

# VIII. Research and Education



Organizers, presenters, and attendees.



Buckeye (*Junonia coenia*) forage on white  
thoroughwort (*Eupatorium album* L.).

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<http://plants.usda.gov>





# VIII. Research and Education

Restoration of wetlands at the Marsh Resources Inc.'s (MRI) Meadowlands Mitigation Bank began in 1999. Like much of the Meadowlands, this site was covered with common reed. Restoration involved several steps: (1) treating existing stands of common reed with herbicide, (2) removing remaining wrack and other debris, (3) excavating, dredging, and regrading the site to improve tidal flow throughout creeks, low marsh, and high marsh networks, and (4) planting and seeding with smooth cordgrass, salt meadow hay, and spike grass. More than 200 acres at the MRI site have now been restored.

Some restored portions of the MRI site presently have atypical vegetative communities—wetlands dominated by native species such as salt marsh water hemp, marsh fleabane, dwarf spike rush, and uplands characterized by deer tongue grass, smartweeds, goldenrods, and late-flowering thoroughwort. Such unplanted “volunteer” species typically do not dominate tidal marshes in the region, yet the MRI site is used by diverse fish and wildlife species. Restoring the MRI site has raised many interesting questions regarding the volunteer species and their value to fish and wildlife populations. Understanding the factors that enabled these species to colonize this site may help us enhance and restore other sites.

Scientists are not alone in needing more information to understand the Meadowlands responsibly. Every one of the 20 million residents of the New York metropolitan area has the potential to effect change (both positive or negative) in the entire estuary. Thus, public education is absolutely crucial to restoration efforts. Area residents must be encouraged to take pride in the Meadowlands, appreciate its value, advocate restoration, and seek active participation in recovery efforts. Public action today will benefit future generations.



The Marsh Resources, Inc. Meadowlands Mitigation Bank (1999).

# VIII. RESEARCH AND EDUCATION

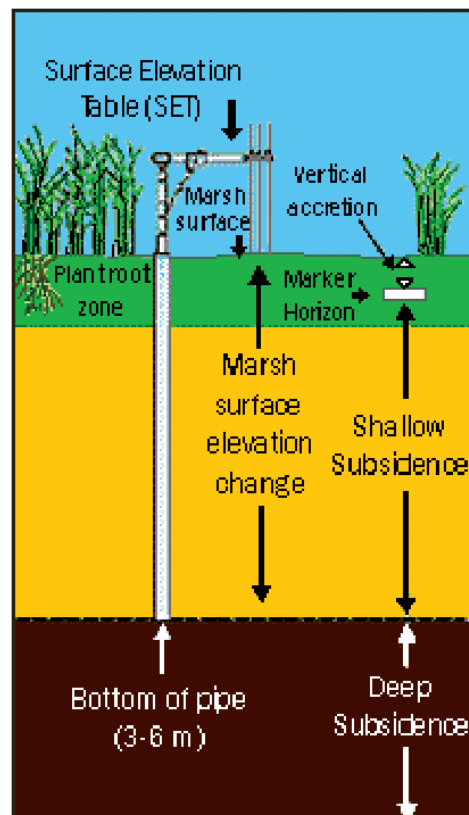
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## C. SUMMARY



Networks of surface elevation tables such as the one shown here can be used to monitor sea level rise on different restoration sites.

## **VIII. RESEARCH AND EDUCATION**

Research and education are vital to Service and other stakeholder efforts to restore the Meadowlands and protect its fish and wildlife. To date, however, research activities conducted in the Meadowlands have been largely associated with site-specific regulatory matters. Remediating, enhancing, and restoring the Meadowlands will require additional, comprehensive, long-term monitoring, assessment, and research programs. Comprehensive research programs will be needed in several different areas of concern, such as contaminants, invasive species, and landscape effects, to provide the technical information needed for successful remediation, enhancement, and restoration. Unfortunately, the Service, and to some extent, other stakeholders are currently limited in their capacity to generate and provide needed information to remediate, enhance, and restore the Meadowlands ecosystem and provide for the long-term protection of its fish and wildlife.

Research can address broad and specific concerns; however, varied and effective educational programs are also needed to foster public appreciation for the Meadowlands and an awareness of the numerous challenges to its remediation and restoration. Public concerns drive public policy; thus, an educated, informed, and involved public can be effective in holding regulatory agencies and officials accountable for making informed decisions, solving existing problems, and preventing future problems.

In many ways the Hackensack Meadowlands serves as the harbinger of the Nation's environmental challenges. Research and education developed to address the environmental challenges of remediating, enhancing, and restoring the Meadowlands may help prevent or solve similar environmental problems elsewhere.

### **A. PRIORITY RESEARCH OBJECTIVES**

#### **1. Expanded Capability, Collaboration, Access, and Communication**

The Meadowlands is located in one of the busiest commercial port complexes in North America, in what has long been considered one of the most contaminated waterways in the United States (National Oceanic and Atmospheric Administration, 1991a). As a result, fish and wildlife resources in the Meadowlands will continue to face a wide array of chemical and biological challenges (*e.g.*, chemical spills, invasive species). Thus, scientific research in many disciplines will be critical to guiding remediation, enhancement, and restoration in the Meadowlands.

The Service acknowledges the contributions of the Meadowlands Environmental Research Institute (MERI) to improving our understanding of the Meadowlands environment. Since its inception in 1998, MERI has initiated research projects to address the HMD's environmental problems (*e.g.*, Kearny Marsh), collaborated with scientists at academic institutions in the region, developed support facilities (*e.g.*, the GIS Laboratory, MERI Library), and raised the profile of research in the Meadowlands through outreach and other professional activities (*e.g.*, co-sponsoring *The Meadowlands Symposium*).

Nonetheless, substantial additional monitoring, assessment, and other research efforts are needed to guide remediation, enhancement, and restoration. The necessary efforts exceed the capabilities, areas of expertise, and other resources presently available within *any* single stakeholder agency or organization. Such efforts also include certain legislative responsibilities (*e.g.*, water quality assessment, restoration monitoring) of different agencies as designated by federal or State law. Thus, monitoring, assessment, and research capacities of all stakeholder agencies (including the Service), educational institutions, and NGOs must be expanded to provide scientific, technological, and other information essential to the remediation, enhancement, and restoration of the Meadowlands. Addressing these research and information needs will likely require: (1) expanding formal and informal partnerships among federal and State agencies currently working in the Meadowlands and the NY-NJ Harbor (*e.g.*, Service, EPA, NMFS, NJMC, and NJDFW), and (2) involving additional federal and State entities (*e.g.*, USGS, NMFS Sandy Hook Laboratory, the Rutgers University Institute for Marine and Coastal Science, New Jersey Marine Science Consortium) and private organizations (*e.g.*, American Museum of Natural History Center for Biodiversity and Conservation) that can provide critical areas of expertise.

These expanded research activities must focus especially on three major environmental concerns: (1) environmental contaminants, water quality, and hydrology, (2) urban land use and ecology, and (3) invasive and exotic species. In support of these research objectives, it will also be necessary to increase our overall understanding of the biodiversity and ecology of the Meadowlands, expand and enhance routine monitoring and assessment of water quality and contaminants, and continually explore and expand use of innovative technologies.

The research (and educational) objectives discussed here cannot be achieved without access to sites throughout the HMD and the HRW. While existing waterways provide access to the interior of the Meadowlands, public docks and facilities for recreational access (discussed in detail in Section IX) can also provide access for research and educational purposes. Thus, improving public access to the Meadowlands, including its waterways, must be a high priority in regional planning.

Finally, results from these research activities must also be effectively communicated to Meadowlands stakeholders and the public. Regular communication among research collaborators and the principals' group (discussed in Section I.C) is essential for sound decision-making regarding the remediation, enhancement, and restoration of the Meadowlands ecosystem and for science-based management of its fish and wildlife resources. As public demand for all coastal resources continues to increase, restoration and long-term management of coastal ecosystems will increasingly rely on effectively communicating and integrating information across disciplines and institutions (*e.g.*, Crooks and Turner, 1999).

## **2. Environmental Contaminants, Water Quality, and Hydrology**

Water is the key to nearly all biological processes and the biodiversity of estuaries; thus, water-related issues, including contaminants, will increasingly affect decision-making regarding the remediation, enhancement, restoration, and long-term protection of ecosystems such as the

Meadowlands in the northeastern United States (Pringle, 2000). One of the major obstacles to advancing the remediation and restoration of the Meadowlands is the lack of a comprehensive research program to address contaminant distributions and fates (including bioaccumulation) and the effects of contaminants and water quality on fish, wildlife, and indirectly, human health.

Contaminant and related studies conducted to date in the Meadowlands, including those directed through other regional contaminant centers (*e.g.*, the EPA Center for Hazardous Substances in Urban Environments, NOAA Center for Coastal Monitoring and Assessment), do not provide sufficient information on a site- or species-specific basis to guide decision-making for remediation, enhancement, and restoration. Therefore, environmental contaminants, water quality, and hydrology must comprise a major research emphasis to move restoration forward. Research activities of the contaminants and water quality program should address: (1) contaminant distributions, sources, availability, bioaccumulation, effects, and risk assessments; (2) nutrients, eutrophication, hypoxia, and sewage treatment; and (3) other hydrologic issues such as river flow, flooding, ground water, and SLR. These activities should be coordinated with contaminant programs throughout the entire HRE and New York Bight (*e.g.*, the New York Academy of Science Harbor Consortium, the EPA Harbor Estuary Program's Contaminant Assessment and Reduction Program [CARP]).

The Service and other stakeholders should expand collaborative research and monitoring activities to better understand the Meadowlands ecosystem and its watershed. In particular, increasing efforts to monitor and assess ground- and surface- (including reservoir) water quality, including contaminants and nutrients, and the bioaccumulation of contaminants in the flora and fauna of the Meadowlands and surrounding region are essential. These data should be integrated into and synthesized with other information being collected throughout the NY-NJ Harbor estuary. Moreover, water, sediment, and biotic information in the Meadowlands (*e.g.*, continuous and seasonal water quality information) does not appear thoroughly integrated into data sets (*e.g.*, Regional Data Depot; Harbor Estuary Program, 2005b) used in NY-NJ Harbor-wide evaluations and models of contamination and water quality. Additional collaboration among stakeholders regarding water quality and contaminant issues in the Meadowlands is also needed. For example, considerable progress has been made on understanding nutrient cycling processes in individual estuaries; however, generalizing those results, especially to systems as heavily contaminated and unstudied as those in the Meadowlands, is not yet possible (Nedwell *et al.*, 1999; Sobczak *et al.*, 2002). Over time, establishment of a comprehensive and coordinated research program of water quality, contaminants, and biogeochemical cycling would: (1) improve our understanding of the Meadowlands ecosystem and watershed, (2) help guide and evaluate remediation and restoration activities, (3) prevent future degradation of the Meadowlands, and (4) facilitate development and application of new technologies (*e.g.*, ground penetrating radars, high-frequency electromagnetic sounding, radar tomography; Lane, 2003).

Since the 1980s, considerable funding has been expended to improve the delivery of drinking water to urban areas, including suburban/urban counties within the Hackensack and Passaic River watersheds. Substantial commitments also must be made by all levels of government to address additional hydrologic issues, including water flow, water conservation and reuse, and wastewater treatment.



### 3. Urban Land Use and Ecology

Land use is the principal anthropogenic factor of ecosystem alteration. Sometime this decade, more people will be living in urban areas than in rural areas worldwide (Global Rural Urban Mapping Project, 2005). The suburban/urban landscape has become the most common landscape in coastal areas of the northeastern and middle Atlantic states. Nationwide, 70 million acres of forested and agricultural lands are projected to be converted into urban and other developed landscapes in the next 25 years (U.S. Global Change Research Program, 2003). At current rates of landscape change, New Jersey is projected to be “built-out” around 2040 (Hasse and Lathrop, 2001). The suburban/urban landscape is becoming more common, but many complex effects of this landscape on the earth’s ecosystems and biodiversity (*e.g.*, hydrologic cycle, carbon sequestration) are just beginning to be recognized (Pickett *et al.*, 1997; Collins *et al.*, 2000; Luck *et al.*, 2001). In addition to a focus on water and contaminant issues, the Service recommends an expanded research effort on suburban/urban ecology, including ecosystem, landscape, and other issues (*e.g.*, transportation) that affect the long-term protection of fish and wildlife resources.

For example, habitat connectivity has been an objective in the restoration of natural areas, but its effectiveness in supporting wildlife, especially in suburban and urban areas, and in promoting other biological processes (*e.g.*, seed dispersal, succession, disease transmission, invasive species pathways) is not well understood (*e.g.*, Beier and Noss, 1998; Levey *et al.*, 2005). Certain corridor networks may be more effective than others in connecting habitats and supporting wildlife, especially migratory species (*e.g.*, Rudd *et al.*, 2002). Connectivity among urban landscapes may also be disrupted by buildings and landscaping with exotic species that create zones of high mortality for adult and immature birds (Klem, 1990; Meffe and Carroll, 1997; Borgmann and Rodewald, 2004). These and similar studies may have important implications for the restoration and protection of certain wetlands and natural areas in the HMD. For example, Berry’s Creek marshes are situated directly between the two Hackensack sub-basins with the greatest acreage of emergent wetlands (see Section V); thus, remediating and restoring the Berry’s Creek marshes would provide a large contiguous area of high-quality habitat, widely recognized as important for certain fish and wildlife populations (*e.g.*, tidal marsh birds; Benoit and Askins, 2002). Providing corridors and other connections (*e.g.*, habitat patches) may also be critical for species inhabiting isolated marshes along Penhorn Creek and other wetlands east of the Hackensack River. Research is therefore needed to identify features of effective corridors and improve connections among those wetlands.

The importance of and need for ecological research programs that address urbanization is increasingly recognized: urban ecology centers have been established on the West Coast (*e.g.*, San Francisco Bay, Seattle), the Midwest (Detroit, St. Paul-Minneapolis), and elsewhere. For example, the National Park Service established a Center for Urban Ecology to provide “science, service, and partnerships” to understand, protect, and restore natural resources in the Washington, D.C. metropolitan area. Several institutions in the NY-NJ metropolitan region, such as Rutgers University’s Center for Urban Restoration Ecology, Columbia University’s Center for Sustainable Urban Development, and New Jersey Institute of Technology’s Center for Hazardous Substances in Urban Environments, also have developed programs focusing on urban environmental issues (*e.g.*, landfills, land use planning, hazardous waste remediation). The GIS



Laboratory of NJMC's MERI and The Institute for Meadowlands Studies (jointly established with Rutgers University's Center for Urban Policy Research in 2005) may also provide focal opportunities to develop collaborative research activities. Collaboration of Meadowlands stakeholders and USGS researchers familiar with diverse USGS data resources and cutting-edge technologies would also prove useful (*e.g.*, assessing alternative energy technologies [Aerotecture, Ltd. (2005) and McKenzie Bay, Ltd. (2005) turbines]).

#### **4. Invasive and Exotic Species**

Most wetlands in the Meadowlands are dominated by a single invasive species, common reed; many other exotic and invasive species occur in aquatic and terrestrial communities in the HRW. The Service recommends developing a harbor-wide program on exotic and invasive species as a third research focus. The role of this program would be to: (1) assess exotic and invasive species throughout the HMD, (2) address invasive species issues relating to restoration (*e.g.*, contaminant criteria for removing common reed, re-invasion of restoration sites), and (3) facilitate collaboration with other stakeholders in the urban area to manage, control, eradicate, and prevent invasions by exotic species.

Impacts from invasive species are increasingly recognized as globally important (Lowe *et al.*, 2000). Comprehensive long-term research programs have been established in other estuaries, including the Chesapeake Bay (Smithsonian Environmental Research Center) and San Francisco Bay (San Francisco Estuary Institute). In the Meadowlands, research, control, management and other activities should be coordinated with the federal interagency Invasive Species Council and the Department of Interior's related Advisory Committee, pursuant to Executive Order 13112 of February 3, 1999 on Invasive Species and other pertinent authorities (*e.g.*, NEPA, Lacey Act).

### **B. PRIORITY PUBLIC EDUCATIONAL OBJECTIVES**

#### **1. Outreach Program**

As noted throughout this report, in recent years a diverse group of stakeholders comprised of federal and State agencies and NGOs has raised awareness of the need to restore and protect the Meadowlands ecosystem and its fish and wildlife resources. Other stakeholders, notably the NJMC and the Hackensack Riverkeeper, are currently engaged in a variety of public outreach efforts. An even greater commitment by stakeholders with additional public support will be needed to remediate, enhance, restore, and protect the entire Meadowlands ecosystem and its resources. Stakeholders have disparate interests, different responsibilities, and sometimes conflicting goals; nonetheless, the Service recommends that stakeholders collaborate to develop a unified outreach program to generate and maintain public support for the remediation and restoration of the Meadowlands. A unified outreach program will send a clear and consistent message to the public and elected officials and is more likely to gain support.

The unified outreach program should inform the public about the Meadowlands and needed or ongoing restoration efforts. In doing so, stakeholders will gain *broad* public support for restoration and long-term protection of the Meadowlands. Components of the outreach program

must share a common focus, but the outreach program should be evaluated periodically and modified as restoration proceeds. The outreach program must address high-profile issues effectively. For example, outreach must use different media (*e.g.*, television, radio, web, print), government agencies, educational institutions, and NGOs to inform the ethnically diverse people in the urban area. Meadowlands stakeholders should consider establishing a restoration web site to which key stakeholders are connected and may contribute. The Service and other stakeholders interested in developing the unified outreach program should consider evaluating and building upon previous outreach efforts by the Service (*e.g.*, Hackensack Meadowlands Issue of *Field Notes*) and other stakeholders (*e.g.*, the NJMC informal education programs such as “Wonderful Weeds,” the Corps’ HMER Fact Sheets, the Hackensack Riverkeeper’s Meadowlands video). The Service also recommends exploring and developing new outreach efforts, such as public television and radio programming, a “coffee-table” book of the Meadowlands, and presentations to local civic and other groups.

Meadowlands stakeholders must also work together to overcome language barriers in the area. To maximize the effectiveness of public education, the Service and its partners need to communicate key messages in Spanish, Portuguese, Chinese, and Russian, all of which are primary languages for sizable minority populations in the Meadowlands area and used by providers of local government services. Despite warnings, consumption of contaminated fishes and shellfishes from the Hackensack River and the surrounding area remains substantial; thus, advisories and other outreach efforts in the languages noted above would be beneficial to protecting public health (Burger *et al.*, 1999; Chess *et al.*, 2005).

Slogans used in various outreach efforts (*e.g.*, the Hackensack Riverkeeper’s “Work to Save the Meadowlands, Not Pave the Meadowlands”) and the New Jersey motor vehicle license plate “The Meadowlands” have successfully focused the public’s attention on protective efforts in the Meadowlands. Other slogans could be developed to unify public support for the present challenge of remediating and restoring the Meadowlands. Such slogans could be used on bumper-stickers, t-shirts, and other materials to gather public support.

## **2. Formal and Informal Educational Programs**

It would appear necessary if not vital to expand educational programs, resources, and facilities not only within the Meadowland but throughout the watershed in order to protect the region’s fish and wildlife resources. The Service acknowledges the NJMC’s past commitment to education through its support of programs and activities of the Meadowlands Environment Center; moreover, the Service supports the NJMC’s efforts to expand its current facilities and develop more educational programs, some in collaboration with other educational institutions (*e.g.*, Ramapo College) to familiarize the public with the Meadowlands, including its resources, problems, and restoration. The Service recommends that the NJMC collaborate with other resource agencies (including the Service) and the State to develop new programs to increase public awareness of the Meadowlands ecosystem and its fish and wildlife resources.

Educational programs should be developed for children and adults, as well as for communities, and include: (1) formal activities in schools and other settings, and (2) informal programs and other components (*e.g.*, additional web-based and take-home materials). Formal classroom

programs with lessons and activities designed for different age groups have been used successfully by the Service (*e.g.*, the NFWF, the NJFO's collaborative *The Nature of Learning* program) and other federally and State-supported comprehensive restoration programs (*e.g.*, San Francisco Bay Estuary Restoration, Gulf of Mexico Restoration Programs).

While there are any number of existing or potential environmental education programs that could be used or developed for the Meadowlands, two complementary programs for environmental education, the Department of the Interior's *Hands on the Land*, and the NFWF/Service's *The Nature of Learning*, are examples of programs that could serve public schools within the HMD and the HRW. Providing a national network of "field classrooms" on public lands to enhance student learning from kindergarten through high school, *Hands on the Land* also sponsors annual workshops for educators, supplies a range of lesson plans and educational programs, and offers ideas for class projects. *The Nature of Learning* is a 3-year program that partners a Service field station with a school to integrate environmental education into the total curriculum with the intent that the school will be able to retain the environmental component in its curriculum when the program is completed. Over the past decade, the NJFO has maintained this program at four schools in New Jersey. Both *The Nature of Learning* and *Hands on the Land* would encourage local schools to use the Meadowlands and the HRW as a learning environment.

### **3. Demonstration Projects and Exhibits**

As a visually stimulating means of increasing public interest in the Meadowlands, demonstration projects and exhibits could be developed through partnerships with current stakeholders and other organizations to inform the public about the natural history and importance of the Meadowlands, its fish and wildlife resources, remediation, and restoration. The purpose of these projects and exhibits should be to stimulate public interest, encourage community, and inspire involvement in land-use planning at the municipal and county levels. Such demonstration projects and exhibits could focus on diverse topics but emphasize common themes such as the value of conserving and restoring biodiversity in the Meadowlands. Each exhibit would serve as a portal to obtain additional information about the Meadowlands restoration initiative. The demonstration projects would also serve to develop a public appreciation for the uniqueness of the Meadowlands ecosystem and its importance in supporting fish and wildlife at local, regional, national, and international levels. Demonstration projects could be located in support of existing educational programs (*e.g.*, the NJMC's MEC/MERI facility) and exhibits (*e.g.*, Bergen Museum of Science and Art's Hackensack Mastodon exhibit), developed in conjunction with access and facilities that support recreational objectives, and placed in novel venues that attract large segments of the public (*e.g.*, the Xanadu complex, Meadowlands Stadium, Newark Airport, American Museum of Natural History). Examples of potential demonstration projects and exhibits are presented below.

#### **a. Atlantic White-Cedar**

Atlantic white-cedar once formed the dominant vegetative cover in the Meadowlands and other parts of New Jersey. Although eradicated from the Meadowlands due to exploitation and to hydrologic and other changes, Atlantic white-cedar was still present in the Meadowlands in the 1940s. The feasibility of establishing one or more stands of Atlantic white-cedar (5-10 acres)



should be investigated at certain locales (*e.g.*, Teterboro Woods and Kearny Freshwater Marsh, once restored). Establishing a few stands would underscore the importance of water resources to biodiversity and serve as a living visual symbol of the commitment of stakeholders to Meadowlands restoration.

b. Mastodon

The natural history of the Meadowlands has continually changed throughout geological and human history. Mastodon roamed the Meadowlands at the retreat of the last great Ice Age, 10,000 or so years ago. A specimen excavated from the upper Berry's Creek drainage is being prepared for display at the Bergen Museum of Science and Art. Museum personnel have expressed interest in partnering with other stakeholders to develop the exhibit (J. Waldron, pers. comm., 2005).

c. Bioremediation

Bioremediation, the use of biological organisms such as plants or microbes to aid in removing or altering hazardous substances, has been explored at several sites in New Jersey (*e.g.*, Launen *et al.*, 2002) and has potential application at sites contaminated by certain hydrocarbons (*e.g.*, PAHs) in the Meadowlands. Small demonstration projects could be set up near the NJMC facilities and at other sites as feasibility studies and to provide relevant examples of the value of biodiversity (*e.g.*, direct-use values such as harvest, indirect-use values such as ecotourism, and option values such as undiscovered medicinal drugs in plants and fungi).

d. The Old Landfill Legacy: Leachates and Methane Gas

Potential demonstration projects could identify specific problems associated with waste streams and how to reduce these problems. For example, two problems of landfill wastes are methane gas and leachates. Two potential sites for demonstration projects are the Meadowlands Stadium, location of one of the Meadowlands' worst landfill fires, and the NJMC facilities, where efforts are being made to collect methane. Such demonstration projects could stress the importance of reducing waste streams, their impacts, and their real (and often hidden) costs.

e. The New Landfill Legacy: Golf Courses and Resident Canada Geese

Remediation and redevelopment of landfills into golf courses generally provide little habitat for fish and wildlife. Golf courses impact water quality in the Meadowlands: they use large volumes of water and receive considerable amounts of nutrients, herbicides, and pesticides that contribute to further water quality impairments in the HRW. In addition, golf courses often provide nesting and foraging habitat for resident Canada geese, which forage extensively on newly established vegetation at restoration sites (K. Spendiff, pers. comm., 2004) and make revegetation very difficult. Although the Service generally encourages most actions that are supportive of waterfowl, populations of resident Canada geese have increased throughout much of the Northeast, where they have become a nuisance species and adversely affect migratory populations of waterfowl in the Meadowlands and elsewhere. Venues for this exhibit might

include public areas where resident Canada geese might occur; such exhibits would remind the public that wildlife species are not domesticated and should not be fed.

f. Prevention and Biological Control of Invasive Species

Demonstration projects could feature exotic species that have invaded locally, the problems associated with them, and biological control efforts. For example, biological control of purple loosestrife at Harrier Meadows in the HMD is being accomplished by NJDEP through propagation and release of several exotic, leaf-eating beetle species. One demonstration might focus on ongoing studies (supported by the Service and other federal agencies) to evaluate the potential of native and exotic species as control agents of common reed.

g. Sea Level Rise and Global Change

Sea level rise is a complex and controversial subject, which is made even more difficult in urban areas owing to more limited options (*e.g.*, insufficient area for rolling easements, reliance on seawalls and bulkheads to protect property) and the high costs of real estate (Titus *et al.*, 1991). Using three-dimensional displays and hands-on models, such a project could clearly show possible consequences of minimal, moderate, and maximum rates of SLR in the Meadowlands and the surrounding urban area.

h. Native Peoples: Subsistence on Fish and Wildlife Resources

The indigenous peoples that lived in the HRW subsisted on fish and wildlife resources for thousands of years. Their cultures coexisted and depended upon a relatively unspoiled environment. The fish and wildlife resources existing in the Meadowlands during this time included large predators, such as grey wolf and eastern cougar, and large populations of shellfishes, fishes, waterfowl, raptors, and other migratory birds. Potential exhibits located at several venues could focus on (1) present-day archeological efforts, (2) accurate depictions of native cultures, and (3) resources used by native cultures.

i. The Watershed: Connecting the Landscape and the Hackensack River

Diverse exhibits and outreach focusing on the entire watershed, such as efforts undertaken by the Chesapeake Bay Program (*e.g.*, signage stenciled onto sewage grates and gutters “This flows into the Meadowlands,” commercial radio and television announcements), can be effective tools in addressing point and non-point sources of pollution and protecting potable water supplies and sensitive areas such as wetlands and headwaters. A watershed approach should also emphasize landscape and watershed priorities and pollution prevention strategies to improve water quality for fish, wildlife, and people. Improved watershed management is vital to the future of the Meadowlands.

## C. SUMMARY

*Research and public education are vital to restoring the Meadowlands and protecting its fish and wildlife resources.* Developing additional monitoring, assessment, and research capabilities among federal and State agencies and other stakeholders is essential to move restoration forward. Additional research programs should especially focus on: (1) environmental contaminants, water quality, and hydrology, (2) suburban/urban ecosystems, landscapes, and habitats, and (3) invasive and exotic species. Outreach and education are also critical for sustaining the public's commitment to remediate and restore the Meadowlands. Development of a unified outreach program should build on previous successes of all partners; incorporate various media, including television; communicate key messages in several languages; and utilize access and facilities developed for recreational objectives. Formal and informal educational programs should be developed for adults and children and innovative use made of demonstration projects and exhibits to stimulate public interest and inspire involvement in Meadowlands issues. Continued public support for research and education is vital to future efforts to remediate and restore the Meadowlands and to ensure responsible land use and management of the HRW.