accomplished with NJ Executive Order #97, but must be made permanent and provided funding to meet the standard. Standard will be met if Council made permanent and funding is provided.
3	Coordination	Comprehensive invasive species plan	--	X	X		A comprehensive plan fully addresses all categories of invasive species including wildlife, aquatic life, plants, insects, and microorganisms. / This requirement will be accomplished and standard met through adoption of this Plan.
4	Prevention	Identifying and mitigating future threats	--	X	X		Authorize the study of future threats to ensure that state officials are alerted to potential and relative risks of new infestations. / The Plan provides guidance. Standard will be met if recommendations are adopted and funding is provided.
5	Prevention	Detection	Surveying for invasive species	X	X		Authorize survey for new populations of existing invasive species. / The Plan provides guidance. Standard will be met if recommendations are adopted and funding is provided.
6	Prevention	Detection	Mapping species and sensitive locations	X			Authorize the mapping of invasive species and sensitive locations. / The Plan provides guidance. Standard will be met if recommendations are adopted and funding is provided.

Item Number	Broad Function	Elements of Broad Functions or Activities	Additional Activities	Gold	Silver	Bronze	Explanation of Standards / NJ Status Notes and NJISC Recommendations
7	Prevention	Detection	Inspection authority	X	X	X	Authorize inspections to detect, survey, and map new outbreaks and existing infestations on public and private lands. / The NJDA already has this authority for particular situations. The NJISC does not recommend further regulatory action to address this issue. Standard will be met as part of existing programs.
8	Prevention	Introduction / Import / Release Requirements	Standards	X	X	X	Standards that establish a prescreening process so that every imported species can be assessed to determine whether it should be formally regulated, discouraged from use, or approved for entry. The burden must be placed on the party seeking to import or introduce invasive species to show that the species will not harm the ecosystem. / The Plan provides guidance, but Federal standards are required to provide support for this function. Standard will not be met unless federal regulations are adopted.
9	Prevention	Introduction / Import / Release Requirements	Advisory committee	X			The above procedure should be provided through an advisory committee. / The Plan provides guidance, but Federal standards are required to provide support for this function. Standard will not be met unless federal regulations are adopted.
10	Prevention	Quarantines	Specific species and facilities	X	X	X	Authority covers specific species and facilities, the restriction and prohibition of certain items transported into the state, and mandatory quarantines for particularly dangerous invasive species. / The NJDA already has this authority for particular situations. Standard will be met if recommendations adopted and funding is provided.
11	Prevention	Quarantines	Transportation	X	X	X	See below under Regulation.
12	Prevention	Quarantines	Mandatory	X			See above under specific species and facilities.
13	Prevention	Education	--	X	X		Development of educational materials and workshops, training courses, and private landowner outreach programs. / The Plan provides guidance. The NJISC website, RCE Environmental Stewards Program, and Watershed Watch Program will meet this goal. Standard will be met if recommendations are adopted and funding is provided.

Item Number	Broad Function	Elements of Broad Functions or Activities	Additional Activities	Gold	Silver	Bronze	Explanation of Standards / NJ Status Notes and NJISC Recommendations
14	Regulation	Permits and licenses	--	X	X	X	Authority to issue a permitting or licensing program to possess an invasive species or to operate a facility containing invasive species that allows access for inspection and, if present, escape prevention and record keeping requirements to ensure that only qualified entities possess them. / The Plan provides guidance. This only applies to arboreta and botanic gardens allowed to maintain listed invasive species. The NJISC recommends regulatory action to address this problem. Standard will be met if recommendations are adopted and funding is provided.
15	Regulation	Transportation and shipping requirements	Prohibitions	X	X		For all shipments through the state - authority to prohibit the transport of certain categories of invasive species, require permits and licenses, allow inspections of shipments, establish boarder inspection stations, require labeling of invasive species shipments, and require the registration of invasive species shippers within the state. / The Plan provides guidance. The NJISC recommends regulatory action to partially address some of these problems. Standard will be partially met if recommendations are adopted and funding is provided.
16	Regulation	Transportation and shipping requirements	Permits and licenses	X	X	X	See above under Prohibitions.
17	Regulation	Transportation and shipping requirements	Inspection authority	X	X	X	See above under Prohibitions.
18	Regulation	Transportation and shipping requirements	Labeling requirements	X			See above under Prohibitions.
19	Regulation	Transportation and shipping requirements	Registration of shippers	X			See above under Prohibitions.

Item Number	Broad Function	Elements of Broad Functions or Activities	Additional Activities	Gold	Silver	Bronze	Explanation of Standards / NJ Status Notes and NJISC Recommendations
20	Regulation	Monitoring	--	X	X		Authorize a post-release monitoring program that evaluates newly released species to control unforeseen effects on the ecosystem or unintended spreading. / The Plan provides guidance. The NJISC recommends implementation of regulatory reporting requirements for nursery growers and the implementation of an ED/RR program to address this problem. Standard will be met if recommendations are adopted and funding is provided.
21	Regulation	Bonds and Insurance	--	X			Authorize the requirement for bonds or insurance to guarantee that the possessor of an invasive species will be able to contribute to the damages caused if escape occurs. ELI reports that six states already have this for specific species. / The NJISC does not recommend regulatory actions. Standard will not be met.
22	Control and Management	General control and management authority	Authority over public and private lands	X	X	X	Authorize to undertake control and management measures on both public and private land and establish a statewide program of control and management for specific invasive species. / The Plan provides guidance. This is primarily an issue for ED/RR efforts. The NJDA already has this authority for particular situations. The NJISC does not recommend further regulatory action to address this problem. Standard will be met if recommendations are adopted and funding is provided.
23	Control and Management	General control and management authority	Notice of state agency of presence of invasive species	X			Authorize requirement of private landowners to report occurrences of invasive species. / The NJISC does not recommend regulatory actions. Outreach programs will encourage private landowners to report occurrences of invasive species through an ED/RR program. Standard will not be met.
24	Control and Management	General control and management authority	Statewide program	X	X		See above under 1) Authority over public and private lands and 2) Notice of state agency of presence of invasive species.

Item Number	Broad Function	Elements of Broad Functions or Activities	Additional Activities	Gold	Silver	Bronze	Explanation of Standards / NJ Status Notes and NJISC Recommendations
25	Control and Management	Emergency powers	--	X	X	X	Authorize to provide the ability to quickly respond to emergency outbreaks before widespread infestation. / The Plan provides guidance. The NJDA already has this authority for particular situations. The NJISC does not recommend further regulatory action to address this problem. Standard will be met.
26	Control and Management	Biological control agents	Permits and licenses	X	X		Assure that control agents do not become problematic to non-target species by requiring a permit or license to use a control agent. / NJDA already has this authority. The NJISC does not recommend further regulatory action. Standard will be met as part of existing programs.
27	Control and Management	Biological control agents	Standards	X	X		Authorize standards for the release of biological control agents. / NJDA already has this authority. The NJISC does not recommend further regulatory action. Standard will be met as part of existing programs.
28	Control and Management	Restoration	--	X			Authorize restoration programs with the realization that eradicating invasive species is only the first step in recovery and that healthy native systems provide protection against future outbreaks. / The Plan provides guidance. NJISC recommends restoration whenever possible. Standard will be met if recommendations are adopted and funding is provided.
29	Enforcement and Implementation	Enforcement	Criminal and civil sanctions	X	X	X	Authorize meaningful consequences to provide recognition of the seriousness of the offence. / The Plan provides guidance. The NJISC recommends regulatory action to address this issue. Standard will be met if recommendations are adopted and funding is provided.
30	Enforcement and Implementation	Enforcement	Liability for damages	X	X		Authorize fines for possessors to assure that they are liable for damages to the environment (see criminal and civil sanctions above). / The Plan provides guidance. The NJISC recommends regulatory action to address this issue. Standard will be met if recommendations are adopted and funding is provided.

Item Number	Broad Function	Elements of Broad Functions or Activities	Additional Activities	Gold	Silver	Bronze	Explanation of Standards / NJ Status Notes and NJISC Recommendations
31	Enforcement and Implementation	Enforcement	Positive incentives	X			Provide amnesty and reward programs to facilitate regulatory compliance. / The Plan provides guidance. The NJISC recommends regulatory and non-regulatory action to address this issue. Standard will be met if recommendations are adopted and funding is provided.
32	Enforcement and Implementation	Funding	--	X	X	X	Provide multi-year, designated funds for invasive species activities, especially for ED/RR. / The Plan provides guidance. NJISC recommends annual funding to support this standard. Standard will be met if recommendations are adopted and funding is provided.

Appendix 11

Recommendations of the New Jersey Invasive Species Council

New Jersey Strategic Management Plan for Invasive Species

Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
1	Tier 1	2.C: Messengers and Methods	Coordinate a campaign to educate stakeholders and improve public awareness - Step 1: Create website	Create a website with NJ-specific information and links to other invasive species websites; Include basic overview of NJ's valuable natural and agricultural resources and threats posed by invasive species; Include NJISC information including members, statement of vision, mission and guiding principles. Links will include existing nationwide outreach efforts including "Stop Aquatic Hitchhikers" and "Habitattitude".	NJISC, RCE	Website established, 10,000 hits per year	13
2	Tier 2	2.C: Messengers and Methods	Coordinate a campaign to educate stakeholders and improve public awareness - Step 2: Create printed materials and signage	Create educational flyers, brochures, and signage that provide a basic overview of the invasive species problem including several examples of non-invasive alternatives for gardens. Distribute to visitor centers/trail heads at State-owned lands, horticultural retailers, landscape architects, landscape architecture programs, municipalities/ environmental commissions, conservation organizations, schools, Association of New Jersey Environmental Commissions, Soil Conservation Districts, Rutgers Cooperative Extension, etc. The website address will appear on the printed materials and signage.	NJISC, NJDA, NJDEP	Materials created, 100,000 items distributed	13
3	Tier 2	2.C: Messengers and Methods	Encourage endorsement and adherence to the St. Louis Declaration Voluntary Codes of Conduct	Codes were created through active engagement of stakeholders through participation in industry-lead conferences and other public meetings. There is a code for various bodies including government, nursery professionals, gardening public, landscape architects and botanic gardens/arboreta.	NJISC, OIS, RCE	Outreach conducted, 25 new groups from each category endorsing and adhering to Codes	13
4	Tier 2	2.C: Messengers and Methods	Coordinate a campaign to educate stakeholders and improve public awareness - Step 3: Enhance website	Website additions including NJ specific information and photos of invasive species, species lists with state distribution, potential new invaders with reporting link to ED/RR program, teaching modules and expert lists with points of contact. Develop an interactive page where citizens report observations of invasive species occurrences.	NJISC, OIS	Improvements created, 20% increase in website hits per year	13

Appendix 11
Recommendations of the New Jersey Invasive Species Council
New Jersey Strategic Management Plan for Invasive Species

Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
5	Tier 2	2.C: Messengers and Methods	Create a rewards and recognition program for voluntary nursery industry efforts to reduce the production of invasive and potentially invasive plants	Rewarded efforts would include stopping propagation of invasive species before regulatory requirements take effect or producing only clean listed species.	NJISC, OIS, RCE	Award program created, annual awards distributed	13, 31
6	Tier 2	2.C: Messengers and Methods	Create invasive species teaching modules	Create invasive species teaching modules for Rutgers Cooperative Extension, Rutgers NJAES, Office of Continuing Education, curriculum modules for K-12 education, and expanded undergraduate and graduate-level education at New Jersey's institutions of higher learning. Modules may include identification and control of current invasive species and identification of emerging invasive species for the Master Gardener and Environmental Steward Programs and could also be used to provide continuing education requirements for NJ-certified pesticide applicators and operators, foresters, commercial farm operators and landscape professionals.	NJISC, RCE	Five modules created, 5,000 people completing modules per year	13
7	Tier 2	2.C: Messengers and Methods	Provide outreach and incentives to reduce the reservoir of invasive species that continue to spread from planted landscapes	Encourage plant distributors to supply non-invasive plant materials to replace invasive species currently planted in gardens. This could take the form of a design competition with rewards for the most attractive landscapes that do not contain invasive species.	NJISC, OIS, RCE	Outreach conducted, 10 participating nurseries, annual design competition established	13, 31
8	Tier 2	3.B: Prevention Strategies for Unintentional Species Introductions	Prepare a recommendation to ensure that Federal inspection efforts are commensurate with the risks posed to NJ	The recommendation should seek two new federal positions at the Linden facility to provide increased inspection capacity.	NJISC, OIS, NJDA	Recommendations delivered and implemented	7

Appendix 11
Recommendations of the New Jersey Invasive Species Council
New Jersey Strategic Management Plan for Invasive Species

Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
9	Tier 2	3.B: Prevention Strategies for Unintentional Species Introductions	Minimize the spread of invasive species through recreational activities	Install boot cleaning stations at trailheads; Install interpretive signage at trailheads and boat launches	NJISC, OIS, NJDEP	50 boot cleaning stations with informational brochure installed; 50 signs located at popular boat launches	13
10	Tier 2	3.B: Prevention Strategies for Unintentional Species Introductions	Minimize the spread of invasive species through forestry activities	Provide outreach to foresters and request voluntary cleaning of equipment prior to arriving at new job sites to remove mud that potentially contains seeds of invasive species	NJISC, OIS	Brochure created and mailed to all certified foresters	13
11	Tier 2	3.B: Prevention Strategies for Unintentional Species Introductions	Minimize spread of invasive species in marine systems	Marine system threats are not deeply explored in the plan. Specific goals to determine appropriate prevention strategies should follow communications with the New Jersey Marine Science Consortium (http://www.njmsc.org/) and other relevant stakeholders.	NJISC, OIS	Marine system prevention goals are outlined and implemented	13
12	Tier 1	3.C: Prevention Strategies for Intentional Species Introductions	Formalize NJ banned plant species list	Use a modified Massachusetts protocol to seek peer-review of the DEP's 2002 Prioritized Listing of New Jersey's Nonindigenous Plant Species to better promote education and outreach efforts and as a basis for potential regulatory programs. Incorporate into this effort the development of a "Clean List" of nonindigenous species that lack invasive qualities and are safe for planting. Formal list will be created through an administrative rule making process and will include all cultivars/varieties of listed species and fines for non-compliance.	NJISC, NJDA	List created through NJISC approved process	1

Appendix 11
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Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
13	Tier 1	3.C: Prevention Strategies for Intentional Species Introductions	Enforce ban on the production and sale of demonstrably invasive or potentially invasive listed plant species through inspections of propagators and retailers	Use current nursery inspection and certification program to enforce banned species list with fines for violators. Revenue generated from violations to be distributed to the NJISC to fund control programs. Program provides licenses to 990 certified nurseries and 1,510 certified plant dealers. A time frame of three years is recommended to allow growers to avoid undue financial impacts that would be caused by prohibiting the production of popular species. In addition, all cultivars/varieties/selections/sub-species of listed species will be assigned the same status assigned to the 'straight species' unless they are proven to be completely sterile through published scientific research. An extended phase-out period of five years is proposed for commercially valuable cultivars of Japanese barberry to allow significant time to develop alternatives or for the horticultural industry to deliver sterile cultivars. An annual report will be prepared that summarizes findings of the inspections (including species and quantities produced).	NJDA	Compliance rate of 95%.	1, 29
14	Tier 1	3.C: Prevention Strategies for Intentional Species Introductions	Eliminate use of invasive species on state lands	Enforce Policy Directive 2004-04 prohibiting the intentional introduction of specified invasive species into DEP lands and waters, and require planting of native or "Clean Listed" non-native species only on all State-owned lands.	NJISC, OIS, NJDEP, NJDA, NJDOT	Policy Directive revised and implemented	8
15	Tier 1	3.C: Prevention Strategies for Intentional Species Introductions	Educate Federal representatives and request increased federal legislation for prevention measures	Encourage passage of revisions to the Quarantine 37 rules to require pre-screening of plant introductions.	NJISC, OIS, NJDA	US implements requirements to pre-screen plant introductions for invasive potential	8

Appendix 11
Recommendations of the New Jersey Invasive Species Council
New Jersey Strategic Management Plan for Invasive Species

Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
16	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Evaluate invasive potential in all non-native plant species used in trade in New Jersey	A comprehensive list would be developed to incorporate all non-native plant species used for agricultural, horticultural, or medicinal purposes to include all species commercially available and capable of growing in NJ. These species require evaluation and categorization as performed for all non-native plant species currently found in our flora. This will require searching NJDA importation records (Quarantine 37 process), nursery growers and dealer plant lists, and mail-order catalogs.	NJISC, OIS	List created and species evaluated through NJISC approved process	4, 8
17	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Prohibit shipment of invasive species into New Jersey	Deny any shipment of plants or animals considered invasive species through the interstate phytosanitary inspection certification program.	NJISC, OIS, NJDA	Rules adopted and implemented	10, 15
18	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Re-evaluate all non-native species every 5 years	Coordinate continued listing and evaluation of non-native species to determine threats and control decisions	NJISC, OIS	List created and species evaluated through NJISC approved process	4, 20
19	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Produce an annual report and database of new plant introductions to NJ through the Quarantine 37 process	Circulate annual report for public review and comment. This is very important to establish a successful ED/RR program.	NJISC, OIS, NJDA	Annual reports produced, Comments received, Database of reports maintained	4
20	Tier 2	3.C: Prevention Strategies for Intentional Species Introductions	Create regulation of public gardens regarding the maintenance of invasive species	Create a permitting and licensing program for public gardens that wish to maintain listed invasive species. Requirements would include a licensing fee based upon the number of individual plants of invasive species. Certification under this program would require public gardens to monitor spread from plantings and implement control programs as necessary. Distribution of propagules to any outside entity would be prohibited.	NJISC, OIS, NJDA	Regulation adopted and implemented	14, 29

Appendix 11
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Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
21	Tier 1	3.D: Early Detection and Rapid Response	Incorporate invasive species strategies into Community Forestry plans	Require the incorporation of invasive species issues and ED/RR principles into the development and update of municipal Community Forestry plans.	NJISC, NJDEP	All new and updated plans address invasive species	4
22	Tier 2	3.D: Early Detection and Rapid Response	Prioritize non-native species identified as having the potential to become invasive species in New Jersey	Develop a process to rank potentially invasive species of greatest concern to New Jersey's biodiversity, natural resources, and agricultural resources for ED/RR efforts. This would require coordination with neighboring states and regional entities to determine invasive species threats to NJ.	NJISC, OIS	Prioritized list of species created	4, 8
23	Tier 2	3.D: Early Detection and Rapid Response	Prioritize areas within the state to conduct searches for newly establishing invasive species	Prioritize and select areas for ED/RR that should be searched based upon sites with high probabilities of occurrence (e.g., ports, warehouses) and pristine areas where new invasions would be most detrimental. Pristine areas with high biodiversity value should be selected by utilizing a site prioritization system, such as that outlined in this plan.	NJISC, OIS, NJDA, NJDEP	Prioritized list of sites created	4, 6
24	Tier 2	3.D: Early Detection and Rapid Response	Begin a site-led ED/RR program by focusing on six pristine sites throughout the state	Begin site-led ED/RR by initially selecting six sites and create comprehensive management plans that focus on protecting the health of biodiversity elements threatened by invasive species. One site should be selected from each of the geographic areas in the state - i.e., Ridge and Valley, Highlands, Piedmont, Inner Coastal Plain, Outer Coastal Plain (Pine Barrens) and coastal dune system. These areas would serve as a site-based ED/RR for all known and potential invasive species and could be highlighted on the website as 'what it should look like.' This effort would also have great research value by increasing our understanding of site susceptibility to infestations.	NJISC, OIS, NJDEP	Sites selected, plans created and treatments performed	22

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Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
25	Tier 2	3.D: Early Detection and Rapid Response	Create a comprehensive ED/RR program	Early detection and taxonomic verification of species through RCE, Watershed Watch Program, and volunteers; response and record keeping through NJISC and NJDA. Integrated state database maintained by NJISC. Develop training program for volunteers (e.g., IPANE). Ensure that ED/RR program has access to expertise in taxonomy, ecology, and risk assessment through the NJISC. Eliminate fee for species ID to a free program through RCE; Enlist support from the Flora of New Jersey Project and the New Jersey Native Plant Society. Advertise new program through website to recruit volunteers. Create a large base of 'coincidental' Weed Watchers through outreach to consulting foresters, CTE, DEP land managers, wetland delineators, land use managers, arborists, environmental consultants, etc. Simple forms provided to professionals would include a list of species and gross estimate of infestation severity. Request that they fill out whenever possible during their normal business activities. This also supports the assessment of non-native plant	NJISC, OIS, NJDA, NJDEP, RCE	Comprehensive program established	4, 22, 25
26	Tier 2	3.G: Site-based Control Efforts	Begin species-led ED/RR program by focusing on five invasive species that have limited distribution in New Jersey	The goal for these species would be eradication. Initial invasive species should include feral hog, Asian longhorned beetle, Chinese silver grass, water chestnut and giant hogweed	NJISC, OIS, NJDA, NJDEP	Five invasive species eradicated from NJ	4, 22
27	Tier 1	4.A: Control and Restoration	Encourage management of state-owned lands through agricultural lease program	Encourage public/private partnerships in managing invasive species on state-owned lands through a creative agricultural lease program with farmers and the involvement of trained and certified volunteers.	NJISC, NJDEP, NJDA	Initiate one pilot project	22, 28
28	Tier 2	4.A: Control and Restoration	Perform field surveys to update status of rare plant species and ecological communities	New Jersey Natural Heritage Program to lead new field surveys to update old records of rare species/ecological communities and search for additional occurrences to provide prioritization of invasive species prevention and control efforts.	NJISC, OIS, NJDEP	Existing occurrences updated; completed survey of 20 potentially important sites	5, 6

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Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
29	Tier 2	4.A: Control and Restoration	Create a prioritized list of public lands to focus future control activities	Use existing and newly collected data within a site prioritization protocol to create a prioritized list of public lands for future control activities.	NJISC, OIS, NJDEP	Prioritized list created	5
30	Tier 2	4.G: Site-based Control Efforts	Determine distribution of invasive species currently found in New Jersey	Use existing data (e.g., Brooklyn Botanic Garden, municipal inventories, etc.) and additional data collected through volunteer 'Weed Watchers' program along with NJNHP and ENSP. This recommendation would complement an ED/RR program. The Invasive Plant Atlas of New England can be used as a model for this program.	NJISC, OIS, NJDEP	Data collection and management program developed; 100 volunteers recruited	5, 6
31	Tier 2	4.A: Control and Restoration	Encourage completion of comprehensive management plans by public and private land managers prior to initiating invasive species control efforts	The creation of management plans encourages efficacious and efficient treatment of invasive species based upon conservation goals.	NJISC, OIS	10 plans created; Provide text and web links through NJISC website	22
32	Tier 2	4.A: Control and Restoration	Select one site to demonstrate a major control and restoration effort	Demonstrate various innovative strategies and techniques required to control and restore one heavily infested area of at least 500 acres. The selected site should primarily consist of upland habitat to provide an alternate example to the Cape May Meadows Ecosystem Restoration (see Text Box 4), which involved a coastal wetland system.	NJISC, OIS, NJDEP	Complete a management plan and meet its control and restoration goals	22, 28
33	Tier 1	4.B: Native and Non-Native Animals	Implement a comprehensive program to reduce the white-tailed deer population	Improve hunting access on lands with limited or absent hunting opportunities on public and private lands. Determine protocols to guide harvest goals by measuring the health of ecological systems. This program would provide outreach and technical assistance to support increased hunting access on public and private lands across the state. These efforts would be implemented by the Division of Fish & Wildlife with support from NJISC and its constituent members along with OIS. The ultimate goal is to reduce the deer population and allow the potential for ecological control of invasive species.	NJISC, OIS, NJDEP, NJDA	Program developed and implemented; Available acreage and hunting days increased by 25% across state, measurable indicators of ecological health above established thresholds	22

Appendix 11
Recommendations of the New Jersey Invasive Species Council
New Jersey Strategic Management Plan for Invasive Species

Relative Priority Values: Tier 1 (1-2 Years After Plan Adoption), Tier 2 (3-10 Years After Plan Adoption)

Recommendation Number	Tier Group	Sub-Section Number and Name	Recommendation	Recommendation Comments	Lead(s)	Recommendation Completion Measurements	Appendix 11 - ELI Item # Crosslinks
34	Tier 1	4.B: Native and Non-Native Animals	Provide state financial support for Hunters Helping the Hungry program	Seek re-appropriation of the Hunters Helping the Hungry (HHH) program, which enables hunters to donate venison to needy individuals throughout NJ, with a suggested restart amount of $250,000, to enhance incentives for increased deer hunting in NJ. This program can increase deer harvest numbers and support ecological control of invasive species.	NJISC, NJDEP, NJDA	HHH program statewide and fully funded	22, 28
35	Tier 2	4.B: Native and Non-Native Animals	Provide greater outreach to reduce impacts of feral and outdoor domestic cats	Provide outreach through support of NJAS "Cats Indoors!" program and encourage participation in the existing cat spay/neuter program.	NJISC, OIS, NJDHSS	Participation in program increased by 10%	22
36	Tier 2	4.B: Native and Non-Native Animals	Implement a plan to reduce resident Canada geese, snow geese and mute swans	Canada Goose: NJDEP-DFW should continue to take advantage of liberal hunting opportunities and depredation orders allowed under U.S. Fish and Wildlife Service (USFWS) regulations; Mute Swan: Legislative changes should be considered to include mute swans as game birds in New Jersey. This change would allow the mute swan to be efficiently controlled through hunting seasons, with reduction of population to 500. Snow Goose: NJDEP-DFW should continue to take advantage of liberal hunting opportunities and adopt any additional means of take that are being considered by the USFWS	NJISC, OIS, NJDEP, NJDA	Plan prepared; populations reduced by 50%	22
37	Tier 1	4.E: Coordinated Control Programs	Establish Cooperative Weed Management Areas (CWMAs) in New Jersey and request federal funding for the establishment of a State-sponsored cost-share program that encourages control of invasive species	Encourage linkages between land managers and volunteer groups willing to perform invasive species control. Use advertising (e.g., NJISC website, Central Jersey Invasive Species Strike Team, MA-EPPC, Environmental Stewards Program, Watershed Watch Program, Morris Land Conservancy's - Partners for Parks Program) to reach potential groups including corporations, scouts, schools, etc. Seek grant funding to establish and maintain the program.	NJISC, OIS, RCE, NJDEP	CWMAs established, 5 CWMA projects funded	22

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38	Tier 2	4.D: Control Methods and Techniques	Request federal grant funding to enhance biocontrol agent production by the New Jersey Beneficial Insect Laboratory	Mass produce and offer biocontrol agents at a subsidized price to landowners interested in control. Also see Section 5.	NJISC, OIS, NJDA	Funding received - $500,000, agents produced and released, sites treated, invasive cover reduced	22
39	Tier 1	4.F: Restoration	Create list of native plants recommended for various habitat types for use in restoration efforts	This would not include non-invasive, non-native plants because it would be for native community restoration.	NJISC, OIS, NJDEP	List created and added to NJISC website	28
40	Tier 2	4.F: Restoration	Formulate protocols for restoration success by geographic region	This would be a restoration 'tool kit' with goals for successful restoration projects.	NJISC, OIS, NJDEP	Protocols created and added to NJISC website	28
41	Tier 2	4.D: Control Methods and Techniques	Create comprehensive phenology and treatment table for all invasive species	Using Zerbe et al. (2003) as a model, create comprehensive source of information on phenology and treatment options across the year for all invasive species. See Central Jersey Invasive Species Strike Team efforts at www.fohvos.org for initial efforts.	NJISC, OIS	Guide created and posted on website	22
42	Tier 1	5.B: The Role of a Permanent NJ Invasive Species Council	Create a permanent New Jersey Invasive Species Council	A permanent NJISC, co-chaired by NJDEP and NJDA, should continue in its capacity as advisory body to the Governor of New Jersey. The NJISC will emphasize partnerships among government agencies, non-governmental and private-sector organizations representing the full range of stakeholders affected by invasive species problems, and concerned citizens. Responsibilities will include representing the State in policy decisions where invasive species may be an issue. The NJISC will meet at least quarterly, promote volunteer-based actions to reduce the impacts of invasive species and educate the public, and ensure that the requirements of the Environmental Law Institute's 'Silver Standard' for state action on invasive species are met.	NJISC	Council made permanent with recommended structure and function	2

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43	Tier 2	5.B: The Role of a Permanent NJ Invasive Species Council	Recommend that NJ comply with the Environmental Law Institute's 'Silver Standard'	ELI's 'gold standard' is an exhaustive list of recommendations to fully address the threat of invasive species. The 'silver standard' involves strong steps, but falls short of comprehensively addressing the threat. However, it is reasonable for New Jersey to meet this standard within 10 years if all recommendations are implemented. Achievement of the 'gold standard' should be the ultimate goal for New Jersey, but this cannot reasonably be achieved in less than 10 years.	NJISC	Silver Standard achieved	2
44	Tier 2	5.C: Resource Requirements	Create an Office of Invasive Species	A total of seven staff would consist of a Director (coordinate activities between state agencies, staff supervision, liaison to regional and national efforts), Grant Coordinator (partially fund the Office of Invasive Species/ obtain and administer grant funding for cost-share programs provided to non-state programs), Prevention Coordinator (ED/RR system implementation, risk assessment and pathway analyses), GIS/Information Manager (administer tabular and spatial data, website administration), Research Coordinator (liaison to universities and other researchers, track latest innovations in prevention, control, and restoration), Outreach Coordinator (liaison to stakeholders and the public, foster CWMAs, recruit volunteers for prevention, control, and restoration), and an administrative assistant.	NJISC, NJDA, NJDEP	staff positions filled with a stable source of funding	N/A
45	Tier 2	5.C: Resource Requirements	Create a NJ Invasive Species Strike Team	The NJISST would report to the Office of Invasive Species and consist of two full-time staff positions and two seasonal staff positions. They would also administer $500,000 annually for invasive species control contracts across all state lands.	NJISC, NJDA, NJDEP	staff positions filled and contract fund allocation maintained with a stable source of funding	N/A
46	Tier 2	5.C: Resource Requirements	Recommend the addition of one new staff position for the Division of Fish and Wildlife	It is extremely important to enhance programs to reduce deer densities. This recommendation represents a cost effective method to reduce existing invasive species through 'ecological control' (see Plan text).	NJISC, NJDEP	staff position filled with a stable source of funding	N/A

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47	Tier 2	5.C: Resource Requirements	Recommend the addition of two new NJDA inspection staff	NJDA inspection is vital to enforcing the banned plant species list.	NJISC, NJDA	staff positions filled with a stable source of funding	N/A
48	Tier 2	5.C: Resource Requirements	Provide funding to biological control researchers and seek federal matching funds	Provide $100,000 of state funding and seek federal matching grants to be provided to researchers. Communicate NJ's priority species for biological control to researchers. Initial priority should be given to the most harmful pests including garlic mustard, Japanese stiltgrass and Japanese barberry.	NJISC, OIS, NJDA, NJDEP	State provides $100,000 to promote development of a new biocontrol agent. Federal government match of at least 1:1.	22
49	Tier 2	5.C: Resource Requirements	Recommend the addition of two new staff position at the Rutgers Cooperative Extension	RCE is integral to the completion of numerous goals.	NJISC, RCE	staff positions filled with a stable source of funding	N/A
50	Tier 2	5.C: Resource Requirements	Recommend the addition of two new invasive species staff positions – one at the New Jersey Natural Heritage Program and one at the Endangered and Nongame Species Program	Positions would focus on mapping threats posed by invasive species and monitoring health of selected rare species and communities.	NJISC, NJDEP	staff positions filled with a stable source of funding	N/A
51	Tier 2	5.C: Resource Requirements	Recommend the addition of one new staff position for the Division of Watershed Management - Watershed Watch Program	This program has the potential to harness thousands of volunteers for detection and control of invasive species.	NJISC, NJDEP	staff position filled with a stable source of funding	N/A
52	Tier 2	5:D: Potential funding sources	Encourage invasive species control through use of existing state and federal cost-share programs	Maximize use of programs such as the USDA-NRCS Conservation Reserve Enhancement Program (CREP) and Wildlife Habitat Incentives Program (WHIP).	NJISC, NJDEP, NJDA	Provide outreach to private citizens and create ongoing communications with USDA-NRCS	22, 28

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53	Tier 2	5.D: Potential Funding Sources	Seek State funding for New Jersey's Invasive Species Program	Consider incorporation of funding for stewardship into future GSPT bond initiatives, and explore additional funding sources, recognizing that habitat lost through the proliferation of invasive species represents the loss of our State's capital assets.	NJISC	Annual funding of $2.4 million for programs identified in the plan	2, 32
54	Tier 1	5.E: Partnerships and Regional Cooperation	Enhance federal participation within a permanent NJ Invasive Species Council	Federal agencies have significant expertise and resources to assist NJ. Invite US Department of Agriculture, US Department of Interior and US Environmental Protection Agency.	NJISC	3 new groups participating, communication timely and effective	2
55	Tier 1	5.E: Partnerships and Regional Cooperation	Expand statewide efforts for two-way communications on invasive species issues	Invite representatives from private arboreta/botanic gardens, shade tree commissions, environmental commissions, etc. to NJISC meetings.	NJISC, OIS	Create a e-mail distribution list and advertise all upcoming meetings	2
56	Tier 1	5.E: Partnerships and Regional Cooperation	Expand regional efforts for two-way communications on invasive species issues	Multiple groups from adjacent states and the region face similar problems with invasive species. Create dialogue through meetings/conferences to standardize data collection and archiving to ensure two-way data flow. Cooperation between New Jersey and other groups, including invasive species councils from adjacent states, could increase the efficiency of regional efforts.	NJISC, OIS	Regular communication with all neighboring states and regional invasive species groups	4
57	Tier 1	5.E: Partnerships and Regional Cooperation	Communicate goals of NJ Strategic Management Plan for Invasive Species to the Port Elizabeth Committee	Group consists of APHIS, DHS, Customs, and NJDA. The group assesses risk assessment to better target inspections.	NJISC, OIS, NJDA	NJ plan distributed to Committee.	4

Appendix 12

State of New Jersey
Executive Order #97

New Jersey Strategic Management Plan for Invasive Species

Governor James E. McGreevey

WHEREAS, harmful non-indigenous species of plants, animals, and other organisms, commonly referred to as invasive species, pose a threat to New Jersey's native vegetation and natural resources by invading healthy ecosystems where they displace, impair or destroy indigenous species and impair ecosystem function; and

WHEREAS, invasive species threaten New Jersey's agricultural resources through loss of production and loss of product marketability; and

WHEREAS, invasive species pose a threat to natural biodiversity, the integrity and function of natural ecosystems, and economic vitality in New Jersey and throughout the United States; and

WHEREAS, this national threat affects approximately 1,880 federally listed species; and

WHEREAS, it has been estimated that damages from non-indigenous species in the United States result in economic losses of $123 billion annually; and

WHEREAS, invasive species have been documented on lands managed by the Department of Environmental Protection's Division of Parks and Forestry and Division of Fish and Wildlife, including portions of the State's Natural Areas System, on agricultural lands and on other private lands; and

WHEREAS, the federal government has created a national Invasive Species Council and an Invasive Species Advisory Committee and has mandated the preparation of a National Invasive Species Management Plan to address the invasive species threat; and

WHEREAS, the Departments of Environmental Protection and Agriculture have taken steps to address the threat posed by invasive species, including the formation of study groups, the monitoring of invasive species, the development of agricultural invasive species management plans, along with eradication and biological control programs targeting selected invasive species and plant pests of foreign origin; and

WHEREAS, despite these efforts, invasive species continue to be introduced into New Jersey; and

WHEREAS, the most efficient means of controlling invasive species is to prevent their entry into the State and to address an invasive species before the species becomes established; and

WHEREAS, it is necessary and appropriate for New Jersey to develop uniform policies and a coordinated response to the threat posed by invasive species to the State's native and agricultural vegetation, and to establish a source of advice to the Governor on this issue;

NOW, THEREFORE, I, JAMES E. McGREEVEY, Governor of the State of New Jersey, by virtue of the authority vested in me by the Constitution and by the Statutes of this State, do hereby ORDER and DIRECT:

1. There is hereby established a New Jersey Invasive Species Council (Council).
2. The Council shall consist of:
    - The Commissioner of the Department of Environmental Protection or his designee;
    - The Secretary of the Department of Agriculture or his designee;
    - The Commissioner of the Department of Transportation or his designee;
    - The Secretary and Chief Executive Officer of the Commerce and Economic Growth Commission or his designee;

    Additional members of the Council shall be appointed by the Governor as follows:

    - Three representatives from conservation organizations;
    - One representative from the agricultural sector;
    - Two representatives of the nursery and landscape sector;
    - One representative of the New Jersey Agricultural Invasive Species Council;
    - One representative from academia;
    - One or more representatives from the general public.
3. The Co-Chairpersons of the Council shall be the Commissioner of the Department of Environmental Protection and the Secretary of the Department of Agriculture, or their designees.
4. The Council shall request the participation of the United States Department of Agriculture, the United States Environmental Protection Agency and the United States Department of the Interior.
5. The Council shall develop a comprehensive New Jersey Invasive Species Management Plan to be submitted to the Governor no later than June 2005. The management plan shall include but not be limited to: a statement of policy and mission; definitions; findings concerning the current status of non-indigenous plant species in New Jersey and their impact on habitat, biota and natural ecosystems; identification of prevention methods and procedures for early detection and rapid response, and control measures; identification of restoration and research needs and pilot projects; establishment of information management, education and interpretation measures; and coordination among state agencies and adjacent states.
6. The Council shall undertake the following tasks and any other reasonable measures necessary to prevent the introduction of invasive species and to eliminate or minimize invasive species already established in the State. These tasks, as appropriate, may become components of the New Jersey Invasive Species Management Plan:

a. Recommend measures necessary for the Departments and non-governmental organizations to cooperate with federal agencies and other states in complying with Executive Order 13112 and the National Invasive Species Management Plan;
b. Identify research needs to better assess the sources, degree, distribution and threat posed by invasive species, and methods for preventing the introduction and control of invasive species;
c. Review ongoing invasive species control efforts being carried out by the Departments, and recommend new or revised measures to limit the introduction and effectuate the control of invasive species;
d. Produce educational materials for public distribution regarding the threats posed by invasive species, outlining measures to prevent the introduction of invasive species and to control invasive species, and encourage the use of local native genotypes propagated in New Jersey in landscaping and planting (including drought tolerant native plants);
e. Develop partnerships with federal, State and local government agencies and private organizations, including the horticultural industry, necessary to implement the policies and recommendations of the Council;
f. Identify funding sources for research, monitoring, control and outreach programs;
g. Plan, design and implement two invasive species eradication and native plant restoration pilot projects by June 2005.
h. Identify legislative or regulatory actions necessary to implement or further the policies and recommendations of the Council.

7. This order shall take effect immediately.

GIVEN, under my hand and seal this 27th day of February in the Year of Our Lord, Two Thousand and Four, and of the Independence of the United States, the Two Hundred and Twenty-Eight

/s/ James E. McGreevey

Governor

[seal]

Attest:
/s/ Michael R. DeCotiis
Chief Counsel to the Governor

Appendix 13
List of Stakeholder Groups
New Jersey Strategic Management Plan for Invasive Species

Name	Web Contact Information
Garden Clubs and Societies *Note that many clubs do not have web pages, but may be accessed through their affiliation with one or both of the first two listings.*	
The Garden Club of America	Includes multiple garden club affiliates in NJ: http://www.gcamerica.org/index.php3
The Garden Club of New Jersey, Inc.	Includes multiple garden club affiliates in NJ: http://www.gardencentral.org/gcnj; member of the National Garden Clubs, Inc. (http://www.gardenclub.org/)
All Seasons Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Allenhurst Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Atlantic Highlands Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Basking Ridge Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Bayberry Garden Club of Brielle	No direct website (Affiliated with the GCNJ / NGC)
Bernardsville Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Brigantine Garden Club	http://dir.gardenweb.com/directory/bgc/
Clifton Garden Club	http://dir.gardenweb.com/directory/cgc1/
Clio Club/Golden Treasures	No direct website (Affiliated with the GCNJ / NGC)
Community Garden Club of Hunterdon County	No direct website (Affiliated with the GCNJ / NGC)
Contemporary Club	No direct website (Affiliated with the GCNJ / NGC)
Countryside Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Demarest Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Dogwood Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Floraphile Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Allentown	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Avon-by-the-Sea	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Belvedere	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Bound Brook	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Bridgewater	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Candlewood	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Central Sussex	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Chatham	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Chester	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of East Brunswick	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Edison	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Elizabeth	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Englewood	No direct website (Affiliated with the GCNJ / NGC and GCA)
Garden Club of Essex Falls	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Fair Haven	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Fairways	No direct website (Affiliated with the GCNJ / NGC)

Name	Web Contact Information
Garden Club of Florham Park	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Greater Woodbury	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Haddonfield	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Hanover	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Harrington Park	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Hoboken	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Ho-Ho-Kus	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Hunterdon Hills	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Island Heights	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Little Silver	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Long Beach Island	http://www.thegardenclubofllbi.com/
Garden Club of Long Valley	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Madison	No direct website (Affiliated with GCA)
Garden Club of Maplewood	http://www.maplewoodgardenclub.org/
Garden Club of Marlton	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Medford Lakes	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Metuchen	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Milton	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Montclair	http://gardenclubmontclair.tripod.com/
Garden Club of Montville/Valhalla	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Moorestown	http://moorestowngarden1.tripod.com/
Garden Club of Morristown	No direct website (Affiliated with GCA)
Garden Club of Mount Holly	http://www.geocities.com/mthollygardenclub/
Garden Club of Mount Laurel	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Mount Tabor	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Mountain Lakes	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Navesink	http://www.navesinkgardenclub.org/
Garden Club of Neshanic	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of New Providence	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of New Vernon	http://www.nvgardenclub.org/
Garden Club of Nottingham	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Oakland	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Ocean Township	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Oceanport	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Packanack Lake	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Panther Valley	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Pines Lake	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Piscataway	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Plainfield	No direct website (Affiliated with GCA)
Garden Club of Point Pleasant	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Princeton	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Ringwood	No direct website (Affiliated with the GCNJ / NGC)

Name	Web Contact Information
Garden Club of Rockaway Valley	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Rocky Brook	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Rolling Hills	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Rumson	No direct website (Affiliated with GCA)
Garden Club of Rutherford	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Saddle River	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Short Hills	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Shrewsbury	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Somerset Hills	No direct website (Affiliated with GCA)
Garden Club of Somerset Valley	http://www.wegarden.org/
Garden Club of Spring Lake	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Springfield	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Summit	No direct website (Affiliated with GCA)
Garden Club of Tenafly	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of the Caldwells	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of the Oranges	No direct website (Affiliated with GCA)
Garden Club of Trenton	No direct website (Affiliated with the GCNJ / NGC and GCA)
Garden Club of Verona	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Warren	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Washington Valley	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Watchung	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of West Trenton	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Westfield	No direct website (Affiliated with the GCNJ / NGC)
Garden Club of Woodbridge	http://www.woodbridgegardenclub.com/
Garden Club of Wyckoff	http://www.wyckoffgc.org/
Garden Club RFD, Middletown	No direct website (Affiliated with the GCNJ / NGC)
Garden Gate Garden Club of Lawrenceville	No direct website (Affiliated with the GCNJ / NGC)
Garden State Iris Society	http://dir.gardenweb.com/directory/gsis/
Garden State Rose Club	http://dir.gardenweb.com/directory/gsrc/
Gardeners of Somerset Valley	http://wegarden.org/
Green Thumb Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Green Thumb Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Green Thumb Garden Club of Jackson	http://dir.gardenweb.com/directory/gtgcj/
Grow and Shoe Garden Club of Interlaken	No direct website (Affiliated with the GCNJ / NGC)
Happy Workers Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Holly Club of Sea Girt	No direct website (Affiliated with the GCNJ / NGC)
Holly Club of Toms River	No direct website (Affiliated with the GCNJ / NGC)
Home Garden Club of Morristown	No direct website (Affiliated with the GCNJ / NGC)
Hunterdon Garden Guild of Flemington	No direct website (Affiliated with the GCNJ / NGC)
Jumping Brook Garden Club	No direct website (Affiliated with the GCNJ / NGC)
North Jersey Dahlia Society	http://mywebpage.netscape.com/njdahlia/
Northfield Garden Club of Atlantic County	No direct website (Affiliated with the GCNJ / NGC)

Name	Web Contact Information
Pinelands Garden Club of Medford, Inc.	http://pinelandsgardenclub.tripod.com/
Rake and Hoe Garden Club of Westfield	http://www.rakeandhoe.org/
Ramsey Area Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Riverview Inc. Garden Club of Greater Wayne	No direct website (Affiliated with the GCNJ / NGC)
Royal Garden Club of the Bay	No direct website (Affiliated with the GCNJ / NGC)
Seaweeders Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Snufftown Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Somerville Spade and Hoe Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Stony Brook Garden Club	No direct website (Affiliated with GCA)
Sundial Garden Club	No direct website (Affiliated with the GCNJ / NGC)
Terra Nova Garden Club	No direct website (Affiliated with the GCNJ / NGC)
The Country Garden Club of Mount Laurel	http://dir.gardenweb.com/directory/cgcml/
The Garden Club of Long Beach Island	No direct website (Affiliated with the GCNJ / NGC)
The Garden Club of Somerset Hills	No direct website (Affiliated with GCA)
The Jersey Shore Rose Society	http://www.jsroses.com/home.html
Trowel Club of New Brunswick	No direct website (Affiliated with the GCNJ / NGC)
Village Garden Club of Middletown	No direct website (Affiliated with the GCNJ / NGC)
West Jersey Rose Society	http://dir.gardenweb.com/directory/wjrs/
Women Gardeners of Ridgewood	No direct website (Affiliated with the GCNJ / NGC)
Public Gardens, Arboreta, and Botanic Gardens	
Acorn Hall Gardens (Morris)	www.acornhall.org
Avis Campbell Gardens (Essex)	http://gardenclubmontclair.tripod.com/
Bamboo Brook Gardens (Morris)	http://parks.morris.nj.us/aspparks/bbrookmain.asp
Barclay Farmstead Gardens (Camden)	http://www.barclayfarmstead.org/
Branch Brook Park (Essex)	http://www.branchbrookpark.org/
Brookdale Park Rose Garden (Essex)	http://www.last-exit.net/essexcounty/index.php?section=dept/p/br
Buceleuch Mansion Gardens (Middlesex)	http://www.cityofnewbrunswick.org/depts/publicworks/parks.asp
Butterfly Garden at Cape May Bird Observatory (Cape May)	www.njaudubon.org/Centers/CMBO/#goshen
Camden Children's Garden (Camden)	www.camdenchildrensgarden.org/
Cedar Brook Park and Shakespeare Garden (Union)	www.ucnj.org/svcsgov/parksrec/parkfacl.htm
Colonial Park Arboretum and Gardens (Somerset)	www.park.co.somerset.nj.us/activities/gardens/gardens_CP.htm
Cora Hartshorn Arboreta and Bird Sanctuary (Essex)	http://www.hartshornarboretum.com/
Cross Estate Gardens (Somerset)	http://www.crossestategardens.org/
Davis Johnson Memorial Park and Gardens	http://www.tenaflynj.org/content/56/112/default.aspx
Deep Cut Gardens (Monmouth)	http://www.monmouthcountyparks.com/parks/deep_cut/deep_cut.asp
Delbarton Gardens (Morris)	http://www.jerseygrown.nj.gov/njgardens.html
Denville Community Garden	http://denvillegardens.org/
Dey Mansion (Passaic)	www.fieldtrip.com/nj/16961776.htm
Drumthwacket Gardens (Mercer)	www.drumthwacket.org/index.html
Duke Gardens (Somerset)	http://www.dukefarms.org/
Durand-Hedden House and Garden (Essex)	www.somsd.k12.nj.us/~chssocst/durandhedden.htm
East Jersey Olde Towne Herb Garden (Middlesex)	http://www.jerseygrown.nj.gov/njgardens.html

Name	Web Contact Information
Edith Duff Gwinn Gardens of the Barnegat Light Museum (Ocean)	http://lbinet.com/nonprof/blhist.htm
Emlen Physick Estate (Cape May)	www.capemaymac.org/Physick-Estate/physick-estate.htm
Erlanger Memorial Gardens at Monmouth College (Monmouth)	http://www.jerseygrown.nj.gov/njgardens.html
Ferry House Kitchen Garden (Mercer)	www.state.nj.us/dep/parksandforests/parks/washcros.html
Flat Rock Brook Nature Center (Bergen)	http://www.flatrockbrook.org/
Florence and Robert Zuck Arboretum (Morris)	www.drew.edu/campus/map/building.php?name=zuck
Frelinghuysen Arboretum (Morris)	http://www.morrisparks.net/aspparks/frelarbmain.asp
Garden for the Blind and Physically Handicapped (Middlesex)	www.woodbridgegardenclub.com/
George Washington Memorial Arboretum (Mercer)	www.state.nj.us/dep/parksandforests/parks/washcros.html
Glenmont (Essex)	www.fieldtrip.com/nj/17360550.htm
Greenwood Gardens (Essex)	http://www.greenwoodgardens.org/
Grounds For Sculpture (Mercer)	www.groundsforsculpture.org/
Hammond Wildflower Trail at Tourne Park (Morris)	www.mtnlakes.org/~environ/TMp-Wildflower.htm
Helen C. Branson Herb Garden (Camden)	www.historicalsocietyofhaddonfield.org/index.htm
Henry Chatfield Memorial Garden (Union)	www.ucnj.org/svcsgov/parksrec/parkfacl.htm#gardens
Hereford Inlet Lighthouse Gardens (Cape May)	www.herefordlighthouse.org/gardens.htm
Herrontown Woods Arboretum (Mercer)	www.mercercounty.org/parks/parks.htm#HERRONTOWN%20WOODS%20ARBORETUM
Historic Cold Spring Village Gardens (Cape May)	www.hcsv.org/
Holmdel Arboretum (Monmouth)	http://www.monmouthcountyparks.com/parks/holmdel.asp
Howard Van Vleck House and Garden (Essex)	http://www.vanvleck.org/
Hunterdon County Arboretum (Hunterdon)	www.co.hunterdon.nj.us/depts/parks/facilitys/arboretm.htm
Isreal Crane House (Essex)	www.montclairhistorical.org/
James A. McFaul Environmental Center (Bergen)	www.fieldtrip.com/nj/18915571.htm
Kearny Cottage Garden	http://ifplantscouldtalk.rutgers.edu/njfgaa/
Kuser Farm Park Gardens	http://www.superpages.com/cities/mtg/40508/
Lambertus C. Bobbink Memorial Rose Garden (Monmouth)	http://www.ilovegardens.com/New%20Jersey%20Gardens.htm
Leaming's Run Gardens (Cape May)	http://www.leamingsrungardens.com/
Leonard J. Buck Garden (Somerset)	http://www.somersetcountyparks.org/
Lewis W. Barton Arboretum (Burlington)	http://www.mlra.org/arboretum.htm
Longstreet Farm (Monmouth)	http://www.monmouthcountyparks.com/parks/longstreet_revised.asp
Macculloch Hall Gardens (Morris)	www.maccullochhall.org/index.html
Marquand Park (Mercer)	www.princetontwp.org/marquand.html
Merril Creek Reservoir Butterfly and Hummingbird Garden (Warren)	www.merrillcreek.org/home.html
Morven Museum and Garden (Mercer)	http://www.historicmorven.org/
Native Plant Reserve – Highland Park Environmental Commission (Middlesex)	http://www.leoraw.com/hpenv/biod/npr.htm
New Jersey Botanical Garden at Skylands (Passaic)	http://www.njbg.org/
New Jersey State Capitol Complex Gardens (Mercer)	No direct website
Pequest Butterfly Garden (Warren)	www.state.nj.us/dep/fgw/pdf/peqbrochure.pdf
Phoenix House Garden (Morris)	www.mendhamnj.org/index.php
Prentice-Hall Japanese Garden	http://ifplantscouldtalk.rutgers.edu/njfgaa/
Presby Memorial Iris Garden (Essex)	www.state.nj.us/travel/virtual/gardens/presby.html
Prospect Gardens (Mercer)	http://facilities.princeton.edu/prospect/information.htm

Name	Web Contact Information
Quietude Garden Gallery	http://www.sculpture.org/documents/parksdir/p&g/quiet/quiet.shtml
Reeves-Reed Arboretum (Union)	http://www.reeves-reedarboretum.org/
Rockingham State Historic Site Gardens (Somerset)	www.rockingham.net/
Rudolf W. van der Goot Rose Garden at Colonial Park (Somerset)	http://www.somersetcountyparks.org/activities/gardens/RudolfW_vanderGoot.htm
Rutgers Display Gardens (Middlesex)	http://rutgersgardens.rutgers.edu/
Sambol-Ctta Arboretum - Ocean County College (Ocean)	http://ifplantscouldtalk.rutgers.edu/njfgaa/
Sayen Park Botanical Gardens	www.sayengardens.org/
Shakespeare Garden at the College of St. Elizabeth	http://www.stateuniversity.com/universities/NJ/College_of_St_Elizabeth.html
Sister Mary Grace Burns Arboretum - Georgian Court College (Ocean)	http://www.georgian.edu/arboretum/index.htm
Smithville Mansion Courtyard Gardens (Burlington)	http://www.burlco.lib.nj.us/county/culturalheritage/
Stony Brook Millstone Watershed Association Arboretum (Mercer)	www.thewatershed.org/reserve-BC.html
Union County College Arboretum (Union)	http://faculty.ucc.edu/biology-ombrello/
Veteran Park Gardens	http://ifplantscouldtalk.rutgers.edu/njfgaa/
Wagner Farm Arboretum (Somerset)	http://www.wfafnj.org/
Washington Spring Garden - Van Saun County Park (Bergen)	http://www.njwildlifetrails.org/BwtWeb/SiteDetails.aspx?si=101
Waterloo Village Gardens (Sussex)	http://ifplantscouldtalk.rutgers.edu/njfgaa/
Well-Sweep Herb Farm (Warren)	http://www.wellsweep.com/
Wetlands Institute Gardens (Cape May)	www.wetlandsinstitute.org/visit.html
Wheaton Village Garden	http://ifplantscouldtalk.rutgers.edu/njfgaa/
Wick House Kitchen Garden - Morristown National Historic Park (Morris)	http://www.cr.nps.gov/history/online_books/hh/7/hh7f1.htm
William Trent House Herb Garden (Mercer)	www.williamtrenthouse.org/index.html
Willowwood Arboretum (Morris)	http://www.morrisparks.net/aspparks/wwmain.asp
Garden Education and Training	
Master Gardener's of Mercer County	http://www.mgofmc.org/
Native Plant Society of New Jersey	http://www.npsnj.org/
RCRE – 'If Plants Could Talk'	http://ifplantscouldtalk.rutgers.edu/
Rutgers Cooperative Research and Extension	http://www.rce.rutgers.edu/
Rutgers Master Gardener Program	http://www.rce.rutgers.edu/mastergardeners/
Rutgers University – Landscape Architecture Program	http://landarch.rutgers.edu/
The James Rose Center for Landscape Architecture and Design (Bergen)	http://www.jamesrosecenter.org/
Professional Associations	
American Nursery and Landscape Association	www.anla.org/
American Society of Landscape Architects – New Jersey Chapter	http://www.njasla.org/
National Gardening Association	www.garden.org/
New Jersey Nursery and Landscape Association	www.gardennj.net
Perennial Plant Association	www.perennialplant.org/
Professional Landscape Alliance of New Jersey	www.planj.org
Tree Care Industry Association	www.natlarb.com

1,510 Certified Nurseries and Plant Dealers - see listing at **http://www.nj.gov/agriculture/divisions/pi/pdf/NJWEBDIR.pdf**
113 Registered Wholesale Seedsmen - see listing at **http://www.nj.gov/agriculture/divisions/pi/pdf/weblist.pdf**
263 Certified Tree Experts - see **http://www.state.nj.us/dep/parksandforests/forest/community/pdf_files/cte_2005directory.pdf**
330 Certified Arborists - see listing at **http://www.isa-arbor.com/findArborist/findarborist.aspx**
38 Land Trust Alliance members - see listing at **http://www.ltanet.org/findlandtrust/state.tcl?state_id=newjersey34**

Appendix 14
List of Web Sources for Invasive Species Outreach, Control, and Restoration
New Jersey Strategic Management Plan for Invasive Species

Name	Website/Contact	Notes
Technical and Educational Resources (see below for K-12 Educational Resources)		
National Invasive Species Information Center	**http://www.invasivespeciesinfo.gov/**	**Gateway to invasive species information; covering Federal, State, local, and international sources. This is a very comprehensive website and should be the first stop for looking for invasive species information on the web.**
USDA PLANTS	http://plants.usda.gov/index.html	The PLANTS Database provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories.
Biological Control of Invasive Plants in the Eastern United States	http://www.invasive.org/eastern/biocontrol/index.html	Review of status of biological control of selected invasive plants in the Eastern United States
Flora of North America	http://flora.huh.harvard.edu/FNA/	information on the names, taxonomic relationships, continent-wide distributions, and morphological characteristics of all plants native and naturalized found in North America north of Mexico.
Global Invasive Species Programme	http://www.gisp.org/	The GISP mission is to conserve biodiversity and sustain human livelihoods by minimizing the spread and impact of invasive alien species.
Invasive Plant Atlas of New England (IPANE)	http://nbii-nin.ciesin.columbia.edu/ipane/index.htm	The Invasive Plant Atlas of New England's (IPANE) mission is to create a comprehensive web-accessible database of invasive and potentially invasive plants in New England that will be continually updated by a network of professionals and trained volunteers.
Invasive.org	http://www.invasive.org/	provide an accessible and easily used archive of high quality images related to forest health and silviculture, with particular emphasis on educational applications.
NAS – Non-indigenous Aquatic Species	http://nas.er.usgs.gov/	established as a central repository for accurate and spatially referenced biogeographic accounts of nonindigenous aquatic species.
NEMESIS - Smithsonian Environmental Research Center	http://invasions.si.edu/	NEMESIS is a resource for information on non-native (or exotic) species that occur in coastal marine waters of the United States.
Ontario Federation of Anglers and Hunters – Invading Species Awareness Program	http://www.invadingspecies.com/indexen.cfm	Provides a well-designed program for early detection
Pest Tracker	http://www.ceris.purdue.edu/napis/	public access web site of the National Agricultural Pest Information System (NAPIS), the agricultural pest tracking database of the US Department of Agriculture Animal and Plant Health Inspection Service (APHIS) Plant Protection

		and Quarantine (PPQ) Cooperative Agricultural Pest Survey (CAPS).
Name	**Website/Contact**	**Notes**
Plant Invaders of the Eastern United States	http://www.invasive.org/eastern/index.html	identification characteristics, distribution, and control options for 97 tree, shrub, vine, grass, fern, forb, and aquatic plant species that are invading the eastern United States.
Plants for a Future	http://www.pfaf.org/	resource centre for rare and unusual plants, particularly those which have edible, medicinal or other uses.
The Nature Conservancy's Global Invasive Species Initiative	http://tncweeds.ucdavis.edu/	Contains fact sheets, control methods, alerts of new species, and much more
USDA National Invasive Species List	http://www.fs.fed.us/database/feis/plants/weed/index.html	Provides detailed fact sheets on invasive species
Weed Science Society of America	http://www.wssa.net/	Provides science-based information to the public and policy makers; Fosters awareness of weeds and their impacts on managed and natural ecosystems.
Weeds Gone Wild – Alien Plant Working Group of the Plant Conservation Alliance	http://www.nps.gov/plants/alien/index.htm	provides information for the general public, land managers, researchers, and others on the serious threat and impacts of invasive alien (exotic, non-native) plants to the native flora, fauna, and natural ecosystems of the United States.
Professional Societies and Regional Groups		
Center for Urban Restoration Ecology	http://www.i-cure.org/	The Center for Urban Restoration Ecology is the first scientific initiative in the U.S. established specifically to study and restore human-dominated lands.
Delaware River Invasive Plant Partnership	http://www.paflora.org/DRIPP.html	To advance regional cooperation and planning for invasive plant management in the Delaware River watershed
Mid-Atlantic Exotic Pest Plant Council	http://www.ma-eppc.org/	provides regional leadership to effectively address the threat of invasive plants to the native flora, fauna, and natural habitats of the Mid-Atlantic. Provides advice on control strategies and techniques.
National Biological Information Infrastructure	http://www.nbii.gov/portal/server.pt	The National Biological Information Infrastructure (NBII) is a broad, collaborative program to provide increased access to data and information on the nation's biological resources.
National Invasive Species Council	http://www.invasivespeciesinfo.gov/council/main.shtml	The National Invasive Species Council (Council) is an inter-Departmental council that helps to coordinate and ensure complementary, cost-efficient and effective Federal activities regarding invasive species.
NatureServe	http://www.natureserve.org/	NatureServe is a non-profit conservation organization that provides the scientific information and tools needed to help guide effective conservation action.
Society for Ecological Restoration International	http://www.ser.org/default.asp	to promote ecological restoration as a means of sustaining the diversity of life on Earth and reestablishing an ecologically healthy relationship between nature and culture.

Name	Website/Contact	Notes
Native Plant Sources and Information		
eNature.com – National Wildlife Federation	http://www.enature.com/native_invasive/	Native plant gardening and invasive plant guide
Flora of New Jersey Project	http://njflora.rutgers.edu/index.html	Volunteer effort to create an atlas, manual, and web-based information source for all plant species in New Jersey
iVillage Garden Web	http://forums.gardenweb.com/forums/exnative/	Native plant exchange forum
Native Plant Society of New Jersey	http://www.npsnj.org/	The Native Plant Society of NJ is a statewide non-profit organization founded for the appreciation, protection, and study of the native flora of New Jersey.
NJ Native Plant Sources	http://www.rce.rutgers.edu/njriparianforestbuffers/sources.htm	Sources of retail suppliers of native plants in New Jersey
North Creek Nurseries, Inc.	http://www.northcreeknurseries.com/	Retail supplier of native plants for gardening (Pennsylvania)
Pinelands Nursery	http://www.pinelandsnursery.com/	Wholesale supplier of native plants for restoration
Volunteer Recruitment		
Bowman's Hill Wildflower Preserve	http://www.bhwp.org/	Education programs and native plants; also provides seeds and plants of native species
Mid-Atlantic Exotic Pest Plant Council	http://ma-eppc.org/forum/	Allows advertising of volunteer opportunities
Morris Land Conservancy - Partners for Parks	http://www.morrislandconservancy.org/parks.html	Match individual volunteers and organizations with groups performing stewardship activities (including invasive species control)
NJDEP - Division of Watershed Management	http://www.state.nj.us/dep/watershedmgt/	See Text
RCRE Environmental Stewards Program	http://www.rcre.rutgers.edu/envirostewards/	See Text
Grant Programs		
Landowner Incentive Program	http://www.state.nj.us/dep/fgw/ensp/lip_prog.htm	Funding and expertise for conservation and restoration projects
National Foundation for Fish and Wildlife - Pulling Together Initiative	http://www.nfwf.org/programs/pti.cfm	Funding for invasive species control
New Jersey Natural Resource Conservation Service	http://www.nj.nrcs.usda.gov/	Funding and expertise for conservation and restoration projects
North Jersey Resource Conservation and Development Council	http://www.northjerseyrcd.org/	Funding of riparian restoration projects
North Jersey Resource Conservation and Development Council	http://www.northjerseyrcd.org/	Funding and expertise for riparian restoration projects
Plant Conservation Alliance – Grant Opportunity Links	http://www.nps.gov/plants/grantop.htm	
USDA Grants - 2007	http://www.invasivespeciesinfo.gov/docs/toolkit/usdagrants2007.pdf	Description of USDA grant programs. See specific contacts below.
USDA Grants	hdiazsoltero@fs.fed.us, 202-354-1880	USDA Senior Invasive Species Coordinator – Hilda Diaz-Soltero

Name	Website/Contact	Notes
USDA Grants	Bill.a.Dickerson@aphis.usda.gov, 919-855-7345	USDA-APHIS Invasive Species Coordinator – Bill Dickerson
USDA Grants	rnowierski@screes.usda.gov; 202-401-4900	USDA-CSREES Invasive Species Coordinator – Robert Nowierski
USDA Grants	vasavada@ers.usda.gov, 202-694-5540	USDA-ERS Invasive Species Coordinator - Utpal Vasavada
USDA Grants	mielmini@fs.fed.us, 202-205-1049	USDA-FS Forest System Invasive Species Coordinator – Mike Ielmini
USDA Grants	James_Michaels@wdc.usda.gov, 202-690-0794	USDA-FSA Invasive Species Coordinator – Jim Michaels
USDA Grants	Doug.holy@usda.gov, 202-720-9096	USDA-NRCS Invasive Species Coordinator – Doug Holy
USFWS - Partners for Fish and Wildlife Program	http://ecos.fws.gov/partners/viewContent.do?viewPage=home	Funding and expertise for conservation and restoration projects
USFWS - Private Stewardship Grants Program	http://www.fws.gov/endangered/grants/private_stewardship/index.html	Protection of federally listed species
Educational Resources (K-12)		
A kid's journey to understand weeds	http://www.weedcenter.org/education/kids_journey.htm	
Aliens in your neighborhood	http://www.nps.gov/invspcurr/alienhome.htm	
Center for Invasive Plant Management	http://www.weedcenter.org/education/edu_overview.html#k12	Links to various curricula and grant opportunities for environmental education
ESCAPE	http://www.unk.edu/acad/biology/hoback/escape/	
Invasive Species – A knowledge center	http://www2.nature.nps.gov/views/KCs/Invasives/Invasives_Index.htm#	Invasive species facts – National Park Service
Nab Aquatic Invaders	http://www.sgnis.org/kids/index.html	
Return of the Natives – Restoration Curriculum	http://watershed.csumb.edu/ron/roncor/cor/index.htm	
TEACH the Great Lakes	http://www.great-lakes.net/teach/	
The Natural Inquirer	http://www.naturalinquirer.usda.gov/	
What's wrong with this picture?	http://www.blm.gov/education/weed/weed.html	