Chapter 3

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Alternatives Considered, Including the Service-Preferred Alternative

- Introduction
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- Refuge Management Alternatives: Goals, Objectives, and Strategies

3.0 Introduction

Each of the four management alternatives identified below are defined by refuge goals and objectives. As we described in chapter 1, developing refuge goals was one of the first steps in our planning process. We have developed goals that are broad, descriptive statements of our desired future condition for refuge resources. By design, the goals are less quantitative, and more prescriptive, in defining management targets. Goals also articulate the principal elements of refuge's purposes, vision statement, and provide a foundation for developing specific management objectives and strategies. Our goals are common to all four alternatives.

In developing this CCP, we considered a range of possible management objectives that would help us meet the above referenced goals. Objectives are incremental steps toward achieving the relevant goal. Objectives vary among the alternatives and form the basis for strategies, monitoring refuge accomplishments, and evaluating the success in meeting our goals. The FWS guidance in "Writing Refuge Management Goals and Objectives: A Handbook" (USFWS 2004b) recommends that objectives be "SMART" by possessing five key properties: (1) Specific; (2) Measurable; (3) Achievable; (4) Results-oriented; and (5) Time-fixed. A rationale accompanies each objective to explain its context and importance.

The next step in developing a CCP/EA for Great Swamp NWR involved identifying strategies to support each objective. These strategies are specific actions, tools, techniques, or a combination thereof that we may use to achieve a specific objective. The list of strategies supporting each objective is the series of actions to be implemented and evaluated.

We grouped objectives into "alternative themes." For example, we considered themes such as "current management" (e.g. the "no action alternative," "enhance biological diversity and public use opportunities," "maximize forest habitats," and "maximize priority public uses"). We then developed four alternatives after evaluating how each respective objective complements the other objectives. We also evaluated the alternatives for their compatibility with refuge purposes, and the feasibility of accomplishing the objectives in a reasonable time frame and budget. The four alternatives were scrutinized for their feasibility in managing the refuge for a 15-year period. The selected alternatives represent a reasonable range of proposals for achieving the refuge purpose, vision and goals, and addressing the issues described in chapter 1. Unless otherwise noted, all actions will be implemented by refuge staff with the assistance of partners and volunteers.

Alternative A is the "no action" alternative, which is defined as "continuing current management." This alternative describes the FWS current management priorities and activities, and serves as a baseline for comparing and contrasting alternatives B, C, and D.

Alternative B is the FWS preferred alternative because it combines the actions that most closely achieve Great Swamp NWR purposes, vision, and goals, the mission of the Refuge System, and responds to public issues. This alternative emphasizes management of specific refuge habitats to support viable populations of focal species whose habitat needs benefit other species, especially those of conservation concern, while maintaining some early successional habitats that provide popular and high quality wildlife viewing opportunities. Habitats will be reconfigured and maintained to create large (greater than 50 acres), contiguous patches to promote wildlife use, increase connectivity, decrease fragmentation, increase maintenance efficiency and reduce equipment, maintenance and fuel costs. The total number of acres of

refuge land that would undergo intensive management would decrease. Within 5 years, open water habitat will be evaluated to determine the ecological costs and benefits of maintaining, enhancing, or allowing succession in each of the impoundments. Alternative B emphasizes habitat for priority bird species identified for BCR 28 and BCR 29, as well as for PIF Physiographic Areas 9 and 10. Habitat for federally listed species, including the bog turtle and Indiana bat, is also prioritized in the preferred alternative. In developing Alternative B, we consulted with the NHP and NJWAP to identify State and regional species and vegetation communities of conservation concern. Alternative B also addresses the Refuge System's mandate to manage habitat in accordance with the BIDEH policy (601 FW 3). This alternative proposes to improve wildlife viewing and photography opportunities in a variety of habitats, as well as expand partnerships and increase public outreach. We would increase outreach to urban populations in the vicinity of the refuge including Newark and New York City and encourage new visitation from urban population centers. We are also proposing additional hunting opportunities at the refuge, including an archery deer hunt and spring turkey hunting. We are proposing these additional hunting opportunities to comply with our mandate to provide additional opportunities for wildlife-dependent recreation when they are found to be compatible. The turkey population in the vicinity of the refuge has increased since turkeys were reintroduced to the area in the 1980s and the population can support a spring hunting season. We would increase the number of environmental education programs and efforts to draw urban populations to the refuge. Alternative B attempts to balance public use with resource protection.

Alternative C emphasizes management to maximize core forest habitats, while maintaining large (greater than 50 acres) contiguous patches of actively managed grasslands and scrub-shrub habitats. Compared to alternatives A and B, this alternative would more strictly follow the BIDEH policy to guide management to restore, where practical, the distribution of natural communities of the Great Swamp that would have resulted from natural processes without the influence of human settlement or management intervention. This alternative recognizes that refuge habitats and wildlife populations are not ecologically independent from the surrounding landscape and, that by taking a long-term regional perspective, the refuge can best contribute to higher conservation priorities at greater scales. Management direction is primarily derived from regional plans and directives, including relevant BCR and PIF plans and the NJWAP, which prioritizes forest and successional shrub habitats in the Northern Piedmont Plains region of the State. Alternative C would continue to provide actively managed habitats in select areas to maintain wildlife viewing and photography opportunities for refuge visitors, as well as vital habitat for the refuge's species of conservation concern. These areas would also be more accessible to refuge staff for performing management activities, such as mowing, since a majority of these areas would be located adjacent to roadways and small isolated tracts would be allowed to succeed. Although some open water habitat would be eliminated (i.e., Pools 3A and 3B), the refuge would continue to maintain open water habitat for waterfowl use. Similar to alternative B, this alternative also proposes to improve public use opportunities, as well as expand partnerships and increase public outreach.

Alternative D emphasizes expanding wildlife-dependent priority public uses on the refuge. Public use and access would be maximized to the greatest extent practical, while minimizing impacts to wildlife, through the creation of new trails, observation towers, and parking lots. In addition, fishing opportunities would be provided in select areas of the refuge. This alternative would maximize public outreach, enhance and develop new environmental interpretation and education programs, aggressively expand partnerships, and increase staff presence at programs and events. In general, refuge habitats would be managed similarly to alternative B; however, this alternative would increase open water habitat to improve public viewing opportunities.

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We developed a habitat management map and a public use map for alternative B; a habitat management map for alternative C; and a public use map for alternative D. Using Geographic Information Systems (GIS) mapping tools and data sets, the habitat maps are intended to help readers visualize where the refuge would likely conduct habitat management strategies on the ground in each alternative. The habitat management maps are not meant to identify exact locations for implementing a particular strategy on the ground. Explanation of habitat management strategies are detailed further in the objectives section of each alternative. During the implantation phase, the refuge staff will have the management discretion to determine the specific strategies to apply to particular sites, as well as, the level, and timing of these applications. These details will be developed in the Habitat Management Plan and annual habitat management work plans (see "Refuge Step-Down Plans" below).

The public use maps are intended to show where the refuge would add new infrastructure for visitors, such as new trails, parking lots and pull-offs, and new observation platforms. The exact location of the new trails and other infrastructure to be built will also be decided during the implementation stage or during development of a VSP (see "Refuge Step-Down Plans" below) with the help of engineers and other professionals.

3.1 Actions Considered, but not Included in Alternatives

Elimination of hunting programs

The planning team reviewed the hunting program on the refuge and determined that the existing hunting program is effective in maintaining a healthy deer population, healthy forest ecosystems, and providing a quality public hunting opportunity. We determined that because hunting opportunities in the area are limited, that eliminating all hunting opportunities on the refuge would have a detrimental impact on the health of the deer population in the area, habitats, and the public that participates in hunting. We have included minor changes to the hunting programs in each of the alternatives.

Non-motorized Boating Access to the Passaic River and Great Brook

Currently, we do not provide access across refuge lands to the Passaic River or Great Brook. A number of individuals requested canoe/kayak access to these rivers across refuge lands. There are existing access points off refuge from which boaters can paddle upstream along the Passaic River along the western boundary of the refuge. We have determined that while portions of the Passaic River may be considered navigable; we are concerned about the potential for impacts to species and habitats, including endangered species adjacent to these streams if we provided access to the Passaic River or Great Brook. The area that would be impacted by creating access points is adjacent to sensitive waterfowl nesting areas and would cross potential bog turtle habitat. Therefore, we have not included river access in any of the alternatives.

3.2 Actions Common to All of the Alternatives

All of the alternatives share certain actions that are required by law or policy, or; they may be administrative actions that do not necessarily require public review, but we want to highlight them in this public document. They may also be actions that we believe are critical to achieving the refuge's purpose, vision, and goals. The following actions are common to all alternatives:

- use an adaptive management approach, including strategic habitat conservation, where appropriate
- construct additional facilities to improve administrative infrastructure
- control pest plants and animals
- monitor and abate diseases affecting wildlife health
- facilitate or conduct biological research and investigations
- address climate change
- issue special use permits
- protect cultural resources
- develop an off-site interpretation program
- complete findings of appropriate use and compatibility determinations
- provide refuge staffing and administration
- complete refuge step-down plans
- improve inventory and monitoring programs by maintaining an organized data management system

3.2.1 Developing Refuge Step-Down Plans

The FWS planning policy identifies 25 step-down plans that may be applicable on any given refuge. We have identified and prioritized the plans below as the most relevant to this planning process. These plans will be modified and updated as new information becomes available. Completion of these plans supports all five refuge goals.

All of the alternatives require the completion of these step-down management plans, as described below:

- an HMP, immediately following CCP approval
- a Wilderness Stewardship Plan, within 2 years of CCP approval

- a VSP, within 2 years of CCP approval
- an FMP, within 5 years of CCP approval
- Hazardous Waste Site Operation and Maintenance Plan, within 5 years of CCP approval
- Hunting Plan, within 1 year of CCP approval
- Population Management Plan, within 10 years of CCP approval
- Law Enforcement Plan, within 5 years of CCP approval (see discussion below)

We will use the objectives in the alternative selected for the final CCP to write refuge step-down plans. Each of the step-down plans will contain specific strategies and implementation schedules for achieving refuge goals and objectives identified in the CCP. Some plans require annual revisions, while others require revision every 5 to 10 years. In addition, some plans may require additional NEPA analysis, public involvement, and compatibility determinations before they can be implemented.

Habitat Management Plan

An HMP will define management areas, treatment units, treatment types or methods, management actions, and success measurement over the next 15 years. An HMP is the first step in achieving the objectives of goals 1, 2, and 3, regardless of the alternative selected for implementation. For example, the HMP will incorporate the selected alternative's habitat objectives developed herein and will also identify more precise descriptions of the locations of the actions and strategies that will be implemented over the 15-year time frame of the CCP. The HMP will also address prescribed burning as a management tool. In this CCP, the goals, objectives, and list of strategies under each objective identify how we intend to manage habitats on the refuge. Both the CCP and HMP are based on current resource information, published research, and our own field experiences. Our methods, timing, and techniques will be updated as new, credible information becomes available based upon the principles of adaptive management. To facilitate our management, we will regularly maintain our GIS database, documenting any major vegetation changes on at least a 3-year basis. As appropriate, actions listed in "Actions Common to All Alternatives" will be incorporated into the HMP.

Wilderness Stewardship Plan (WSP)

A WSP guides the preservation, stewardship, and use of a particular wilderness area. A WSP is a step-down management plan (602 FW 1.6, 602 FW 4, and 610 FW 3) that provides detailed strategies and implementation schedules for meeting the broader wilderness goals and objectives identified in this CCP. The WSP will provide specific, measurable stewardship strategies, as well as indicators, standards, conditions, or thresholds that define adverse impacts on wilderness character and values. The WSP will describe stewardship actions that will be implemented to preserve wilderness character and reduce or prevent adverse impacts to the wilderness area. Lastly, the WSP will describe new and continued monitoring and research needs, appropriate and compatible uses and associated determinations, and Minimum Requirement Analyses (MRAs) for refuge management activities and commercial services. A

WSP for the refuge will be necessary in achieving the objectives of goals 1, 3, 4, and 5 regardless of the alternative selected. The WSP will be updated, as necessary.

Visitor Services Plan

A VSP is a step-down management plan that documents approved recreational activities, identifies the structure of the visitor services program, and discusses operational limitations, biological constraints, and partnership opportunities. A VSP will guide visitor services and ensure recreational uses are compatible with the Refuge System mission and the purposes of the refuge. The plan will set goals, determine measurable objectives, identify strategies, and establish evaluation criteria for all visitor services. A VSP for the refuge will be needed in order to accomplish the objectives of goals 4 and 5, regardless of the alternative selected.

Fire Management Plan

An FMP enables the refuge to consider a full range of appropriate fire suppression strategies and to conduct prescribed fires. An FMP defines a program to manage wildland fires and assures that wildland fire management goals and components are coordinated. The Department and FWS require that every area with burnable vegetation have an approved FMP. The goal of wildland fire management is to plan and make decisions that help accomplish the mission of the Refuge System. Without a FMP, prescribed fires cannot be conducted and only wildfire suppression strategies may be implemented. Prescribed fire will be included in the HMP since it will be used as a habitat management tool. The FMP will identify and integrate all wildland fire management and related activities within the context of this approved CCP. The FMP will be reviewed and/or revised at a minimum of 5-year intervals, or when significant changes are proposed, such as if major land use changes occur adjacent to refuge lands (621 FW 2.3C-4).

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Hazardous Waste Site Operation and Maintenance (O&M) Plans

A Hazardous Waste Site O&M Plan documents the FWS approach for maintaining the integrity and monitoring the effectiveness of the remedial actions that have been implemented at contaminated sites on the refuge. O&M plans have been developed and implemented for the two major remediated sites on the Refuge (OU 3 and Harding Landfill). OU3 remediation was performed by FWS pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process and was completed in 1998. The 6-acre site was removed from EPA's NPL in 2010. The 1-acre Harding Landfill remediation was completed in 2001 pursuant to a presumptive remedy agreement with EPA and NJDEP. Both O&M plans have provisions for 5-year reviews at which time they can be modified to address changing conditions. The Refuge Contaminants Biologist is responsible for implementing both plans, evaluating their effectiveness and making changes as necessary. Currently, both plans involve quarterly

inspections, annual collection and analysis of groundwater, surface water and sediment samples, and maintenance of native grass cover.

The third major contaminated site on the Refuge is the Rolling Knolls Landfill. This site is currently in the CERCLA remedial investigation phase. The work is being performed by private parties under EPA oversight. Approximately 30 acres of the more than 100-acre landfill is within the refuge boundary on the east side of the refuge within the Wilderness area. Therefore, once remediation is completed, an O&M plan will be developed by the responsible parties and approved by EPA. FWS will have opportunity to review and comment on the plan. It will not be the responsibility of the Refuge to perform any O&M activities. However, all O&M reports and data will be reviewed by the Contaminants Biologist in coordination with EPA.

An additional minor site requiring O&M is the former Bardy Field. The former agricultural site was remediated under a plan approved by FWS and NJDEP, prior to purchase by FWS. O&M consists of visual inspections by the Refuge Contaminants Biologist and periodic mowing of approximately 20 acres to maintain a grass cover and prevent establishment of woody vegetation.

Hunting Plan

The purpose of the Hunting Plan is to establish guidelines for hunting that will provide the public with a quality wildlife-dependent recreational experience, an opportunity to use a renewable resource, and the ability to maintain wildlife populations at levels compatible with refuge habitat. Although a Deer Hunting Plan currently exists in draft form, a Hunting Plan will be developed that will also include wild turkey. The Hunting Plan will describe the species covered by the plan; the objectives of refuge hunts; compatibility and conformance with refuge purposes; measures taken to avoid conflicts with other management objectives (i.e., biological, public use, and administrative); conduct of the hunt; procedures for consultation and coordination with others; hunter requirements and regulations; data collection and monitoring; and funding and staffing requirements to conduct the hunts. The hunting program will be reviewed and updated annually by refuge staff. Refer to section 2.7.2, Priority Public Uses, Hunting for additional information.

Law Enforcement Plan

A Law Enforcement Plan describes the refuge's policies, rules and regulations, and standard operation procedures for the law enforcement program.

3.2.2 Refuge Staffing and Administration

In all the alternatives, our objective is to fiscally sustain levels of annual staffing, fleet, facilities, equipment, and supplies that allow us to achieve refuge purposes, as interpreted by the goals, objectives, and strategies in this draft CCP/EA. We achieved many of our most highly visible projects since refuge establishment through special project funds that typically have 1 to 2 year durations. Although those funds are still vital, their flexibility is limited, because they cannot be used for any other priority project that may arise, and there is often no reliable source for sustaining recurring work over the longer term. Funding for land acquisition derives primarily from two sources: the LWCF and the Migratory Bird Conservation Fund. We generally direct the funds from those sources at specific acquisitions.

In 2007, our Regional Directorate completed the "Strategic Workforce Plan for National Wildlife Refuge System in Region 5" (Phase 2; January 16, 2007) to support a new base budget approach. Its goal is a maximum of 75 percent of a refuge station budget to cover salaries and fixed costs, while the remaining 25 percent or more would be operating and maintenance funds. Our strategy is to improve the capability of each refuge manager to do the highest priority work, and not to have most of a refuge budget tied up in inflexible fixed costs. This strategy was successful for a few fiscal years; however, we now anticipate a level or declining budget environment, which will impact flexibility in managing financial resources and may have implications for the level of permanent staffing. A new round of workforce planning began in 2013 in response to the sequester and anticipated future budget reductions.

In appendix D, we identify the different levels of staffing needed to successfully implement each alternative; however, our budgets are determined annually by Congress and distributed through our Washington and Regional offices before arriving at field stations. In all alternatives, within the constraints or opportunities of our budget and in conformance with future workforce, plans, we would seek to fill any currently approved but vacant positions, which we believe are necessary to accomplish our highest priority projects. Alternatives B, C, and D also propose additional staff to provide depth in our biological and visitor services programs.

3.2.3 Appropriateness and Compatibility Determination

The requirements for appropriateness and compatibility determinations are described in chapter 1. Appendix B includes draft appropriateness and compatibility determinations to support the activities in alternative B, the FWS-preferred alternative. The final CCP will include the approved compatibility determinations for the alternative selected. Only those activities that we have determined to be compatible and meet or facilitate refuge purpose, goals, and objectives will be allowed. (603 FW 2) (USFWS 2000d).

When the FWS acquires land within the current acquisition boundary in full, fee-simple ownership, we would consider public access and compatible public recreation, and other refuge uses, consistent with what is currently permitted or proposed, on existing refuge lands. All tracts of land considered for acquisition are reviewed for compatible priority public uses, which may get incorporated into the management of the parcel. In addition, all parcels are acquired under the primary purposes of refuge. Any potential conflicts are researched and resolved by a Department Solicitor prior to acquisition. When a conservation easement, or a partial interest, is purchased, the FWS objective is to obtain all rights determined necessary to ensure protection of the federal trust resources of that parcel. At a minimum, the purchase would include development rights; however, we may also seek to obtain the rights to manage habitats, and/or to manage public use and access, if the seller is willing and we have funding available.

3.2.4 Wildlife-Dependent Recreational Program

In 2006, wildlife observation, photography, and environmental interpretation were identified by the Regional Office as the refuge's lead areas of emphasis (USFWS 2009c). This determination was made based on careful consideration of our natural resources, existing staff, operational funds, existing and potential facilities, and which programs we would be most effective in providing "quality" opportunities for visitors.

The Policy Analysis and Science Assistance (PASA) Branch of the USGS, in cooperation with the FWS, has been a conducting a study of refuge visitation that provides useful data at the national, regional, and field station levels. This survey effort allows for a better understanding of visitors' recreational, educational

and informational experiences, and measures satisfaction with current services, access, and facilities. USGS conducted a visitor survey at the refuge in fall 2010 and spring 2011. While all priority public uses are important, wildlife observation and environmental interpretation will receive greater emphasis as the refuge prioritizes resources for visitor services in this draft CCP/EA. As always, we look to our partners, friends, and/or other volunteers to help develop and assist with the refuge's public use programs.

3.2.5 Refuge Operating Hours

Refuge lands that are open to the public are open for visitation 7 days a week, year round, from sunrise to sunset. The entire refuge is closed to the public from sunset to sunrise to ensure visitor safety and to protect refuge facilities and resources. The refuge headquarters, located at 241 Pleasant Plains Road, is open from 8:00 a.m. to 4:30 p.m., Monday through Friday. The WOC is open from sunrise to sunset and is staffed by volunteers on weekends during spring and fall.

The Helen C. Fenske Visitor Center (Visitor Center), located at 32 Pleasant Plains Road, is open from 12:00 p.m. to 4:00 p.m. on Thursdays and Fridays, and 10:00 a.m. through 4:00 p.m. on Saturdays and Sundays. The Visitor Center also contains the Friends of Great Swamp NWR Nature Shop. North Gate on Pleasant Plains Road opens 30 minutes before and closes 30 minutes after Visitor Center hours to allow travel between the Visitor Center and other refuge facilities. South Gate opens at sunrise and closes 15 minutes before sunset daily.

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The refuge manager has the authority to issue a SUP to authorize access outside of these timeframes. For example, researchers may be permitted access at different times, if necessary, for successful completion of a research project.

3.2.6 Commercial and Economic Uses

There are currently no commercial or economic uses on the refuge and none are proposed under any of the alternatives.

3.2.7 Reserved Rights

While purchasing land to complete the refuge boundary, the FWS has acquired land with reserved rights, rights-of-way, leases, and other agreements. Most include rights-of-way to run power transmission lines and gas pipelines across the refuge to serve commercial and residential interests. Other types of agreements listed in realty files include flooding and drainage rights, riparian rights, and access rights. There are also 13 life estates currently listed in realty files for land owned by the refuge. A life-use reservation is established when a landowner chooses to sell land to the FWS in fee simple, while retaining the right to occupy an existing residence. As the name implies, life- estates apply to the seller's lifetime or to a specific number of years. After the appraisal is approved and before making an offer, the FWS

discounts from the appraised value of the buildings and land the value of life use, based on the age of the owner and the term of the life estate. The occupant is responsible for the upkeep on the reserved premises (USFWS 2011b).

The refuge will follow policy guidance when any of these reserved rights are exercised. Specifically, the refuge will follow 50 C.F.R. 29.21-8 for electric power transmission line rights-of-way and 50 CFR 29.21-9 for rights-of-way for pipelines for the transportation of oil, natural gas, synthetic liquid, or gaseous fuels, or any refined product produced there from. The refuge will also ensure compliance under the refuge compatibility policy (603 FW 2) and BIDEH policy (601 FW 3). Depending on the location, nature and extent of disturbance required to exercise reserved rights on refuge lands, other laws may apply. In general, the refuge will coordinate with all private parties exercising their rights to ensure the protection of refuge resources. The refuge will issue SUPs, as necessary, to manage these uses and to ensure that impacts to refuge resources are minimized to the greatest extent practicable.

3.2.8 Additional Office Space

With the addition of the Helen C. Fenske Visitor Center, refuge staff are now housed in three different buildings, which incurs additional costs associated with utilities and maintenance. In addition, the FWS is currently assessing the viability of collocating multiple offices onto FWS managed lands. There is potential to provide office space at the refuge for employees of the Office of Law Enforcement or Ecological Services. The current Visitor Center plans include the addition of a multi-use wing. The refuge will pursue the potential for the design and funding of additional office space to house all of the refuge staff and additional FWS staff in one structure. The refuge will comply with all wetlands laws and regulations for such an addition. Under this scenario, the existing pole barn that is located behind the Visitor Center would be converted to additional maintenance, visitor services program, and/or storage space.

3.2.9 Community Relations

Knowing that public lands cannot survive without the constituency that supports them, the refuge will continue to uphold and build relationships that promote sound stewardship through partnerships developed in the communities we serve. The refuge will continue to work with community organizations, such as the GSWA, attend township meetings, and participate in other venues. Refuge staff will maintain an ongoing dialogue with our congressional delegation, the State of New Jersey, the Somerset and Morris County Commissions, local elected officials, the business community, and refuge neighbors. We will foster a spirit of cooperation with all of our stakeholders and be transparent in our management of lands entrusted to us by the American people.

3.2.10 Cultural Resources

As a Federal land management agency, we are entrusted with protecting historic structures and archaeological sites on refuge land, which are eligible for or listed on the National Register of Historic Places. The FWS archaeologists in the Regional Office keep an inventory of known sites and structures and ensure that we consider them in planning new ground disturbing or structure altering changes to the refuge. We consult with the New Jersey Historic Preservation Office (SHPO) concerning projects that might affect sites and structures, and conduct archaeological or architectural surveys, when needed. Projects can usually be redesigned to avoid affecting National Register eligible sites or structures.

Under all alternatives, we will conduct an evaluation of the potential to impact archaeological and historical resources as required, and will consult with SHPO. We will be especially thorough in areas along the rivers and streams where there is a higher probability of locating a site. These activities will ensure we comply with Section 106 of the NHPA, regardless of the alternative. That compliance may require any or all of the following: a State Historic Preservation Records survey, literature survey, or field survey.

3.2.11 Land Acquisition

The refuge currently comprises 7,768 acres of wildlife habitat. The refuge has an approved acquisition boundary that would allow for the refuge to expand to 9,429 acres. Under all alternatives, we would continue to pursue acquisition from willing sellers of the 1,661 acres that remain in private ownership within the refuge's approved acquisition boundary. The tracts identified for acquisition include a variety of habitat types, along with residential, commercial, and agricultural land (including nurseries and greenhouses). In the past, lands that the refuge acquired that were disturbed or developed have been restored to natural habitat conditions. Other lands within the approved acquisition boundary include land that is owned by a Natural Lands Trust and four Farmland Preservation properties (map 2-3). Other lands adjacent to the refuge include the Fairmont Country Club, a portion of which is located within the eastern portion of the approved acquisition boundary. The former Rolling Knolls Landfill is located adjacent to the northeast boundary of the refuge. Approximately 40 acres of the former landfill is owned by the refuge and situated within the Wilderness Area (refer to section 2.1.4, Chemical Contaminants, for further information).

In general, the refuge acquires additional tracts of land through monetary purchases, land donations, and in rare circumstances, land exchanges. Our preference would be to acquire new lands in fee simple since that method ensures maximum management control and flexibility; however, the acquisition method would also take into consideration the needs and desires of the present landowner. As we continue to acquire new lands, we will manage them in accordance with the goals, objectives, and strategies under the approved alternative.

As land is considered for acquisition by FWS, the habitat types, habitat connectivity, and associated wildlife populations and plant community values are factored into the FWS decisions about priorities. Once land is acquired, we would determine future management of the site based on the particular habitat type that it contains in relation to the habitat types on adjacent lands. For example, new land acquisitions that contain pasture may be considered for continued grassland management for grassland obligate bird species if there are at least 50 acres of habitat within the newly acquired property or the land is contiguous with existing refuge lands currently being managed for grassland. Lands that contain wetland habitat would be protected and we would consider increasing the adjacent transition area (or buffer) to improve riparian corridors, prevent soil erosion, and reduce habitat fragmentation. We would consider managing land that contains forest edge habitat for successional forest management to provide young, dense vegetation for early successional priority bird species. Alternatively, forested habitat that is contiguous with stands of forest on existing refuge lands may be protected and managed to improve forest interior breeding bird habitat or to maintain movement corridors between the refuge and other protected lands in the watershed.

3.2.12 Land Conservation Partnerships

All alternatives include the refuge's continued participation in land conservation partnerships with the goal of permanently protecting and sustaining federal trust resources and other unique natural resources of the

refuge. An important component of this goal is to improve connectivity between conservation tracts to increase habitat patch size and reduce fragmentation. The Preferred Alternative includes provisions for increased partnerships with local land conservation agencies, such as the Nature Conservancy and the township and county environmental education centers. Under alternative C, the refuge would increase coordination with regional partnerships, such as PIF, to encourage dynamic, landscape-level, multi-partner efforts. Existing and potential partners include other federal agencies, state agencies, private conservation organizations, local communities, educational institutions, private businesses, and private landowners.

3.2.13 Youth Conservation Corps

The Youth Conservation Corps (YCC) Act of 1970 (16 U.S.C. 1701-1706, 84 Stat. 794) establishes permanent programs within the Departments of the Interior and Agriculture for young men and women between the ages of 15 and 18 to perform specific tasks on lands and waters administered under the jurisdiction of these Secretaries (USFWS 2010f). Within the FWS, YCC participants perform various tasks on national wildlife refuges, national fish hatcheries, research stations, and other facilities (USFWS 2011c). The YCC programs are conducted for 8 to 10 weeks during the summer, most of which is spent outdoors. All participants are expected to gain an appreciation and understanding of the environment and America's conservation heritage equal to one full academic year of study (USFWS 2010f).

The refuge formerly participated in the YCC program, which generally consisted of a crew of 6 to 24 persons and one crew leader for every six enrollees. In the past, YCC crews accomplished many important tasks in support of our biological programs, visitor services programs, and maintenance needs. Alternatives B and D propose to re-establish the YCC program as a tool for targeted outreach and recruitment of urban and minority youths.

3.2.14 National Natural Landmark

The National Natural Landmarks (NNL) Program was established by the Secretary of the Interior in 1962 under the authority of the Historic Sites Act of 1935 (16 U.S.C. 461 *et seq.*) to identify and encourage the preservation of geological and biological features that were determined to represent nationally significant examples of the Nation's natural heritage (NPS 2009). NNL are selected for their outstanding condition, illustrative value, rarity, diversity, or value to science and education (NPS 2008). The NNL Program has involved private, municipal, state, and federal landowners. Participation in the program is voluntary.

A portion of Great Swamp NWR was designated as a Registered NNL in 1966. The Great Swamp NNL currently consists of 3,852 acres, all of which is located on the refuge and primarily in the Wilderness Area. The refuge was chosen for the registry as an "exceptional example of the natural history of the United States" (USFWS 1987). The designation recognizes Great Swamp's unique blend of unspoiled forest, swamp, and marshland that provides habitat for a variety of wildlife species (NPS 2009). All alternatives will uphold the founding purposes for the establishment of the NNL and the refuge will work with the NPS to further the purposes of the NNL in keeping with the purposes of the refuge and the mission of the FWS. For additional information on the National Natural Landmark Program, please visit *http://www.nature.nps.gov/nnl.*

3.2.15 Invasive Species

The Refuge System has identified management to control the establishment and spread of invasive plants as a national priority.

The objective is to ensure no new non-native plant species become established on the refuge and to control or eliminate the spread of those species that already exist. To the extent possible, invasive species will be eradicated. A variety of control methods, including chemical, biological and mechanical control methods, will be used to maximize treatment effectiveness while minimizing risks following the FWS Integrated Pest Management (IPM) approach to controlling invasive species (569 FW 1).

Within the historically disturbed and early successional forested areas, species such as garlic mustard, wineberry, Japanese honeysuckle, multiflora rose (*Rosa multiflora*), tree-of-heaven, Japanese stiltgrass and long-bristled smartweed may be observed. Certain species, such as reed canary grass, purple loosestrife and common reed, are highly capable of creating monotypic cultures and are most common in heavily manipulated wetland areas and along utility rights-of-way. Beginning in 1995, 500,000 *Galerucella* beetles were released, resulting in a significant reduction in purple loosestrife by 2005. Invasive plant species that have been documented nearby but not on the refuge include sycamore maple (*Acer pseudoplatanus*), poison hemlock (*Conium maculatum*), common water hyacinth (*Eichhornia crassipes*), and cutleaf blackberry (*Rubus laciniatus*), among others.

In conjunction with the HMP, we will develop a list of species of greatest concern on the refuge, identify priority areas, and establish monitoring and treatment strategies (see section 2.5.4 and table 2-17 above for a list of species and existing treatment strategies). In addition, refuge staff will refer to the National Wildlife Refuge System Invasive Species Management Strategy, dated May 2003, for additional tools, processes, and strategies. The 2003 report is complemented by a technical report issued in May 2004 by USGS and others, entitled "The Invasive Species Survey: A Report on the Invasion of the National Wildlife Refuge System" (Simonson et al. 2004). These reports together give both a status review and a management strategy for combating invasive species. In addition, we will remain current with FWS policy revisions currently being reworked to facilitate implementation. Other strategies will include:

- Institute proper care of all refuge equipment to avoid introduction or transport of invasive plants.
- Require researchers on the refuge to take steps to prevent the transportation of terrestrial invasives, aquatic invasives, and pathogens.
- Work with state and federal agencies to prevent introduction of invasive species and prioritize efforts.
- Implement outreach and education programs, including signage, where appropriate, and actively support state initiatives on this topic.
- Work with partners, such as local greenhouses and landscaping companies, to educate the public about the ecological problems caused by invasive plants and to promote the sale of native plant alternatives.

Implementing this program supports refuge goals 1, 2, and 3 relating to the conservation of all wetland, upland and aquatic habitats, as well as goal 4 relating to outreach and environmental education.

3.2.16 Monitoring and Abatement of Wildlife and Plant Diseases

The FWS Manual chapter on Disease Prevention and Control (701 FW 7) is not yet published. In the meantime, we derive guidance on this topic from existing refuge plans and specific directives from the FWS Director. In all alternatives, we will conform to these plans and any specific directives when monitoring and abating wildlife and plant diseases.

Avian Diseases

Avian Influenza

Avian influenza A viruses occur naturally among birds worldwide, which includes many different strains of the virus (NJDEP 2007c). Avian influenza is very contagious among birds and some of these viruses are capable of making certain domesticated species, especially chickens, turkeys and ducks very sick and die (CDC 2010). The strains are classified as "low pathogenic" or "high pathogenic," which refer to the potential for the viruses to kill poultry, not infect humans. The "low pathogenic" strain may go undetected and usually causes only mild symptoms, such as a drop in egg production or ruffled feathers (CDC 2010). The rate of low pathogenic viruses in waterfowl typically peaks in late summer and early fall (NJDEP 2007c). The highly pathogenic form spreads very rapidly through flocks of poultry, affects multiple internal organs, and has a mortality rate that can reach 90-100 percent, often within 48 hours (CDC 2010).

The strain that has been receiving considerable attention worldwide is the highly pathogenic Eurasian form, known as H5N1. H5N1 is a very deadly strain of virus for chickens and other domestic birds. Although H5N1 has not yet been detected in North America, there is some concern that wild birds may spread the virus into North America during migration (NJDEP 2007c). The refuge monitored waterfowl for the highly pathogenic strain of avian influenza during the summer of 2009. Results were negative. Monitoring will continue as the threat dictates.

West Nile Virus (WNV)

WNV was first documented in the Western Hemisphere during a 1999 outbreak in the New York City metropolitan area. By 2003, WNV was documented in 46 states and caused illness to more than 9,800 people (USGS 2011c). Infectious mosquitoes carry WNV in their salivary glands and infect susceptible bird species during feeding. Infected birds containing high levels of WNV in their blood act as reservoir hosts, infecting other mosquitoes (USGS 2011c). WNV is only transmitted to humans and other animals through the bite of an infected mosquito. WNV has been detected in dead birds of at least 326 species (CDC 2009a). Although birds, particularly crows and jays, infected with WNV can die or become ill, most infected birds do survive (CDC 2009b). In 2011, 42 dead bird infections were documented in New Jersey, nine of which were in Morris County. Dead bird infections were documented from late July through mid-October (USGS 2011d). Seven human disease cases were documented in New Jersey in 2011, one case each occurring in the Counties of Atlantic, Hudson, Mercer, Middlesex, Morris, Ocean, and Union (USGS

Pamela Wells

2011e).

Migratory Bird Disease Contingency Plan

The 2003 Migratory Bird Disease Contingency Plan was developed to provide techniques and strategies to minimize the effects of contagious disease in migratory birds. The primary goals of the plan are to (1) prevent the establishment of new or exotic bird diseases; (2) reduce bird mortality to disease; (3) diminish disease impacts; and (4) reduce spread of contagious disease (USFWS 2003c). Reducing spread and diminishing impacts may be accomplished through partial or entire emergency closure of refuge or water level manipulation, as needed, to either concentrate or disperse birds. The ESA must be considered when reducing disease impacts to minimize or eliminate negative impacts on endangered or threatened species or their habitats.

Other Diseases

White Nose Syndrome

As discussed in chapters 1 and 2, the first documented case of WNS was reported near Albany, New York in the winter of 2006-2007. WNS is characterized by the colonization of a psychrophilic, or "cold-loving," fungus on the muzzle, ears, and flight membranes of hibernating bats (Blehert, et al. 2008); however, the presence of the fungus is typically only observable on approximately half of bats affected. The fungus has been identified as *Geomyces destructans.* Affected bats may exhibit low body weights and abnormal behaviors, including early emergence from hibernation and movement to colder areas of caves. WNS quickly spread to hibernacula of several other New England states the following winter. In 2008 to 2009, the syndrome spread as far south as Virginia and included the states of New Jersey and Pennsylvania (USFWS 2010c). Since it was first documented, WNS has been confirmed in 20 states and 4 Canadian provinces, and is expected to continue spreading (USFWS 2012d). WNS has been detected in states as far west as Oklahoma (USFWS 2012d).

In 2009, WNS was confirmed in five hibernacula in New Jersey, including Hibernia mine, both Mount Hope mines, and Upper and Lower Copper mines (NJDEP 2009a). Data suggests that at least some of the refuge's Indiana bats winter in Hibernia and Mount Hope mines (Kitchell 2011). A majority of the bats hibernating in Hibernia mine are little brown bats, with lesser amounts of Indiana bats and Northern long-eared bats (Valent 2011). Visual signs of the fungus and behavioral changes were observed in Hibernia mine in January 2009 and mortality was evident in March and April 2009 (Valent 2011). In February 2010, NJDFW estimated 93 percent mortality in Hibernia mine (Valent 2011). The presence of WNS in New Jersey has resulted in at least a 50 percent decline in *Myotis* species (Valent 2011).

WNS has caused the death of more than 5.5 million bats in eastern North America since it was identified in the winter of 2006 to 2007 (USFWS 2012d). In some hibernacula (caves or mines where bats hibernate in winter), approximately 90 to 100 percent of bats are dying (USFWS 2010c). More than half of the 45 bat species living in the United States rely on hibernation for winter survival. Eleven cave-hibernating bats, including four endangered species and subspecies, are already affected by or are potentially at risk from WNS (USFWS 2012d). The majority of bats dying in the Northeast have been little brown bats; however, WNS has also affected tri-colored, Northern long-eared, big brown, Eastern small footed, and Indiana bats (USFWS 2010c).

Amphibian Chytrid Fungus

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* or *Bd,* is a rapidly emerging pathogen that is linked to global declines in amphibian populations (Kolby et al. 2009). *Bd* has been severely impacting amphibian populations worldwide as animals become infected with a disease known as chytridomycosis (USFWS 2010c; Borrell 2009; AARK 2011). The disease attacks the skin of the amphibian and makes trans-dermal respiration difficult. These disease also attacks neurological systems and impacts behavior. As Great Swamp NWR is home to diverse group of New Jersey amphibians, this fungal infection has the potential to have serious implications to the ecology of the refuge. *Bd* has been identified in New Jersey (NJDEP 2011b) and the ENSP is currently testing amphibians throughout New Jersey, including Great Swamp NWR, for disease presence. ENSP is working to determine if the disease impacting or has impacted frog and salamander populations within the State.

Chronic Wasting Disease (CWD) and CWD Surveillance and Contingency Plan

CWD is a transmissible spongiform encephalopathy occurring in North American cervids (members of the deer family), including white-tailed deer, mule deer, elk, and moose (USGS 2007). The disease is not known to infect livestock or humans at this time (USGS 2011a). CWD belongs to a group of rare, fatal and transmissible diseases of the central nervous system. Infected animals display progressive weight loss, as well as behavioral changes, including decreased social interaction, loss of awareness, and loss of fear of humans. Diseased animals may also exhibit increased drinking, urination, and excessive salivation (USGS 2007). Since it was first observed in 1967 in a captive deer facility in Colorado, the disease has been documented in free-ranging populations in 15 states and 2 Canadian providences (USGS 2011b).

Since 1998, the NJDEP Division of Fish and Wildlife, in conjunction with others, has conducted annual CWD surveys by collecting tissue samples from deer taken during the State's hunting season. To date, all samples collected have tested negative for the disease (NJDEP 2005b; NJDEP 2006; Stanko 2011 personal communication). The statistical analysis of these findings indicate that if CWD was present it would be in less than one-half to one percent of the State's adult herd (NJDEP 2005a).

The 2008 CWD Surveillance and Contingency Plan provides Great Swamp NWR with guidelines for management actions to proactively reduce the risk or impact of CWD on station resources, conduct surveillance, and respond to CWD presence should the disease be detected on or near refuge land (USFWS 2008e). This plan places high priority on coordinating actions and sharing resources with other state and federal agencies.

Epizootic Hemorrhagic Disease (EHD)

EHD is a common viral disease in deer that is contracted from the bite of a species of midge known as *Culiocoides sonorensis*. EHD is typically localized and does not spread from deer to deer. It cannot be transmitted to humans and although livestock can be infected, the disease is relatively benign in livestock. New Jersey has documented occasional, localized outbreaks of EHD in various parts of the State for more than 50 years. EHD was reported in Salem County in 2010 and in East Amwell Township (Hunterdon County), Hopewell Township (Mercer County) and Hillsborough (Somerset County) in 2011 (NJDEP 2011d). EHD outbreaks were confirmed at the refuge in circa late 1950s, 2007, and 2011. The 2011 outbreak was severe and resulted in notable declines in the refuge's deer population (refer to section 3.2, alternative A, goal 4, objective 4.1, table 3-1).

Infected deer initially lose their appetite and fear of humans, then grow progressively weaker and often salivate excessively. As the disease progresses, the infected deer breathe heavily and develop a fever,

often causing the deer to go to water. Eight to 36 hours after the onset of observable signs, the infected deer pass into a shock-like state, become prostrate and die. Deer typically die within 5 to 10 days of infection (NJDEP 2011d).

Rabies

Rabies is a preventable, viral disease of mammals, including humans. The virus is found in the saliva of a rabid animal and is transmitted by a bite, or possibly by saliva contamination of an open cut or mucus membranes (i.e., nose, eyes or mouth) (CDC 2011). If left untreated, rabies attacks the nervous system and causes death. Rabies occurs most often in wildlife, particularly raccoons, bats, skunks, groundhogs, coyotes, and foxes. These animals represent 95 percent of the cases in the United States. Less than 1 percent of bats carry rabies and human attacks by bats are extremely rare. In New Jersey, cats account for the vast majority of domestic rabies cases. Farm animals, dogs, and other domestic pets can also become infected from wild animals. Small rodents such as rats, mice, chipmunks, and squirrels are rarely infected. Rabid animals typically exhibit abnormal behaviors, such as aggression, nervousness, friendliness, excessive drooling and foaming at the mouth (NJDHSS and Communicable Disease Service 2007).

Refer to sections 2.1.5 and 2.1.7 for additional information on wildlife and plant diseases.

3.2.17 Protecting Wetlands, Riparian Corridors, and Rare Habitat Communities

The refuge provides vital brooding, nesting, feeding, and resting habitat for a variety of migratory bird species, including waterfowl. Although established primarily for migratory birds, the refuge's mosaic of forested wetlands, emergent wetlands, open water, and various successional stages of upland vegetation provides habitats for a diversity of wildlife species. The refuge's habitats are recognized as important community types in the NJWAP (2009), the FWS Significant Habitats and Habitat Complexes of the New York Bight Watershed Report (1997), and the NJDEP Natural Heritage Program.

The 2008 NatureServ study revealed the presence of one rare vegetation association, known as Floodplain Pool (globally imperiled), which is described as an herbaceous community that may form a continuous bed along the side of slowly flowing water in larger streams, or be characteristic of smaller channels within the floodplain of the larger streams (Sneddon 2008). The Floodplain Pool Association is mapped along portions of the Passaic River, Black Brook and Great Brook. The New Jersey NHP database revealed three historic records of rare wetland plants on or immediately adjacent to the refuge, including featherfoil, water-plantain spearwort, and black-girdle woolgrass. Featherfoil was confirmed on the refuge by Brooklyn Botanic Garden botanists during the 2011 BioBlitz. In addition, water horehound, a State-ranked imperiled or vulnerable plant, was also identified by Bowman's Hill Wildlife Preserve during a vegetation survey in 2008. No other rare plants were recorded on or adjacent to the refuge. Further information about rare plant species and communities is provided in chapter 2.

3.2.18 Research

One of the major purposes of Great Swamp NWR was to serve as an "Ecological Laboratory" for study (USFWS 1987). Accordingly, numerous academic, professional and volunteer research and monitoring activities have occurred at the refuge. Research and monitoring at Great Swamp NWR has been vital in the management of the refuge while also contributing to the academic community. Some examples of recent research projects and refuge studies include roost selection and landscape movements of female

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Indiana bat; wood turtle and bog turtle surveys and telemetry data collection; waterfowl banding and counts; and vernal pool surveys.

In 1967, 746 acres in the eastern portion of the present Wilderness Area were declared a Research Natural Area by the Director of the FWS. This area, known as the M. Hartley Dodge Research Natural Area, contains natural shrub swamp habitat and many small upland islands (USFWS 1987). A Research Natural Area is defined as "any tract of land or water that supports high quality examples of terrestrial or aquatic ecosystems, habitats, and populations of rare or endangered plant or animal species, or unique geological study of the features, and is managed in a way that allows natural processes to predominate with minimal human intervention" (USDA 2012). Under certain circumstances, intentional manipulation may be used to maintain the unique features for which the research natural area was established (USFWS 2012e). Activities in research natural areas are generally limited to research, study, observation, monitoring, and educational activities that are non-destructive, non-manipulative, and maintain unmodified conditions.

The FWS encourages and supports research and management studies on refuge lands that will improve and strengthen natural resource management decisions. Research by non-FWS personnel is generally conducted to further the understanding of the natural environment and to improve the management of the refuge's natural resources. Much of the information generated by the research is applicable to management on and near the refuge. In many cases, this type of research ensures the perception of un-biased and objective information gathering, which can be important when using the research to develop management recommendations for politically sensitive issues. The refuge manager encourages and seeks research relative to approved refuge objectives that clearly improves land management and promotes adaptive management. The refuge will also consider research for other purposes that may not directly relate to refuge-specific objectives, but contribute to the broader enhancement, protection, use, preservation, and management of native populations of fish, wildlife and plants, and their natural diversity within the region of flyway.

The refuge will continue to encourage scientific study and research by colleges, universities, volunteers, and qualified organizations, which is directed toward fulfillment of refuge objectives. Typically, the refuge manager will approve permits for research projects that provide a direct benefit to the refuge or that will strengthen our decisions for managing natural resources for biological or public use programs on the refuge. The refuge manager may also consider research requests that do not relate directly to refuge objectives but instead relate to the protection or enhancement of native species and biological diversity in the region. Requests may also be considered if the research supports the goals of ecological conservation teams, such as the Atlantic Coast or Appalachian Mountains Joint Ventures and the Eastern Brook Trout Joint Venture and the Appalachian and North Atlantic Landscape Conservation Cooperatives.

All researchers will be required to submit detailed research proposals following the guidelines established by FWS policy and refuge staff. SUPs will also identify the schedules for progress reports, the criteria for determining when a project should cease, and the requirements for publication or other interim and final reports. All publications will acknowledge the FWS and the role of FWS staff as key partners in funding

and/or operations. We will ask our refuge biologist(s), other divisions of the FWS, USGS, select universities or recognized experts, and the NJDFW for peer review and comment on research proposals and draft publications, and will share research results internally, with these reviewers, and other conservation agencies and organizations. To the extent practicable, and given the publication type, all research deliverables will conform to FWS graphic standards.

Projects, such as those involving listed species, will require additional State and FWS permits. Research projects will not be approved until all required permits are received and the consultation requirements under the ESA have been met.

3.2.19 Adaptive Management

As climate, habitat, visitation, and social conditions are likely to change over the next 15 years, and pursuant to FWS policy, the refuge will use adaptive management to respond to changing conditions that impact the ability to achieve or refine the objectives and strategies of this CCP. All alternatives will employ adaptive management as a method to ensure that we detect and respond to new information, conditions or events quickly. This requires that we establish and maintain a monitoring program.

We must adapt our strategies to respond to new information, spatial and temporal changes, threats, or environmental events that may or may not have been predicted. We will continually evaluate management actions, both formally and informally, through monitoring and research to determine whether our initial assumptions and predictions are still valid.

The refuge manager is responsible for changing management strategies if they do not produce the desired conditions. Significant changes may warrant additional NEPA analysis and public comment. Minor changes that do not alter the objectives analyzed in this CCP will not require additional analysis or public comment. In general, we have the ability to increase monitoring and research that support adaptive management without additional NEPA analysis, assuming the activity is determined to be compatible by the refuge manager. Many of our objectives identify monitoring needs, including climate change, threatened and endangered species, disease, invasive species, and pests.

NEPA requires site-specific analysis and disclosure of impacts for all major federal actions. Other routine administrative and management activities that have been found, individually and cumulatively, to have no significant effect on the environment, are categorically excluded from the NEPA requirements to prepare detailed environmental documents. Those generally include administrative actions.

3.2.20 Site Restoration and Removing Surplus Structures

Under all alternatives, the refuge would continue to address surplus structures currently located on FWS-owned lands, and would continue to restore previously disturbed or developed sites to the character of historic habitat conditions. Surplus structures include old residences, barns, and hunting platforms that are in disrepair and are deemed unnecessary by refuge management. These structures are not necessary and affect the aesthetic values of the refuge. Additionally, surplus structures have often not been structurally sound and have created a public safety hazard. For Great Swamp NWR, surplus structures are acquired as a part of the active land acquisition program. If we acquire land that has a building, we evaluate whether we will be able to use the building or if it should be removed.

Under alternatives B, C, and D, the refuge would improve the trail system by eliminating less used and dead-end trails. These trails will be restored to natural conditions through active planting if necessary, or vegetation will simply be allowed to succeed.

In this draft CCP/EA, we propose the following with respect to surplus structures and unnecessary trails:

- Within 3 years of acquiring property that has a structure on it or impervious surface (such as pavement), the refuge will determine whether the structure is surplus to refuge needs and, if it is, remove the structure, assuming funding and staffing are available. The refuge would restore the site by re-grading it to the natural topography and hydrology, and revegetating it with native species to establish desirable conditions.

- Within 5 years of acquiring property that contains access roads, contingent upon staff and funding, the refuge may implement procedures to retire and restore any unnecessary roads to promote watershed and resource protection.

Implementing this program would support refuge goals 1, 2, and 3 by protecting wetlands from erosion and sedimentation; increasing groundwater infiltration and decreasing stormwater runoff; reducing transportation pathways for invasive species; and reducing edge habitat and fragmentation.

3.2.21 Fire Management

Prescribed fire is not currently used on the refuge; however, prescribed fire has been identified as a potential management tool for grassland and scrub-shrub habitats in alternatives B, C, and D. Under these alternatives, the refuge would evaluate and use fire as a management tool, where and when appropriate. Further details and guidance on using prescribed fire for habitat management can be found in the refuges FMP. A draft FMP was prepared for the refuge in 2008 (refer to section 3.1.5 above). An updated FMP will be prepared upon completion of the CCP (refer to section 3.1.1). The FMP is available for review by request by contacting the refuge.

3.2.22 Climate Change

The FWS has prepared a Strategic Plan for addressing climate change, which will help guide refuge actions, including planning, strategic habitat conservation, and adaptive management practices. These actions will help us address climate change effects on refuge resources. In general, the refuge will continue to work with partners and encourage research and monitoring activities, which will help build an information base to aid in the monitoring of changes and development of strategies to mitigate significant impacts over time. We will use adaptive management to evaluate conditions as they relate to our ability to meet our management objectives and integrate new management decisions into existing plans based on sound science and best professional judgment.

The refuge recognizes that conditions related to global climate change may affect our ability to meet long term biological objectives. In New Jersey, long-term data document an increase in average temperature and a rise in sea level that is consistent with observed and predicted global trends (NJDEP 2008d). In general, spring is arriving earlier, summers are becoming hotter, and winters are becoming warmer with

less snow. Refer to section 2.1.7 for further details on observed and predicted effects of global climate change.

Global daily satellite data, available since 1981, indicates earlier onset of spring 'greenness' by 10-14 days over 19 years, particularly across temperate latitudes of the Northern Hemisphere (Myneni et al. 2001; Lucht et al. 2002). Field studies confirm these satellite observations. Many species are expanding leaves or flowering earlier. There is evidence that the first flowering date of some plants has been advanced by an average of 4 days per degree centigrade over the past 100 years in temperate zones (Memmott et al. 2007). According to some climate change models, phenological shifts resulted in a reduction of floral resources available to 17 to 50 percent of all pollinator species due to a reduced temporal overlap between the pollinators and their floral food resources (Memmott et al. 2007). Specialized species with a limited range of food hosts may be especially vulnerable to these climate induced disruptions. As with other ecological predictions related to global climate change, we could expect great variation in responses among different species or the same species in various locations and conditions (Ibanez et al. 2010).

Increased CO_2 driven photosynthesis within some forests may result in increased growth and productivity rates for some species. This increased growth may result in more efficient water use caused by increased CO_2, demand for soil nutrients, and accelerated decomposition rates and could potentially offset some CO_2 production by providing increases in carbon storage. However, such benefits could be neutralized by forest loss due to land use changes (Frumhoff et al. 2007).

Field, et al. (2007) reports that several species of animals in North America are responding to the effects of climate change. For example, the increase in average spring temperature have led to earlier nesting for 28 migrating bird species on the east coast (Butler 2003) and to earlier egg laying for tree swallows (Dunn and Winkler 1999). Several frog species appear to be responding by initiating breeding calls 10 to 13 days earlier than a century ago (Gibbs and Breisch 2001). Many North American species have shifted their ranges, typically to the north or to higher elevations (Parmesan and Yohe 2003). Red fox have expanded northward into northern Canada, resulting in the retreat of the competitively subordinate arctic fox (Hersteinsson and Macdonald, 1992).

Habitat specific and migratory species, especially northern forest birds, have been determined to be particularly vulnerable to global climate change (NABCI 2010). A number of less common Great Swamp NWR forest passerines and neotropical migrants, such as wood warblers (*Dendroica* spp.), yellow-bellied flycatcher (*Empidonax flaviventris*), veery (*Catharus fuscenscens*) and hermit thrush (*Catharus gluttatus*) have all been predicted to decline as a result of rising global temperatures (NABCI 2010; Frumhoff et al. 2007). Changes in migratory timing, including the seasonal availability of food resources, would be a major contributing factor to these declines (NABCI 2010). Monitoring habitat specific species may be useful in assessing the long-term effects of climate change to the refuge's biota.

Northern grassland areas are expected to become drier with increased evapotranspiration caused by global climate change impacts. It is also suspected that increased atmospheric carbon dioxide may contribute to faster succession of woody species in grassland habitats (NABCI 2010). Approximately 50 percent of grassland bird species of the United States, including the State-listed bobolink (*Dolichonyx oryzivorus*), are expected to be impacted by global climate change (NABCI 2010). Christmas bird count data indicates that grassland birds were the only general group of birds unable to shift north in response to global climate

change over the last 40 years. This inflexible response has been attributed to the poor quality of northern grassland habitats (NABCI 2010).

Changes in global temperature may influence rainfall patterns and subsequent flow and cycling of water within ecological systems. Weather instability (including an increase in short-term droughts and floods) resulting from global climate change may impact water recharge or input timing, reduce storage capacity, and increase drought or flooding (NABCI 2010). Increase in precipitation during winter and spring months may exacerbate flooding conditions during snowmelt. Within the Northeast, winter flooding, precipitation and high flow periods are expected to increase by as much as 20 to 30 percent with increased rainfall impacts under varying levels of emissions (Frumhoff et al. 2007). Some studies have projected two to five fold increases of extremely hot summer days and increases in short-term (one to three month) warm season droughts in the Northeast. Subsequent low flow (least amount of water volume within a stream) periods during summer seasons may be prolonged for northeastern streams. Water demands within ecosystems may also seasonally increase within the region due to increases in plant productivity and subsequent evapotranspiration (Frumhoff et al. 2007).

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Since insects are poikilothermic (cold-blooded) animals and sensitive to temperature fluctuation, climate change may also result in redistributions of pest insects and subsequent forest impacts (Logan et al. 2003). Warmer winters and possible increased drought conditions could have the effect of increasing insect infestations. Drought conditions stress trees, which can also increase their susceptibility to insect pests (IPCC 2007). As growing and reproductive seasons are prolonged, some insects, including pest insects, will likely produce more generations per season (Ibanez et al. 2011). Insects that may benefit from warming scenarios may include the wooly adelgid, emerald ash borer, and gypsy moth. Certain parasitic fungi and other diseases, including Dutch elm disease, white pine blister rust, and beech bark disease are also expected to benefit from climate change (Frumhoff et al. 2007).

Recommendations for forest management include planning for potential changes in plant communities and maintaining and increasing native and natural diversity to create a more resilient forest community. Under alternatives B and D, habitats would be maintained as large (greater than 50 acres), contiguous patches, where possible, to promote wildlife use, increase connectivity, decrease fragmentation, and reduce edge habitat. Alternative C emphasizes management to maximize core forest habitats while maintaining large (greater than 50 acres), contiguous patches of actively managed grasslands and scrub-shrub habitats. Larger, mature trees with well established root systems will likely fair better during drought conditions then smaller, less developed trees. In addition, a more mature and contiguous forest cover will help maintain cooler temperatures on the forest floor which creates more conducive conditions for natural regeneration and benefits associated wildlife. Increasing patch size and connectivity of forest habitats may also improve its resiliency to changes in average and seasonal temperatures and precipitation patterns over the next 50 years.

3.2.23 Wilderness Review

As described in chapter 1, the Great Swamp Wilderness Act of 1968 designated the eastern portion of the refuge, comprised of 3,660 acres, as Wilderness Area. Great Swamp NWR wilderness was the first Wilderness Area designated within the Department of the Interior.

Although a portion of the refuge is already designated as Wilderness, Refuge System planning policy requires that we conduct a wilderness review during the CCP process. A wilderness review is the process we follow to identify and recommend for congressional designation Refuge System lands and waters that merit inclusion in the NWPS. The wilderness review process includes three phases:

- Inventory – We identify lands and waters that meet the minimum criteria for wilderness. These areas are called Wilderness Study Areas (WSAs).
- Study – We evaluate WSAs to determine if they are suitable for Wilderness designation.
- Recommendation – We use the findings of the study to determine if we will recommend the area for designation as Wilderness in the final CCP. The Wilderness recommendations are proposed from the Director through the Secretary and the President to Congress in a Wilderness Study Report. Only Congress can designate Wilderness. By policy, the FWS manages WSAs, recommended, and proposed Wilderness Areas to preserve their wilderness character and thereby retain Congress' option to designate the area as Wilderness at some future time.

Our inventory of the refuge determined that approximately 161 acres within the southwestern portion of the Wilderness Area met the eligibility criteria for a WSA, as defined by the Wilderness Act (610 FW 4). The results of the wilderness review are included in appendix B.

3.2.24 Wild and Scenic River Review

As discussed in chapter 1, we are required to review river segments that cross the refuge for their potential for inclusion in the National Wild and Scenic River System. As a first step, we reviewed the National Rivers Inventory. The inventory is a listing of more than 3,400 free flowing river segments in the U.S. that are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance. Great Swamp NWR is adjacent to a section of the Passaic that is potentially eligible as a Botanic segment. The inventory also includes Great Brook which runs through the refuge.

Refuge staff will work with the NPS Rivers, Trails, and Greenways Program to determine the most appropriate way to move forward with designation and management. Over the last 40 years, refuge staff have restored portions of Great Brook.

3.2.25 Conducting Additional NEPA Analysis

NEPA requires site-specific analysis and discussion of Federal actions and their impacts, either in an a EA or in an EIS. NEPA categorically excludes routine administrative and management activities from that requirement. Generally, those include the administrative actions listed in chapter 3. Most of the major

actions proposed in the four alternatives and fully analyzed in this draft CCP/EA are described in enough detail to comply with NEPA, and would not require additional environmental analysis. The following projects fall into that category:

- Enhance refuge's priority public use programs.
- Create new trails, trail connections, observation towers, and parking facilities.

The following is a list of actions under alternatives B, C, and D that may require further NEPA analysis:

- Construction of a new headquarters facility, visitors center additions, and associated parking.
- Construction of a new or replacement of the bridge over Great Brook on Pleasant Plains Road at North Gate.
- Implement changes to the refuge's hunt program.
- Major changes to impoundment management.

3.3 Refuge Management Alternatives: Goals, Objectives, and Strategies

We designed four management alternatives that characterize different ways of managing the refuge over the next 15 years. Each alternative includes goals, objectives and strategies that were designed to enhance the quality, effectiveness, and sustainability of our management priorities. They include an array of management actions that, in our professional judgment, work toward achieving the refuge's purpose, vision, and goals, the mission of the Refuge System, and would make a significant contribution to conserving natural resources in the region. Accomplishing management strategies is dependent upon sufficient staff, funding, and continued participation of our conservation partners. Refer to section 3.0 above for an explanation of goal, objective, and strategy development.

Alternative A: No Action

Introduction

Alternative A satisfies the NEPA requirement of a "no action" alternative, which is defined as "continuing current management." Alternative A describes the refuge's existing management priorities and activities and serves as a baseline for comparing and contrasting alternatives B, C, and D. Alternative A portrays current, planned, and approved management activities. It describes projects planned, funded, or underway. Actions described under this alternative would be continued.

Also under alternative A, we would continue current levels of public use and outreach as described in chapter 2. Management would sustain these priorities as completely as possible within the limitations of current staffing, funding, and the present involvement of our conservation partners.

The refuge staff currently consists of the following permanent positions: a Wildlife Refuge Manager (GS-13); Deputy Wildlife Refuge Manager (GS-12); Contaminants Biologist (GS-12); Wildlife Biologist (GS-11); Visitor Services Manager (GS-12); Visitor Services Specialist (GS-7/9); Engineering Equipment Operator

(WG-10); Land Management Law Enforcement Officer (GS-7); and Maintenance Worker (WG-7). The refuge also includes one temporary staff: an administrative assistant (GS-4). The refuge also partially funds a temporary Fish and Wildlife Biologist (GS-7) stationed at Wallkill River NWR who also works at Great Swamp and Cherry Valley NWRs. An Administrative Officer located at Wallkill River NWR provides part-time support to Great Swamp NWR for budget, bill paying, purchases, and payroll.

The refuge has undergone numerous renovations recently, including improvements to the headquarters, Visitor Center, WOC, refuge quarters, Pleasant Plains Road, and the Wilderness Area. Recent renovations and improvements to the refuge headquarters include replacement of lights with high-efficiency fluorescent fixtures, installation of an emergency generator, insulation of ductwork, replacement of oil burner with a heat pump system, and repaving of the parking lot and service road to the shop. These renovations will make the headquarters more energy efficient thereby reducing the refuge's carbon footprint and providing long-term cost savings. Numerous interior and exterior repairs and renovations were performed on refuge quarters. Some renovations were undertaken to make the quarters more energy efficient, including replacement of windows, while others were necessary to bring the units up to code, such as upgrading of electrical systems. Other improvements included installation of vinyl siding, exhaust fans, and hardwired smoke detectors; replacement of exterior doors, a deck, well pumps, light fixtures, appliances, and gutters; repair of a septic pump; and painting.

Improvements to the Visitor Center included activation of an alarm system, the installation of a new informational kiosk in front of the building, and installation of a donated bench, which is made of 100 percent recycled plastic, along the Bockhoven loop trail. In addition, the *Friends* planted wildlife-friendly native gardens around the Center and recently opened a "Nature Detectives" trail for children. These improvements will enhance visitor's experiences. Renovations to the WOC included replacement of a well pump and drainage pipes; re-grading, graveling and paving of the entrance road and parking lot; installation of several donated 100 percent recycled material benches; and repairs to sections of the boardwalk.

Maintenance and improvements to refuge roads, trails and parking lots included re-grading, placement of gravel, repaving, repair of damaged boardwalks and bridges, installation of signs, and roadside ditch cleaning. On Pleas ant Plains Road, the manually operated North Gate was replaced with an automatic solar-powered gate. The automatic South Gate was also replaced, whic h included the installation of an energy efficient light emitting diode (LED).

The refuge also has multiple projects planned that have not yet started, including but not limited to:

- Install solar at Visitor Center and Headquarters.
- Covert Visitor Center and Headquarters from heating oil to natural gas.
- Replace Great Brook Bridge.
- Re-align Marsden's Corner on Pleasant Plains Road.
- Replace boundary, informational, and directional signs around refuge.
- Repave Pleasant Plains Road from the North Gate to the cul-de-sac.

- Replace broken pipe gates at service road entrances.
- Repair skylights in Pole Barns at the shop and Visitor Center.
- Replace perimeter lighting at Cement Plant and rewire interior lights.
- Refuge Quarters: install wood stove inserts, replace roof, replace windows, correct drainage problem, renovate bathrooms, replace flooring, interior painting, install vinyl siding, demolish two houses and one barn, replace heating oil tanks, and install generator transfer switches.

Continual maintenance, repairs, and renovations are necessary to ensure that refuge facilities, infrastructure, and equipment are safe and enjoyable for staff and the public to use.

USFWS/Gary Zahm

Many of the objectives in alternative A do not strictly follow the guidance in the FWS goals and objectives handbook because we are describing current management decisions and activities that were established prior to this guidance. Rather, our descriptions of these activities were derived from a variety of formal and informal management decisions and planning documents.

Map 3-1 illustrates the habitat management strategies of alternative A and map 3-2 illustrates the public use strategies.

GOAL 1: Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species and priority conservation species.

Objective 1.1 (Non-Forested Wetlands and Open Water)
Maintain approximately 1,000 to 1,050 acres of high quality non-forested wetland habitat with the following conditions: mix of vegetation, less than 15 percent invasive species, variety of native grasses, forbs, sedges and rushes, and shallow flooded areas. Emergent wetlands consist of wet meadows, freshwater emergent marsh, and open water wetland habitats.

Rationale
Wetlands, in general, are critical natural resources because they perform a variety of important functions, including improvement of water quality through nutrient cycling, prevention of shoreline erosion, flood attenuation, groundwater recharge, and critical habitat for a diversity of plant and animal species, as well as providing aesthetic and recreational opportunities (Balzano et al. 2002).

Since the 1780s, New Jersey has lost approximately 39 percent of its wetlands, from an estimated 1,500,000 acres to approximately 916,000 acres in the 1970s (Tiner 1985; Balzano et al. 2002). Approximately 20 percent of this loss likely occurred between the 1950s and 1970s (Balzano et al. 2002). Wetlands were drained primarily for crop production and pastures and filled for residential development,

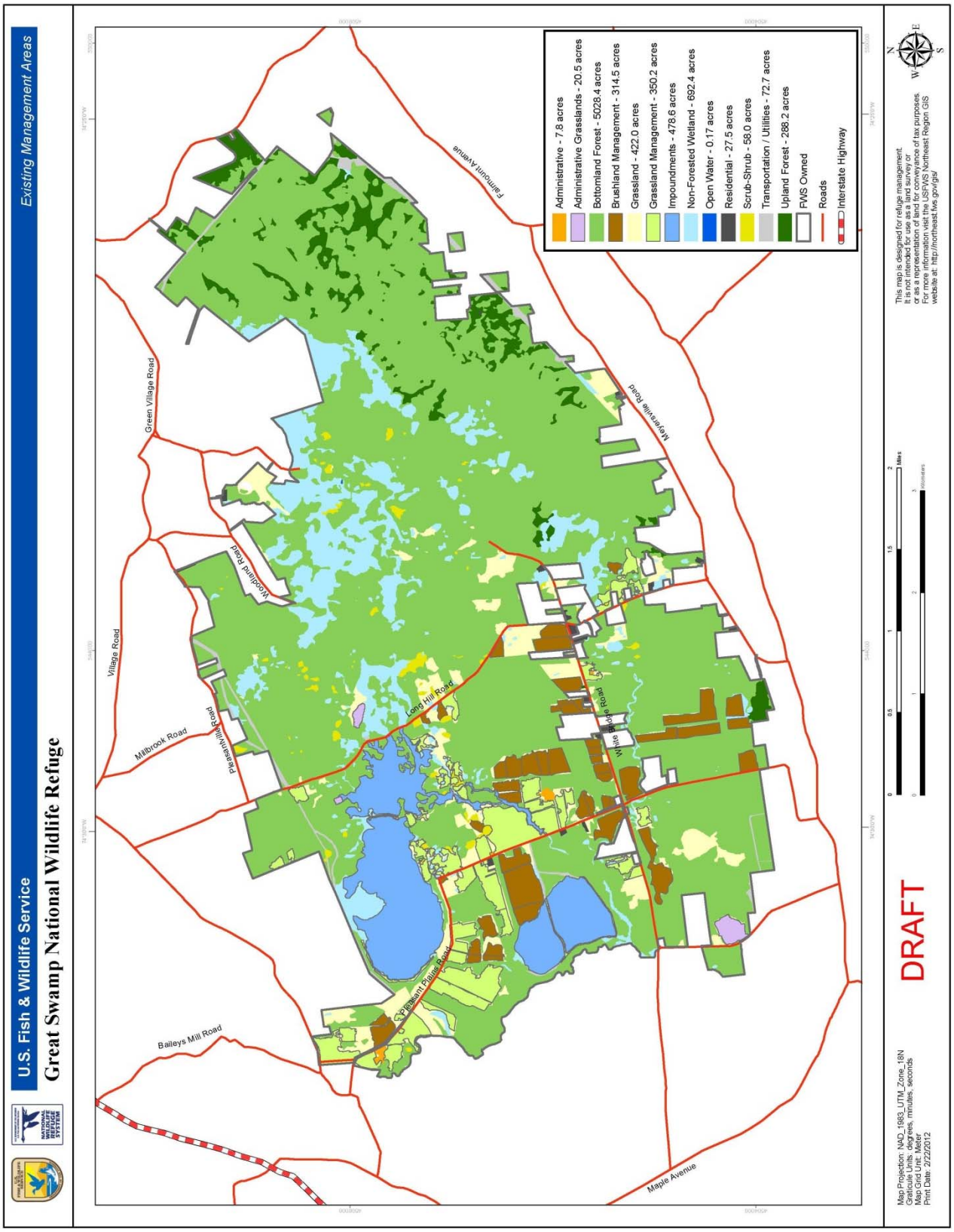
transportation, industrialization, and landfills. Despite the implementation of the Freshwater Wetlands Protection Act in 1987, wetlands are still being lost and disturbed in the state at a rate of approximately 150 acres per year between 1988 and 2001 (Balzano et al. 2002).

The Northern Piedmont Plains contains more than 9,880 acres (4,000 hectares or 15.4 square miles) of emergent wetlands, most of which occur in Great Swamp NWR, Hackensack Meadowlands, Black Meadows, and Saw Mill Creek Wildlife Management Area (NJDEP 2008a). As discussed in chapter 2, land uses that pre-date the refuge resulted in extensive logging to clear land for agriculture and for timber production, as well as extensive wetland ditching and draining. In the 1960s, refuge staff began plugging the previously constructed drainage ditches and creating short dikes with small water control structures in attempt to restore the previously drained wetlands. The refuge currently contains approximately 690 acres of non-forested wetlands and open water habitat, as well as 480 acres of impoundments (refer to objective 1.2 below for impoundments).

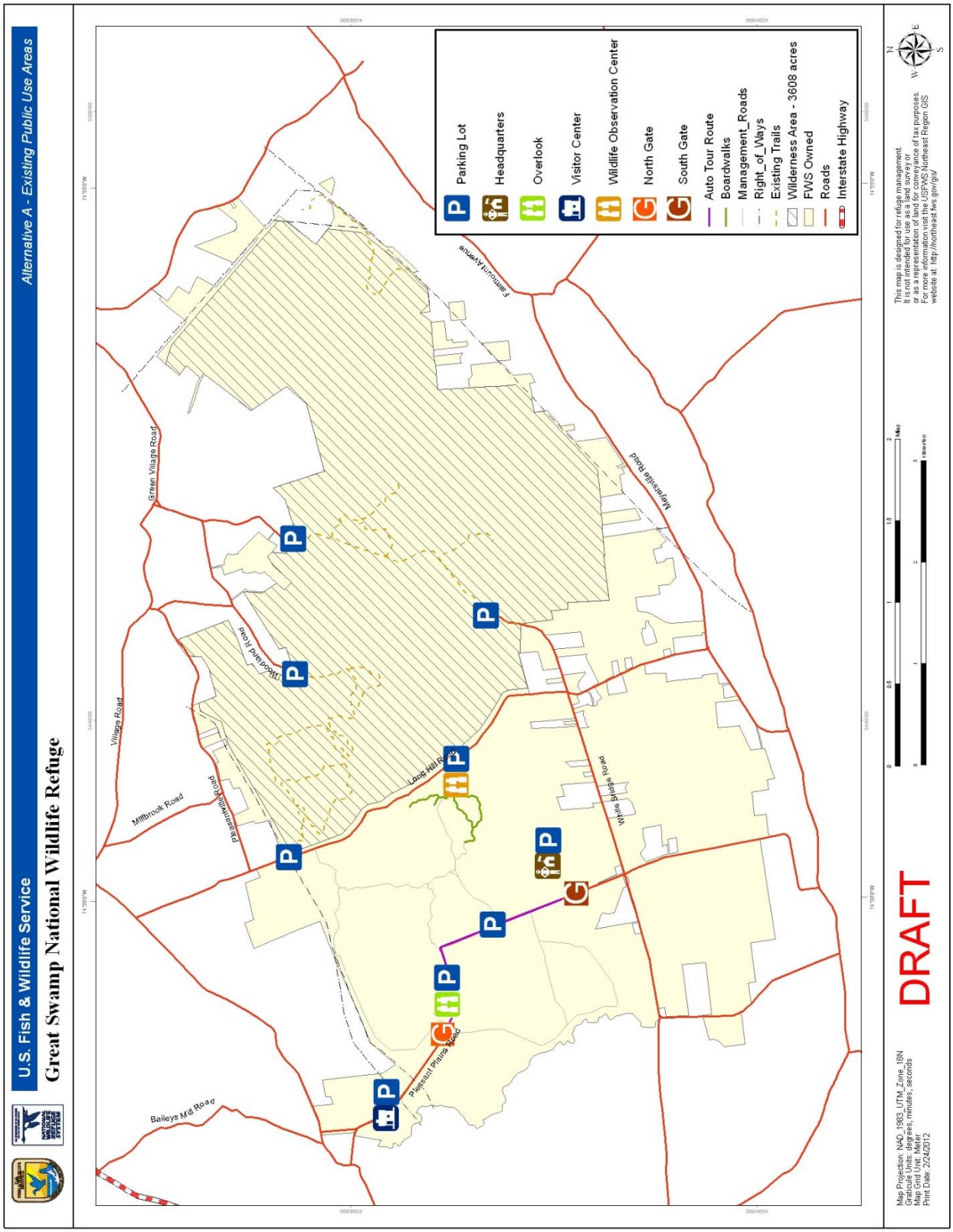
Since the primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl, maintaining a mixture of open water and open marsh will continue to benefit several waterfowl species listed as priorities (highest, high, or medium) in the BCR 28 and 29 Plans, including American black duck, Canada goose (migratory Atlantic), hooded merganser, mallard, wood duck, and other waterfowl species that comprise the many thousands of ducks that pass through the refuge during migration. These habitats also benefit other species, such as the pied-billed grebe, a species of management concern for the FWS in the Northeast region and a species of greatest conservation concern as listed under the NJWAP. Great Swamp NWR is recognized by the New Jersey Important Bird Area (IBA) Program for providing breeding, foraging, and wintering habitat for various waterfowl species, including American black duck, mallard, northern pintail, American widgeon, and green-winged teal. Waterfowl was one of the important criteria utilized in designating Great Swamp NWR as an IBA.

In addition to migratory waterfowl, the refuge's non-forested wetlands and open waters provide habitat for a variety of birds, reptiles, and amphibians, including the bog turtle. The Northern population of the bog turtle is federally listed as a threatened species and State-listed as endangered. The New Jersey NHP's ranking system identifies the bog turtle as G3 (globally, either very rare and local throughout its range or found locally in restricted range because of other factors making it vulnerable to extinction throughout its range) and S1 (critically imperiled in New Jersey because of extreme rarity) (Natural Heritage Program 2008). The NJWAP lists the species as a high priority with a goal to increase and stabilize the population in the Piedmont region of New Jersey. Among the contributing factors to the decline of bog turtles is habitat destruction due to development; illegal collection; wetland ditching, flooding and filling; water quality degradation; and forest succession or invasive species encroachment. Bog turtle populations inhabit areas on refuge, which are locally uncommon and unique. Bog turtles require open wetlands, generally with a scrub/shrub component, with perennial groundwater seepage and typically several inches of mucky substrate (generally greater than 4 inches). Protection of this species' habitat will benefit other key refuge resources of concern, including the spotted turtle, wood turtle, American bittern, and northern harrier.

Threats to the refuge's non-forested wetlands and open water habitats include invasive species, particularly purple loosestrife and common reed; increased flow and sedimentation from upstream development; water quality degradation (i.e., non-point source pollution); altered hydrology due to historic ditching and channeling; flooding and drought; forest succession; and lack of occasional fire.



Map 3-1: Existing Habitat Management



Map 3-2: Existing Public Use Opportunities

Active management of non-forested wetlands and open water habitat in the Management Area consists primarily of invasive species control (i.e, purple loosestrife and common reed grass) and where necessary, suppression of woody plant succession. Suppression of woody plant succession and invasive species is critical to maintain quality basking and nesting habitat for various herptile species. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques, very little active management occurs in these areas since this area historically experienced less land alteration and as a result, has fewer occurrences of invasive species.

Strategies:

- Continue to conduct invasive species management, when and where necessary. Some examples of management include the release of *Galercucella* spp. beetles to control purple loosestrife and application of herbicides to control common reedgrass.

- Continue to manage select fields through a rotational mowing program. Management does not currently include prescribed burning.

- Continue to maintain and restore, when necessary, bog turtle and wood turtle habitats.

- Continue to permit the release of raptors, waterfowl, and other species from The Raptor Trust at the refuge.

- Continue to conduct vegetation and wildlife surveys, such as waterfowl banding data collection and bog turtle and wood turtle surveys to monitor trends, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys and research.

Objective 1.2 (Impoundments):
Maintain the five impoundments, encompassing approximately 485 acres, with the following conditions: water levels ranging between 0-18 inches (averaging 6-12 inches); mix of native vegetation dominated by native forbs, grasses, and aquatic plants for the benefit of wildlife, particularly waterfowl, and restrict invasive species to less than 15 percent cover.

Rationale
The emergent wetlands and open waters of the refuge provide vital wintering and breeding habitat for a variety of waterfowl. The emergent plant community also provides a rich environment for aquatic macroinvertebrates, which in turn provides an important food source for wildlife, especially waterfowl and wading birds. Between 1969 and the early 1980s, five impoundments with low level dikes and water control structures were constructed in order to provide wildlife habitat and influence plant composition and abundance. The refuge currently manages the impoundments for marsh habitat that contains a diversity of wetland vegetation similar to natural marsh habitat in northern New Jersey. Waterfowl breeding and foraging habitat has traditionally been a major focus of management at Great Swamp NWR and the protection of waterfowl is a key element of the refuge's original purpose. The primary objectives of the impoundments are to maintain and improve native emergent vegetation communities, to increase habitat diversity within a wetland, and to provide open water for the resting, staging and foraging activities of

migratory and resident waterfowl. Because of the water level differences within individual impoundments, often a single impoundment will help meet multiple objectives within the same year.

The refuge's impoundments encompass approximately 480 acres and are diverse, including areas of emergent, scrub-shrub and forested wetlands. Pool 1 consists of approximately 116 acres and receives water from Great Brook, Middle Brook, and direct precipitation. This pool contains primarily herbaceous species with some open water and buttonbush stands. The dominant vegetation in Pool 1 is cattail, burreed, mild water pepper, wool grass, buttonbush, bulrush, and willow. The purpose of Pool 1 is to provide waterfowl roosting, brooding, feeding, resting, and loafing habitat during migration (USFWS 1987; USFWS 2003b).

Pool 2 consists of approximately 295 acres and receives water from Primrose Brook, Great Brook, and precipitation (USFWS 2003b). This pool contains persistent herbaceous vegetation, as well as a high diversity of red maple swamp and flooded timber (USFWS 1987). The dominant plants are cattail, swamp rose mallow (*Hibiscus moscheutos*), burreed, wool grass, smartweeds (*Polygonum* spp.), pickerelweed, common reed grass, willows, and some live and standing dead timber in the northwest section of the impoundment (USFWS 2003b). The purpose of Pool 2 is to provide habitat for wildlife, particularly passerines and waterbirds, as well as roosting and feeding habitat for waterfowl during migration (USFWS 1987; USFWS 2003b).

Pools 3A and 3B encompasses approximately 55 and 88 acres, respectively, and are naturally occurring marshes with a mixture of herbaceous vegetation. Pool 3A is dominated by burreed, cattail, wool grass, buttonbush, and various other shrubs. Pool 3A receives water from Pool 2 via a feeder ditch Water Control Structure (WCS) #23, Pool 3B via WCS #34, and precipitation (USFWS 2003b). The pool was managed as a green timber impoundment favoring mast production of oaks (USFWS 1987). Pool 3B receives water from Pool 3A through WCS #34, Middle Brook via WCS #35, and precipitation. The pool is characterized by stands of cattail, buttonbush, and various other shrubs, ash (*Fraxinus* spp.), willow, red maple (*Acer* rubrum), pin oak (*Quercus palustris),* bulrush, swamp rose mallow, burreed, tussock sedge (*Carex* spp.), arrow arum, purple loosestrife, and common reed grass. The purpose of Pools 3A and 3B is to provide feeding and roosting habitat for waterfowl during migration (USFWS 2003b). The pools are frequently used by migratory waterfowl, herons, bitterns, rails, and marsh wrens (USFWS 1987).

Middle Brook Pool is approximately 17 acres in size and receives water from Pool 1 through WCS #5, and a 100-foot emergency spillway between Pool 1 and Middle Brook, and some small ponds, during times of flooding (USFWS 2003b). The upper reaches of the pool are dominated by tussock sedge. During a draw down, the lower portions of the pool are dominated by smartweeds, millets, sedges, burreed, wool grass, cattail, and swamp rose mallow (USFWS 2003b). Middle Brook Pool is used by nesting waterfowl and as a loafing area for Canada geese (USFWS 1987). The purpose of this pool is to provide feeding and roosting habitat for migratory waterfowl (USFWS 2003b).

Water levels are generally maintained between 6 to 12 inches; however, water levels can vary between 0 to 18 inches in some areas of the impoundments. Some impoundments are drawn down periodically (i.e., every 7 years) to alter plant composition and thereby provide a diversity of habitats among the impoundments (USFWS 2003b). During a drawdown year, the water is drawn down for one growing season which allows annual plant species to germinate and mature. The residual seeds from these annuals provide migratory and resident waterfowl with a nutritious food source when the pool is re-flooded

in late-summer/early fall. Dead and decomposing plants also provide food for many kinds of invertebrates that, in turn, provide a protein source for waterfowl, wading birds, shorebirds, and herptiles, such as spotted turtles and wood turtles. The cover from the perennials, with scattered openings, provides ideal conditions for waterfowl broods and migrating waterfowl. Additionally, the interspersion of emergent vegetation and small irregular water areas results in habitat conditions suitable to marsh-nesting birds.

In addition to the five major impoundments, a small 4-acre impoundment was constructed near the refuge headquarters to serve as an observation pond for visitors. This pond is particularly popular with visitors in the season following a mechanical set back of plant succession and is often considered a "must stop" for birders (Byland 2001). Early in the season the water is held at a depth of 4 to 6 inches to attract early waterfowl migrants. Every few years, the impoundment is drawn down completely after the shorebirds have left and the soils are disked to set back perennial plants. Water is pumped back into the impoundment a few weeks later to create a moist soil condition. The most common plants observed in the impoundment include sedges, pondweeds (*Potamogeton* spp.), blunt spikerush (*Eleocharis obtusa*), common water plantain (*Altisma plantago-aquatica*), and seedbox (*Ludwigia alternifolia*) (USFWS 2003b). Although much smaller than the impoundments, this pool attracts a variety of shorebirds in numbers that compare to or occasionally exceed the larger impoundments (Byland 2001).

Strategies:

- Continue to manage impoundments as natural marsh habitat with similar vegetation and characteristics as marsh habitat in northern New Jersey.
- Continue to maintain impoundments with minimal manipulation, except conduct draw-downs every 7 years to mimic a natural drought cycle.
- Continue to conduct repair and/or maintenance of water control structures, as needed.
- Continue to capture and relocate beaver, when necessary, to prevent dam building and flooding in undesired areas.
- Continue to conduct vegetation and wildlife surveys, such as waterfowl banding data collection and marsh bird surveys, to monitor trends, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct wildlife and vegetation surveys and research.

GOAL 2: Create and maintain an interspersion of scrub-shrub, grassland, and successional wet meadows comprised of native vegetation at various successional stages to enhance breeding and foraging habitat for priority species of conservation concern.

Objective 2.1 (Grasslands)

Maintain approximately 375 acres of high quality grassland habitat with the following conditions: a mix of vegetation with heights ranging from 3 to 36 inches; less than 15 percent invasive species; and a mix of native grasses and forbs for the benefit of native wildlife species.

Rationale

USFWS/Steve Maslowski

Prior to the Revolutionary War and through the early-1900s, much of the GSW was logged and cleared for agriculture, primarily "foul meadow" hay. Grassland species, such as Eastern meadowlarks, bobolinks, upland sandpipers, woodchucks, and voles increased as hayfields and pastures expanded during the early 19th century (Foss 1992; Foster and Motzkin 2003). Repeated attempts at draining, ditching, and stream alteration occurred in the Great Swamp Basin through the mid-1900s. Failure to effectively drain and manage flooding of the swamp eventually caused farming to be abandoned as unprofitable and too difficult to maintain and many farmers moved away. By the 1940s and 1950s, many of the remaining farmhouses were occupied by non-farming families, commuters, and local business owners, and abandoned farm fields began to naturally re-vegetate. After the establishment of the refuge, acquired fields that were managed for haying when in private ownership were continued to be managed as grasslands or early-successional wet meadows with shrub cover ranging from 6 to 60 percent, depending upon mowing frequency (Sneddon 2008).

The grassland management program maintains approximately 350 acres of permanent grass and nesting cover. Individual fields are generally small, ranging in size from less than 1 acre to 49 acres (USFWS 1987). The grassland fields require active management to prevent natural plant succession. Thirty six (36) fields are maintained in a desired stage of succession by mowing and cutting of woody vegetation on a 1 to 3 year rotational basis. Between 150 and 250 acres are mowed each year. Rotational mowing generally takes 2 to 3 weeks per year to accomplish by refuge staff. Select small, isolated fields were eliminated from the mowing program to allow succession to scrub-shrub after the Biological Review (2006) determined these fields are non-beneficial to grassland birds (Bitler 2011). Mowed fields also increase the visibility of various wildlife species for the public, improve overall aesthetics, and reduce wildfire potential (USFWS 1987).

The grassland fields provide food for various rodents, green browse for wildlife, and suitable hunting areas for raptors and other predators. The fields are frequently used by various songbirds, including the eastern bluebird. In 1976, the refuge began a bluebird nest box program. There are approximately 160 boxes on the refuge, which are maintained primarily by volunteers. Great Swamp NWR has one of the largest breeding populations of bluebirds in New Jersey because of this highly successful nest box program.

Threats to the refuge's grassland habitats include invasive species, particularly multiflora rose; succession to scrub-shrub or forest; and altered hydrology due to historic trenching, ditching and channelization. Some on-site early successional upland grasslands have management constraints due to the presence of remediated landfills and must be maintained as open fields as part of the O&M requirement.

Strategies:

- Continue to perform rotational mowing of grassland fields within the Management Area on 1 to 4 year rotational basis.

- Continue to conduct invasive species management, when necessary.
- Continue to conduct vegetation and wildlife surveys, such as breeding bird surveys, to document species and trends.
- Continue to cooperate with partners, students, and volunteers, such as New Jersey Audubon Society, to conduct vegetation and wildlife surveys and research.
- Continue to cooperate with partners, such as the Friends of Great Swamp, to maintain and monitor existing artificial nesting and roosting structures.

Objective 2.2 (Scrub-Shrub)

Maintain approximately 315 acres of actively managed scrub-shrub habitat with the following characteristics: varying stages of shrub succession; mix of native woody vegetation and herbaceous vegetation for the benefit of wildlife, especially American woodcock, and less than 15 percent invasive species.

The refuge contains approximately 55 acres of naturally-occurring scrub-shrub habitats consisting of varying stages of succession containing a mix of native woody and herbaceous vegetation; areas of persistent saturation or ponding; and less than 15 percent invasive species. These areas require less management to maintain as opposed to the more heavily managed areas described in the preceding paragraph. For example, refuge staff would conduct monitoring and respond to invasive species as necessary.

Rationale

In the United States, scrub-shrub habitats are found in natural systems, as well as in human altered systems, such as old fields and utility right-of-ways. Scrub-shrub habitats are characterized by low, multi-stemmed woody vegetation in young or stunted stages of succession. These habitats may be densely clustered or consist of a mosaic of low woody cover interspersed with herbaceous cover (USDA 2007). Trees may be present, but are widely spaced or scattered. Habitats consisting of woody shrubs and herbaceous plants have structural diversity that provides nesting sites, escape cover, and food for wildlife (Oehler et al. 2006). The edges of scrub-shrub habitats also provide hunting areas for predatory birds, such as kestrels (USDA 2007).

Early successional wildlife habitats have become critically rare in much of the eastern United States, especially in the Northeast, primarily due to land use changes (DeGraaf and Yamasaki 2003; Oehler 2003). Regional threats to these habitats include forest succession, multiple mowings in a single growing season, invasive species, and clearing for agriculture, residential, and other urban uses. Early successional habitats are less common than they were in pre-settlement times in several regions of the Northeast, specifically southern and south-coastal New England and the coastal mid-Atlantic region. The landscape of the Northeast is dominated by man-altered habitats and human uses; therefore, maintaining early-successional habitats similar to pre-settlement levels is not possible (DeGraaf and Yamasaki 2003).

The refuge actively manages approximately 315 acres of scrub-shrub habitat, also known as brushland. The managed scrub-shrub fields are mowed or cut on 2 to 6 year rotational cycles to maintain a desired stage of succession; however, rotational cycles may be delayed up to 8 years due to access or equipment issues. The refuge includes an interspersion of habitat types produced by the management of grasslands

and brushlands, which substantially increases ecotonal areas and promotes wildlife diversity (USFWS 1987). Well-managed scrub-shrub habitats are critical for birds (USDA 2007).

Natural shrublands are among the most endangered ecosystems in the United States (DeGraaf and Yamasaki 2003). The refuge contains approximately 55 acres of natural shrublands. The refuge's naturally occurring shrub-swamp and wooded marsh habitat types range from seasonally wet scrub-shrub wetlands to permanently or semi-permanently flooded tussock sedge wooded marsh, containing shrubs and young trees growing on hummocks. These naturally occurring shrub habitats support many bird species of high priority in BCR 28 and 29 Plans during nesting and/or during migration, including blue- and golden-winged warblers, Canada warbler, field sparrow, willow flycatcher, and Eastern towhee. The golden-winged warbler, currently being considered for Federal listing, occasionally utilizes the refuge. In addition to birds, herptile and mammal resources of concern benefit from these habitats.

Most wildlife associated with natural scrub-shrub and early successional habitats were once considered generalist species; however, these species have since been determined to be specialists in vegetation structure or area requirements (DeGraaf and Yamasaki 2003). One hundred thirty-nine species of reptiles, amphibians, birds, and mammals either prefer (17 species) or utilize (122 species) shrub and old field habitats (Oehler et al. 2006). Of 40 bird species associated with shrubland habitats, 22 are experiencing significant population declines in the eastern United States (Oehler et al. 2006). A few species in the region are limited to non-forested habitat types, including the northern harrier (*Circus cyaneus*), savannah sparrow (*Passerculus sandwichensis*), and vesper sparrow (*Pooecetes gramineus*) (DeGraaf and Yamasaki 2003). Certain scrub-shrub bird species have not adapted to suburban conditions, such as brown thrashers (*Toxostoma rufum*), eastern towhees (*Pipilo erythrophthalmus*), and field sparrows (*Spizella pusilla*), and as a result, are now declining across the region (DeGraaf and Yamasaki 2003). In addition, 58 species of butterflies and moths in the Northeast are dependent upon shrublands, 56 of which are considered rare (Oehler et al. 2006).

One wildlife species that uses scrub-shrub habitat at the refuge is the American woodcock. The American woodcock is identified as highest priority in BCR 28 and a high priority in BCR 29. This species is also identified as a high continental concern and high regional responsibility for both PIF Physiographic Regions 9 and 10. The NJWAP sets a population goal for the Piedmont Region to increase this species. Woodcock was also identified as a priority in the North American Shorebird Plan for the Atlantic Flyway. The American woodcock, a key early successional management species, is a FWS priority species that has responded well to the staggered rotational management at Great Swamp NWR. According to a Biological Review Report for Great Swamp NWR, the refuge's woodcock data (singing route surveys between 1985 and 2006) indicated relatively stable populations relative to declining statewide populations (USFWS 2006). Under the refuge's current Upland Management Plan (1988), a total of 477 acres were targeted specifically for woodcock management with four cover type needs (singing grounds, feeding, nesting, and roosting cover). Areas were identified to be cut on a staggered rotation to provide field, brush, and early successional stages. An additional 131 acres were targeted for brushland habitat to increase wildlife diversity (USFWS 2006). In addition to American woodcock, management of these habitat types also benefit a suite of wildlife species at the refuge. According to the Biological Review Report (2006), field surveys suggest that the refuge supports fair numbers of scrub-shrub birds, including willow flycatcher, eastern kingbird, gray catbird, brown thrasher, eastern towhee, indigo bunting, and field sparrow.

Strategies

Management of All Scrub-Shrub Habitats

- Continue to conduct invasive species management, when necessary.

- Continue to periodically conduct breeding bird surveys in shrub communities to identify species and monitor trends, especially for birds of conservation concern.

Management of Actively Managed Scrub-Shrub Habitats:

- Perform rotational mowing and cutting on 2 to 6 year cycles to maintain desired stage of succession and prevent succession to forest habitat.

GOAL 3: Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Objective 3.1 (Forest)

Maintain between 6,000 and 6,500 acres (4,000 to 4,500 acres of bottomland forest; 1,500 to 2,000 acres of upland forest) of forest with the following characteristics: interspersion of mixed aged, native bottomland and upland forest habitats with less than 15 percent of invasive species; areas of persistently flooded bottomland forest; and approximately 35 acres of known woodland vernal pool habitat.

Rationale

Prior to European settlement, the composition and density of forests within the region may have been modified through fires set by Native Americans. Several land surveys conducted in the area in the early 1700s documented tree species such as swamp white oak, maple, poplar, beech, elm, and ash (Harris and Ziesing 2010). Prior to the Revolutionary War, early settlers logged the land that presently encompasses the refuge, particularly in the eastern portion (present day Wilderness Area), and farmed much of the open areas and shrub communities of the western portion of the refuge (Momsen 2007). Records suggest that by the mid-1800s, a majority of the lowest elevations in the Great Swamp basin may have been logged. Repeated attempts at draining, ditching and stream alteration occurred through the mid-1900s. Failure to effectively drain and manage flooding of the swamp eventually caused farming to be unprofitable and too difficult to maintain and many farmers moved away. By the 1940s and 1950s, abandoned farm fields began to naturally re-vegetate. Recent threats to New Jersey's forests include habitat fragmentation; invasive species; development and associated encroachment; change in hydrology (i.e., increase in flooding, siltation, erosion) due to development; browsing pressure by white-tailed deer; forest succession to a climax stage (impediment to regeneration); and parasites, disease, and infestations, such as gypsy moth, Dutch elm disease, bacterial leaf scorch, and chestnut blight.

As discussed in section 2.1.5, the soil disturbances caused by agriculture resulted in soil homogeny (mixing) and depletion of key elements, such as carbon and nitrogen, which can last for decades or longer (Momsen 2007). In addition, late season harvests left agricultural soils exposed to harsh winter weather and subject to erosion. These soil impacts may have influenced current vegetation structure and composition. The dichotomy of vegetation patterns in the eastern (Wilderness Area) and western portions (Management Area) of the refuge reflect, in part, the differences in historic land use and land cover. The eastern portion of the present day refuge, while disturbed through logging, was not subject to the intensive soil and hydrologic alteration that resulted from agricultural practices. The western portion of the refuge

has undergone soil disturbance from the clearing, ditching, and plowing associated with farming. As a result, the present day Wilderness Area vegetation patterns are consistent with the influence of post-glacial deposits that characterize the geologic history of the region. The pin-oak swamps and other vegetation communities of the western portion of the refuge more reflect post-colonization agricultural use (Momsen 2007).

The Northern Piedmont Plains contains approximately 82,780 acres (33,500 hectares or 129.3 square miles) of forest, including upland, wetland and riparian habitats (NJDEP 2008a). The largest patches of forested land occur in a scattered network of public natural lands, with the largest patch in Great Swamp NWR (NJDEP 2008a). The largest contiguous bottomland forested areas are located within the Wilderness Area of the refuge. These areas are dominated by red maple in the canopy. The Management Area of the refuge contains a mosaic of tracts of bottomland forest habitat, primarily in the southwestern and western portions of the refuge. The majority of upland forested areas are centrally located on the refuge and are dominated by American beech and oak species. Small upland "islands" of hardwood forest, dominated by American beech and chestnut oak (*Quercus prinus*), are also scattered throughout bottomland forest habitats within the Wilderness Area.

Active management of forested areas in the Management Area consists primarily of invasive species control (i.e., Japanese barberry and Japanese wisteria) and selective thinning to encourage understory growth. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques, very little management occurs in these areas since this area historically experienced less land alteration and as a result has fewer occurrences of invasive species.

Forests of Great Swamp NWR are known to support several priority resources of concern, including Indiana bat, barred owl, and various forest dependent birds (i.e., wood thrush). The Indiana bat is a federally and State-listed endangered species; the NJWAP has been targeted for increase in Piedmont populations of this species. The refuge is documented as having maternal roost colonies for Indiana bat in New Jersey (Kitchell 2008). Maternal roosts are typically established in agricultural areas with fragmented forests. Roosting by Indiana bat occurs within the Management and Wilderness Areas of the refuge where an interspersion of forests, scrub-shrub, open water, and wet meadow exists (Kitchell 2008). Foraging occurs primarily in and around forested habitats that include pole-stage mixed-oak forest, floodplain forest, upland forest, and forested wetlands (Butchkoski and Hassinger 2002; Gardner et al. 1991; Humphrey et al. 1977; Murray and Kurta 2004; Romme et al. 2002, Sparks et al. 2005). Pregnant or lactating bats forage primarily within wooded or riparian corridors, streams, associated floodplain forests, and impounded bodies of water; however, they will sometimes use hedgerows, upland forest, early successional fields, and croplands (Kitchell 2008). Refer to section 2.6.1 for additional details on the habitat preferences and requirements of the Indiana bat.

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The barred owl is a State-listed threatened species, which also has been targeted for increase in Piedmont populations in the NJWAP. Forests within Great Swamp NWR support a significant population of this

species. Barred owls require large tracts of undisturbed forest dominated by mature and old growth stands and high canopy cover (Bosakowski et al. 1987; Bosakowski 1989). Barred owls prefer older stands but earlier stages of forest succession will be used if a suitable number of large diameter trees or snags is present (Allen 1987). In eastern North America, barred owls generally maintain established territories year-round with home ranging from 213 to 914 acres in size (Beans and Niles 2003). Although the barred owl is most often associated with densely forested woodlands, this species is not restricted to specific vegetative associations in their foraging activities. These owls have been documented foraging for amphibians traveling to and from vernal pools (Kenney and Burne 2002). Deciduous forests, especially riparian and lowland areas, are the most frequently recorded forest types for nesting throughout North America. A typical nest tree is tall, decadent, and has a suitable cavity or a nest site greater than 25 feet above the ground (Allen 1987). Barred owls have been known to use hawk nests when tree cavities are not available (Beans and Niles 2003). Owl sites were located a considerable distance (mean of 2,204 feet) from houses and other buildings (Bosakowski and Smith 1997), showing a significant avoidance of human disturbance and habitat alteration in northern New Jersey. This species demonstrates long-term site fidelity in areas that remained undisturbed (Bent 1937; Bosakowski et al. 1987).

The refuge supports various forest-interior breeding birds including wood thrush, eastern wood peewee, scarlet tanager, veery, and red-eyed vireo. The wood thrush is of the highest rank in BCR 28 and a high priority in BCR 29. Both PIF Physiographic Areas 9 and 10 designates this species as the highest (1A) priority. Wood thrush is listed as both a Bird of Conservation Concern and a Species of Regional Concern for the USFWS. Robbins (1979) estimated that a minimum area of 247 acres is required to support a viable breeding population of wood thrush. The forest patches required by this species for successful reproduction result in the protection of numerous other migratory and breeding forest interior birds at Great Swamp NWR, including but not limited to Cerulean warbler, Canada warbler, Prothonotary warbler, Louisiana waterthrush, veery, Cooper's hawk, red-headed woodpecker, Acadian flycatcher, and eastern screech owl.

The refuge currently maintains approximately 200 wood duck nesting boxes, which are established within bottomland forest and scrub-shrub areas. Each year, the wood duck boxes are maintained and monitored by refuge staff and volunteers. According to the biological review (2006), the refuge has had a successful wood duck box program with consistent data collection, documentation, evaluation, and box maintenance. Data collected at Great Swamp NWR was highly influential in the development of national recommendations for proper box placement and the reduction of dump nesting.

The refuge contains approximately 35 acres of vernal pool habitat. Vernal pools are essential habitat for portions of the life cycles of many species, and are also the favored habitat for considerably more species, particularly amphibians, that use them for breeding and foraging in an area of reduced predation (Kenney and Burne 2002). Vernal pool habitats support many other priority species, including spotted turtle and wood turtle, and may occasionally be utilized by barred owls for foraging. Vernal pools are indispensable to biodiversity both locally and globally. In New Jersey, seven species are dependent on vernal pools (i.e., obligate vernal pool species), including blue-spotted salamander and wood frog (New Jersey Division of Fish & Wildlife 2008). In New Jersey, threats to vernal pool habitat include development, which often results in filling and clearing of surrounding vegetation; change in hydrology due to irrigation wells; overuse of fertilizers and pesticides; and mosquito control efforts (biological, chemical, and hydrological changes). Roadways near vernal pool habitats also contribute to high mortality due to vehicular traffic during annual migrations by amphibian species. Protection, maintenance, and enhancement of vernal pools, as well as the surrounding vegetated buffer, are critical for vernal pool-dependent wildlife. The refuge's vernal pools

are monitored annually in early spring for amphibian presence and reproduction as part of an on-going USGS study. Habitat management of the vernal pools includes tree thinning and installation egg mass attachment sites, such as logs.

Strategies

- Continue to conduct invasive species management, as necessary.
- Continue to allow dead trees and snags to persist (i.e., no cutting or removal) for various wildlife species, including bats, woodpeckers, owls, and other wildlife species.
- Continue selective cutting using chainsaws or other techniques.
- Continue to maintain existing Atlantic white cedar (*Chamaecyparis thyoides*) plantings.
- Continue to maintain wood duck boxes and perform nest box checks.
- Continue to conduct vegetation and wildlife surveys, such as Indiana bat surveys, to monitor trends, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys, such as bat emergence counts.
- Continue to monitor, maintain, and restore vernal pool habitat, where practical.

GOAL 4 Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Objective 4.1 (Hunting)

Maintain the deer population at a level that does not negatively impact wildlife habitat and the integrity of ecological communities and provide quality, safe, compatible hunting opportunities according to State regulations and seasons through a refuge permit system.

Rationale

During the winter of 1969 to 1970, formal complaints of excessive deer herbivory were received by both the refuge and the State. Moderate to severe browse lines were apparent on plantings around refuge residences, at the WOC, and on adjacent properties. Heavy browsing occurred on many plant species including red maple, red cedar, spruce, blueberry, white pine, yew, and arborvitae. Refuge and State personnel determined that the deer herd exceeded the carrying capacity of the environment and that deer damage would continue if control was not instituted. Control through hunting was deemed most desirable from administrative, economic, recreational, and practical standpoints (USFWS 2009).

The first deer hunt was held in 1974. Deer hunting is the only form of hunting currently authorized on the refuge. The annual deer hunt occurs every fall and consists of five days; including a 1 day youth hunt,

followed shortly thereafter by a 4 day general hunt. Hunting follows the New Jersey State Statutes and Regulations; detailed regulations and information are included in handouts sent to each of the hunters that purchase hunting permits for the refuge. Regulations are also published in the State's annual hunting digest. The first Deer Hunting Plan was submitted and approved in 1973, and subsequently revised and approved in 1979 and 1987. A draft 2009 plan has been prepared; however, this plan is being held pending completion of the CCP. Deer Hunt Programs are prepared annually under the scope of the current approved Hunt Plan. The draft Deer Hunting Plan states that approximately 275 hunters will be allowed in the field at any one time yielding a maximum hunter density of approximately one hunter per 23 acres (USFWS 2009); however, in 2011, the hunter density was one hunter to 35 acres (USFWS 2012h). Deer hunting is permitted on approximately 82 percent of the total refuge area with the remaining area designated as Safety Zones around residences, facilities, and roads. There are 31 parking lots available throughout the refuge to distribute hunters and facilitate access for this public use.

The primary goals of the refuge's Deer Hunt Program are to: (1) Maintain a white-tailed deer population that allows for a diverse and healthy forest understory and assures continuing production of tree seedlings to maintain forest cover in perpetuity; (2) Avoid a truncated buck age class structure and maintain a more natural buck age class distribution; and (3) Provide a safe and high quality outdoor experience for refuge deer hunters (USFWS 2012h). To achieve these goals, harvest strategies and regulations are implemented, evaluated annually, and adjusted when necessary to carry out the objectives of the Program. Program objectives are to: (1) maintain deer at a moderate density of 20 deer per square mile; (2) maintain a male age class structure where at least 30 percent of the bucks are greater than or equal to 3 years old; and (3) implement necessary safety precautions to prevent accidents (USFWS 2012h).

White-tailed deer are an integral part of the wildlife resources found at the refuge. They are enjoyed by the viewing public and by hunter s that participate in the annual public hunt. Deer, at a moderate density, provide critical ecological functions in contributing to plant species diversity and nutrient turnover. For example, deer browsing reduces the dominance of shrubs that form dense thic kets, facilitating growth of other species, and thus, promoting ecological diversity (Royo et al. 2010). Deer also represent a significant vector of seed dispersal via in gestion and subsequent defecation (M yers et al. 2004), and serve as important seasonal prey to coyotes, bobcats, black bears (Miller et al. 2003, Turner et al. 201 1, Northeast Deer Technical Committee 2009). However, in the abs ence of the intense predat ion pressure in which deer populations evolved, the spec ies has the potential to grow bey ond its biologic al carrying capac ity (BCC) at a local and regional scale (Northeast Deer Technical Committee 2009).

While deer at moderate densities serv e critical ecological functions, deer at high densities are known to significantly and negatively impact forest health. Overbrowsing can eliminat e the woody and herbaceous understory layer in forest stands, in cluding seedlings and saplings of canopy trees. Rare plants may be lost entirely and the under story vegetation may become dominated by unpalatable plants [e.g., ferns, grasses, and sedges (Hors ley et al. 2003); striped maple, American beech (Kain et al. 2011) ; and sugar maple (Anderson and Katz 1993)]. Less palatable, inva sive plants (e.g., Japanese barberry) also may become established, outcompete native regenerating plant s and become pervasive in the understory (Tilghman 1989, Miller et al. 1992). Ultimately, ov erbrowsing reduces habitat quality and r esults in the decline of many species that depend on well-developed, native understory. Long-term, forest composition changes, succession is altered, and the result is a loss of ecological diversity (Warren 1991, Rooney 2001, Horsley et al. 2003, Cote and Rooney 2004, Crimmins et al. 2010, Kain et al. 2011, Tanentzap et al. 2011). Competition for food, shelt er, resting, and rearing cover becomes greater between wildlif e species when

deer populations exceed the refuge's carrying capac ity. Overabundance of deer populations is one of the most challenging problems facing wildlife managers (Warren 1997).

In addition to reducing for est health, overpopulated herds exhibit reduced herd health, manifested by increased prevalence of parasites and disease, reduced body weights, and lower reproductive and winter survival rates (Miller et al. 2003, Northeast Deer Technical Committee 2009). High deer densities also increase the extent that hum an-wildlife conflicts occur, such as a greater number of deer/vehicle collisions, increased damage to landscape plants and agricultu ral crops, and an increas ed abundance of deer ticks (*Ixodes dammini*) that spread Lyme disease (Miller et al. 2003; Northeast Deer Technical Committee 2009). In the early 1970s, the refuge document ed severe "browse lines" in forested habitat due to exc essive deer herbivory, as well as reduced herd health attribut ed to diseas e and starvati on problems (Roscoe and Howard 1974).

Deer populations are managed prim arily by State agencies through regulated hunting s easons, and currently, hunting remains the only practical available option (Palmer et al. 1980, Northeast Deer Technical Committee 2009). Other techniques including: (1) trapping and transferring excess deer to other locations, (2) using fen cing and repellents to manage c onflicts, (3) using fertility cont rol agents, (4) providing supplemental food, (5) controlling deer herds with sharpshooters, and (6) reintroducing large predators are all limited in applicability, prohibitively expensive, logistically impractical, and technically infeasible (Conover 2000, Northeast Deer Technical Committee 2009).

Each year, the number of deer on the refuge is estimated by using data from summer spotlight surveys, fall hunter harvest, and deer browse surveys. The population is then regulated by using different harvest strategies, bag limits, and weapon types. Using these population control techniques the refuge has successfully reduced the deer population from approximately 40 deer per square mile to 20 deer per square mile since hunting began (USFWS 2009). Since the deer population has been reduced, the forest understory has improved though more data are needed to quantify the improvement. Relative trends in deer numbers based on spotlight and harvest data are provided in the table 3-1 below.

According to the National Wildlife Refuge Visitor Survey 2010/2011, there is generally high satisfaction among refuge hunters with regard to Great Swamp NWR's current hunting program (Sexton et al. 2012). During the CCP scoping process, the refuge received comments regarding its hunting program from county and township representatives, non-profit organizations, and individuals. A majority of comments received from these entities supported the refuge's hunting program; however, a few individuals expressed their disapproval of the program.

TABLE 3-1: RELATIVE TRENDS IN DEER NUMBERS BASED ON SPOTLIGHT AND HARVEST DATA FOR GREAT SWAMP NWR (1999-2012)		
Year	Total Deer Spotlighted[1]	Total Deer Harvested
1999	N/A	197
2000	196	215
2001	188	190
2002	306	271
2003	150	178
2004	123	187
2005	167	150
2006	150	102
2007	95	85[2]
2008	85	79
2009	85	113
2010	75	121
2011	104	41[2]
2012	35[2]	18

Notes:
[1] – Spotlight results do not include fawns, which are difficult to observe in tall vegetation.
[2] – After EHD outbreak.

Strategies

- Continue to host annual deer hunt consisting of 1 day youth and 4 day regular season.
- Continue to coordinate with adjacent land managers, including county environmental education centers and NJDFW to encourage cooperative, managed deer hunts.
- Continue to permit use of shotgun and muzzleloader.
- Continue to use antlerless-deer-first or either-sex harvest strategies to regulate the harvest of fawn-bearing females to control deer numbers and protect wildlife habitat.
- Continue to adjust bag limits to allow for an increase or decrease in antlerless harvest, depending on the refuge deer population.
- Continue to evaluate new land acquisitions and incorporate those lands deemed suitable into the hunting program. Additional of new hunting lands would be contingent on a change in the Code of Federal Regulations.
- Continue to provide parking in designated areas for hunting.
- Continue to conduct deer spotlight surveys to obtain population trend data.
- Continue to provide special accommodations to individuals possessing a State disabled hunting license/permit, or a Golden Access Passport, if they qualify.

Objective 4.2 (Fishing)

Fishing is not currently authorized on the refuge.

Rationale

Although fishing is identified in the Improvement Act as a priority public use ("Big Six" public use); multiple resource, access and safety issues at Great Swamp NWR have resulted in the activity not being allowed.

Although the refuge has found some evidence of unauthorized fishing, demand for the activity on the refuge has remained limited. Amongst the general visitor population, approximately 75 percent of those surveyed did not consider fishing "somewhat important" or "very important" when visiting Great Swamp NWR. The largest proportion of visitors surveyed (45 percent) considered fishing "very unimportant" with reference to their visit (Sexton et al. 2012). In addition, off-site fishing derbies previously hosted by the refuge were discontinued as interest and participation in the program declined.

Some of the larger open waters, such as the Passaic River, support a warmwater fishery dominated by panfish, pickerel, black crappie, largemouth bass, catfish, and carp. Trout are stocked by the State in the Passaic River starting at the bridge on White Bridge Road and some points downstream. Stocking only occurs in the spring when water temperatures are cooler for trout survival. The opportunities for fishing at the refuge are limited by on-site conditions. Access to fishing areas, where evidence of fishing has been identified, is limited by lack of available parking opportunities. Some of these locations are potentially hazardous for fishing due to their proximity to busy roads. Expanded safe access to fishing areas will likely require new trails and parking areas, and could not be achieved without impacts to refuge resources. A few small ponds on the refuge may have fish, but access is limited and/or ponds are located in areas not opened to the public because of wildlife disturbance issues. If wildlife disturbance were not an issue, overall, there is very limited fishing opportunity currently available.

Multiple offsite organizations and locations are generally well suited to meet local demand for fishing opportunities. The Somerset County Environmental Education Center, a close partner of Great Swamp NWR, provides a quality alternative to fishing on the refuge. The Center provides designated fishing access and parking areas on the far bank of the Passaic River immediately west of the refuge. Fishing in the river is also allowed. As mentioned above, off-site stocking occurs at the White Bridge Road Bridge (Passaic River). Other opportunities for fishing that have been discussed, such as expansion of open water and stocking of existing refuge ponds are limited by resource allocation and an anticipated complex wetland and environmental permitting process.

Strategies

- Continue to enforce the "no fishing" policy.

Objective 4.3 (Wildlife Observation, Photography and Public Access)

Provide high quality wildlife observation and photography opportunities by facilitating various forms of access. Allow pedestrian and some vehicular access to large portions of the refuge in ways that minimize impacts to wildlife. Access may be expanded in special circumstances such as during the annual deer hunt or through the issuance of a SUP.

Rationale

Wildlife observation and nature photography represent two of the six priority public uses ("Big Six" public uses) identified in the Improvement Act. Providing these opportunities for the public promotes visitor appreciation and support for refuge programs as well as habitat conservation efforts in the GSW and region. The refuge offers many opportunities to view and photograph wildlife, plants, and habitats, as well as opportunities for artists to sketch or paint landscapes and wildlife in its natural habitat. Photography and painting provides wholesome, safe, outdoor recreation in a scenic setting. The refuge also allows commercial photography, filming, or audio recording as these activities may support or enhance the priority public use of wildlife photography. The refuge permits the public to use several different modes of access to facilitate opportunities for wildlife observation and photography. The permitted modes of access have been determined to minimize conflicts and impacts to the refuge's resources.

According to the 2010-2011 National Wildlife Refuge Visitor Survey for Great Swamp NWR, conducted by USGS, visitors reported that they participated in a variety of refuge activities over the past 12 months, including wildlife observation (64 percent), bird watching (62 percent), hiking (57 percent), and photography (36 percent). In addition, a comparison of importance and satisfaction ratings for visitor services indicated that visitors were very satisfied with the activities they reported as very important, including wildlife observation, photography, bird watching, and hiking opportunities. In addition, visitors reported that they were very satisfied with informational kiosks, exhibits about the refuge, and wildlife observation structures (Sexton et al. 2012).

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Strategies

- Continue to maintain approximately 8.5 miles of trails in the Wilderness Area and four parking lots at the trail heads.
- Continue to provide unrestricted daytime access by foot in the Wilderness Area.
- Continue to maintain 1.5 miles of boardwalk and three wildlife observation blinds at the WOC.
- Continue to provide 31 parking spaces at the WOC and multiple hunter-designated parking areas.
- Continue to maintain the Wildlife Tour Route, a self-guided, interpretive road in the Management Area of the refuge.
- Continue to maintain the Overlook and Bluebird parking lots.
- Continue to permit self-guided photography.
- Continue to permit painting or sketching of landscapes and wildlife in its natural habitat without inhabiting pedestrian or vehicular traffic.

- Continue to prohibit public access on refuge management roads in Management Area.
- Continue to maintain refuge gate hours. North Gate is open during Visitor Center hours. South Gate is open during daylight hours.
- Continue to maintain refuge public use infrastructure, including boardwalks and trails.
- Continue to allow commercial filming, photography or audio recording on the refuge with an approved SUP.
- Continue to keep the refuge open only during daylight hours.

Objective 4.4 (Non-Wildlife Recreational Opportunities)

Allow select non-wildlife dependent recreational activities that have been determined appropriate and compatible. Certain non-wildlife dependent recreational activities are permitted in very specific locations to avoid impacts to wildlife, plants, and habitats.

Rationale

Some recreational activities are not dependent on the presence of fish and wildlife, nor dependent on the expectation of encountering fish and wildlife. Although not directly related to wildlife, non-wildlife dependent activities draw visitors and ultimately promote appreciation for the refuge, its resources, and the Refuge System. Some non-wildlife dependent recreational activities are disruptive or harmful to fish, wildlife or plants, or may interfere with the use and enjoyment of a refuge by others engaged in wildlife-dependent recreation. These uses may more appropriately be conducted on private land or other public lands not specifically dedicated for wildlife conservation. All non-wildlife dependent recreational activities must be determined appropriate in accordance with the Policy on Appropriateness (603 FW1) and compatible in accordance with the Policy on Compatibility (603 FW 2).

Strategies

- Continue to permit jogging, bicycling, and horseback riding on the 2.5 mile section of Pleasant Plains Road that is owned and controlled by the refuge.
- Continue to permit walking of properly licensed, leashed dogs on the 2.5 mile section of Pleasant Plains Road that is owned and controlled by the refuge, as well as in designated parking areas, including the Visitor Center and WOC parking lots.
- Continue to issue SUPs on a case-by-case basis.
- Allow virtual (i.e. no physical objects placed on the refuge) geo-caching to promote awareness and use of the refuge.
- Continue to allow cross-country skiing and snow-shoeing in areas open to the public.

Objective 4.5 (Environmental Education)

Participate in educational programs that are designed to meet State curriculum standards.

Rationale

Environmental education is identified in the Improvement Act as a priority public use ("Big Six" public use). Environmental education in the Refuge System incorporates on-site, off-site, and distance-learning materials, activities, programs, and products that address the audience's course of study, the mission of the Refuge System and the management purposes of the refuge. The goal of environmental education is to promote awareness of the basic ecological foundations for the interrelationships between human activities and natural systems. Through curriculum-based environmental education, both on- and off-refuge, refuge staff and partners hope to motivate students and other persons interested in learning the role of management in maintaining healthy ecosystems and conserving our fish and wildlife resources.

The refuge participates in limited educational programs that are designed to meet State curriculum standards. The Visitor Services program is in the process of increasing the number of programs offered by the refuge. In 2011, approximately 25 programs were hosted. Environmental education programs are hosted on and off the refuge. The Friends of Great Swamp also offer environmental education programs and materials. The Friends developed an educational tool known as "Swamp-in-a-Box", which consists of a loanable box containing educational materials that support topics related to science, wildlife, habitats, history, and math. The box typically contains videos, posters, activities, worksheets, a vocabulary list, and Great Swamp NWR brochures. The "Swamp-in-a-Box" program is loaned free of charge to any school group, home-school group, Scout troop, or other community organization. The program is designed to help increase knowledge, understanding, awareness, and stewardship for a NWR. The program is intended for Kindergarten through Grade 12 teachers and students, and is designed to meet New Jersey State Core Curriculum Standards. The Friends also maintain the "Discovery Den" which is located in the Visitor Center. The Discovery Den provides self-guided, hands-on projects, puzzles and games, exhibits, and educational activities for children and adults.

Strategies

- Continue to develop and present environmental education programs on- and off-site.
- Friends of Great Swamp continue to provide educational materials to schools ("Swamp-in-a-Box") and co-host with the refuge three teacher workshops per year.
- Continue limited partnership with county education centers which previously utilized the refuge for educational purposes.
- Continue to host the Congressional Youth Advisory Council, when possible.
- Continue refuge internship program for promising natural resources students.
- When possible, continue trading or sharing interns with partners to provide interns with a broader educational experience and to stimulate interest and motivation.

Objective 4.6 (Environmental Interpretation)

Provide environmental interpretation opportunities that foster stewardship of the environment and reflect the purposes of the refuge and the mission of the Refuge System.

Rationale

Environmental interpretation is identified in the Improvement Act as a priority public use ("Big Six" public use). Interpretation is an educational activity aimed at revealing relationships, examining systems, and exploring how the natural world and human activities intertwine. One of its goals is to stimulate additional interest and positive action. Interpretation is both educational and recreational in nature. That is, participants voluntarily become involved in interpretive activities because they enjoy them, and in the process, they learn about the complex issues confronting fish and wildlife resource managers. Although audiovisual media, exhibits, demonstrations, and presentations are often advantageous and necessary components in interpretation, the program emphasizes first-hand experience with the environment.

In 2009, the Helen C. Fenske Visitor Center was opened to provide informal education to visitors. The development of the center has allowed for the development of displays and expanded educational program space. The Visitor Center exists primarily to offer environmental interpretation by providing exhibits, displays, and audiovisual media that serve to educate the public about the refuge's resources. The center also contains meeting space for demonstrations, presentations, and other interpretative programs, as well as offices for the refuge's Visitor Services staff. An adjacent pavilion is also used for outdoor educational programs. In addition, the Friends of Great Swamp have their Nature Shop, library, and Discovery Den at the Center. The Visitor Center and refuge headquarters also facilitate hunting, wildlife observation, and photography by providing information about where and when visitors can engage in those activities.

The refuge hosts three monthly programs regularly, including *Refuge Rambles, Second Sunday* programs, and *Let's Go Exploring with Ranger Dave*.

- *Refuge Rambles* is a program that is hosted the first Sunday of each month. The first program was held in November 2011. This program consists of a 1-hour interpretive tour, which is guided by refuge staff or an interpretive volunteer.

- Rotating topics are held the second Sunday of each month. The program focuses on conservation topics (i.e., bats, bluebirds, etc.) and is provided by refuge staff or a volunteer that is an expert on the topic.

- *Let's Go Exploring with Ranger Dave* is a program that began in January 2012. This program is held the fourth Sunday of each month and is designed for children ages 6 to 12. The program includes an indoor activity, which is followed by an outdoor activity that promotes exploring. Proposed topics include "*What do animals do during the winter?*" (e.g., hibernation, migration, etc.) and "*Who's tracks are those?*" (e.g. identification of tracks and scat).

In addition, the refuge currently hosts about 10 annual programs, including the *Wildflower Identification Walk, Fall Festival, Sunset Walks* during National Wildlife Refuge Week*, Woodcock Walk, Volunteer Orientation, Christmas Bird Count,* and *Great Backyard Bird Count.* The *Sunset Walks* and *Fall Festival* are among the most popular annual programs.

The Friends of Great Swamp offer the majority of the environmental interpretation programs on the refuge, such as guided tours of the refuge. Interpretative tours include a description of the history of the refuge and the purpose of the Refuge System; exploration of habitats found on the refuge; and identification of plants and wildlife.

Strategies

- Continue to maintain and expand as resources allow kiosks, interpretive displays and signs at the Visitor Center, WOC, wilderness trailheads, parking lots, and headquarters.
- Continue to maintain the existing self-guided, interpretive Wildlife Tour Route.
- Continue to host interpretive programs at refuge and in local communities.
- Continue providing environmental interpretation materials and literature at refuge facilities and trailheads.

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- Continue to maintain and expand refuge information on the Web site, including wildlife and plant lists.
- Continue to have Friends of Great Swamp provide the majority of environmental interpretation tours and programs.
- Continue to request and consider visitor feedback to guide future environmental interpretation programs.
- Continue to utilize the Visitor Center pavilion for environmental interpretation programs.

GOAL 5 Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and throughout the watershed.

Objective 5.1 (Volunteers and Partnerships)

Maintain relationships and cooperate with partners, organizations and volunteers to accomplish the purposes of the refuge and the mission of the Refuge System.

Rationale

Partners, volunteers, interns, and other youth and community service participants contribute significantly to the refuge's biological, public use, and maintenance programs. Their work includes wildlife surveys,

invasive species identification and control, bluebird and wood duck box monitoring and maintenance, visitor services support, environmental interpretation programs, and cleanup or grounds maintenance. In 2010, approximately 200 volunteers contributed over 15,000 volunteer hours.

Each year, Great Swamp NWR allows certain special events to occur throughout the refuge, including areas generally closed to the public. The refuge does not administer these events, but rather controls participant access to the refuge in areas and at times typically closed to the public. For example, several special birding events, including the "World Series of Birding" (hosted by New Jersey Audubon Society), "Christmas Bird Count" (sponsored by National Audubon Society), "Big Sit" (hosted by Bird Watcher's Digest), and "Owl Prowls" (hosted by The Raptor Trust) are held at the refuge each year. These events not only provide ample opportunities for wildlife observation, a priority wildlife-dependent public use, but also provide the refuge with valuable avian data at no additional cost from experienced bird watchers. Over time, the species lists submitted from the various events have provided information useful for monitoring bird populations and updating the refuge's bird list. These events also improve recognition and appreciation for the refuge, the Refuge System, and the FWS among neighbors, local leaders, conservation organizations, and elected officials, thereby generating support for conservation in the region.

Strategies

- Encourage the Friends of Great Swamp and other volunteers to continue to support and promote the refuge.

- Continue to partner with Great Swamp Watershed Association to provide consistent watershed protection in the communities surrounding the refuge.

- Continue to partner with The Raptor Trust, Morris and Somerset County Environmental Education Centers, NJDEP, and private corporations.

Objective 5.2 (Public Outreach)

Participate in events with local partners to advocate resource conservation and stewardship and to promote the mission of the refuge and the Refuge System.

Rationale

Public outreach is two-way communication between the FWS and the public to establish mutual understanding, promote involvement, and influence attitudes and actions with the goal of improving joint stewardship of our natural resources (USFWS 2001c). Public outreach improves recognition of the refuge, the Refuge System, and the FWS among neighbors, local leaders, conservation organizations, and elected officials, thereby generating support for conservation in the region. Outreach can take many forms, including off-site exhibits and displays; news media relations; internet, intranet, and Listservers; partnerships; environmental education; memberships in professional and community organizations; and Congressional relations.

Refuge staff often host or participate in local events, which facilitates direct communication with the public and raises the visibility of the refuge. Volunteers also frequently represent the refuge at local events. For example, each fall the refuge participates in a cooperative outreach program with the Morris County Park Commission. Various other municipal, county, state and federal land management agencies also participate in the event, all of which share a common theme or conservation message. The refuge staff or

volunteers distribute information about the refuge, children's nature games, and display material. The mission of the Refuge System and the refuge's purpose are conveyed to the public to raise awareness and recognition. This public event is typically attended by about 500 people.

Strategies

- Continue to maintain and improve the refuge Web site.
- Continue to maintain key partnerships with The Raptor Trust, Great Swamp Watershed Association, and the Somerset County and Morris County Environmental Education Centers, among others.
- The Friends of Great Swamp continue to provide most outreach through presentations, guided tours, videos, and handouts.
- Continue to participate in outreach as time and resources allow.
- Participate in several large outreach events each year.
- Continue to use nest box cameras at the Visitor Center for wildlife viewing to reach a broader audience.

Objective 5.3 (Climate change)

Recognize and respond to global climate change issues through the use of green technologies to reduce the refuge's carbon footprint. The refuge continues to incorporate the FWS Strategic Plan (finalized September 2010) as guidance for policy.

Rationale

Worldwide scientific consensus tells us that our climate is changing and that these changes are already impacting our natural resources as well as the people, communities, and economies that depend on them. The observed changes in climate have been directly correlated to the increasing levels of carbon dioxide and other greenhouse gases in the atmosphere (USFWS et al. 2012). Signs of rapidly changing climate are unmistakably evident, including melting glaciers, more frequent and longer heat waves, flowers blooming earlier, birds delaying their migrations, rising sea levels, and increases in global average air and ocean water temperatures (USFWS et al. 2012; IPCC 2007).

In response to accelerating climate change, the FWS prepared a plan entitled "Rising to the Urgent Challenges of a Changing Climate: A Strategic Plan for Responding to Accelerating Climate Change in the 21st Century," which was finalized in September 2010 (USFWS 2010a). The primary purposes of the plan are to present a vision for accomplishing the FWS mission in the face of accelerating climate change and to provide direction for our organization and its employees by defining our role within the context of the Department and the larger conservation community (USFWS 2010a). The plan calls for the FWS and its partners to face challenges, lay the foundation for science-based decision making in the future, and take actions now to ensure that our nation's fish and wildlife resources will thrive in the years to come.

Section 2.1.7 provides additional details regarding climate change.

Strategies

- Continue to use and expand green technology to reduce carbon footprint and impact on natural resources, including installation of solar panels, rain barrels, light sensors and timers, high efficiency lighting and HVAC systems, faucet sensors, and hybrid and electric vehicles.

Objective 5.4 (Wilderness Area)

Maintain, monitor and preserve the character of the Wilderness Area in accordance with the Wilderness Act of 1964, the Great Swamp Wilderness Act of 1968, and FWS Wilderness Stewardship Policy.

Rationale

The Wilderness Act of 1964 established the NWPS, which provides the FWS and other federal land management agencies with a process for recommending Wilderness Areas to Congress. Only Congress has the authority to designate lands and water as Wilderness. The Act directs each agency administering designated wilderness to preserve the "wilderness character" of areas within the NWPS, and to administer the NWPS for the "use and enjoyment of the American people in a way that will leave those areas unimpaired to future use and enjoyment as wilderness."

The Great Swamp Wilderness Act of 1968 designated the eastern portion of the refuge, comprised of 3,660 acres, as the first Wilderness Area in the Department of the Interior. In addition, 746 acres in the eastern portion of the present Wilderness Area were declared a Research Natural Area in 1967 by the Director of the FWS. This area, known as M. Hartley Dodge Research Natural Area, contains natural shrub swamp habitat and many small upland islands (USFWS 1987).

The Wilderness Area, although historically disturbed through logging, was not subject to the intensive soil and hydrologic alteration that resulted from agricultural practices. As a result, the vegetation patterns of the eastern portion of the refuge are consistent with the influence of post-glacial deposits that characterize the geologic history of the region. The Wilderness Area is comprised of bottomland floodplain forest and approximately 247 acres of open water that provides quality habitat for a variety of plants and animals. In fact, the Wilderness Area (i.e., southeastern portion of refuge) contains the most contiguous bottomland forested areas on the refuge, which are dominated by a red maple overstory. Small upland "islands" of hardwood forest, dominated by American beech and chestnut oak, are also scattered throughout the Wilderness Area. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques due to legal constraints, very little management occurs in these areas since this area historically experienced less land alteration and, as a result, has experienced fewer invasive species impacts.

Refer to alternative A, objective 4.3 above for information regarding public access opportunities in the Wilderness Area.

Strategies

- When necessary, conduct manual clearing of encroaching vegetation along Wilderness trails.

- Continue to conduct invasive species management, when and where necessary.

- Continue to maintain and restore, when necessary, bog turtle and wood turtle habitats using wilderness-appropriate methods.

- Continue to conduct vegetation and wildlife surveys, such as Indiana bat maternal roost surveys, to monitor trends, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct appropriate vegetation and wildlife surveys and research.

Objective 5.5 (Nuisance Wildlife Control)

Maintain biological integrity, diversity, and environmental health through control of nuisance wildlife, as necessary.

Rationale

The term nuisance wildlife is often associated with an animal that causes or has potential to cause damage to property, presents a threat to public health or safety, or causes an annoyance within, under, or upon a building. An animal that causes negative impacts to other wildlife species or their habitat may also be considered nuisance wildlife. Nuisance wildlife species can be native, non-native, or feral and are often adapted to living in fragmented habitat and in close proximity to humans. Certain species are periodically problematic at the refuge, such as raccoons, resident non-migrating Canada geese, beavers, and feral cats. Management or control of nuisance wildlife may be required to prevent impacts to other wildlife (i.e., predation, competition, and spread of disease) or habitat (i.e., undesired flooding or excessive herbivory). Control techniques are based on a broad, systematic approach using all the information available on the ecology of the pest animal or plant. Population control or reduction methods are chosen based upon their safety, effectiveness, cost, and ecological impact.

Strategies

- Continue to conduct trapping and relocation of raccoons prior to annual waterfowl banding to reduce waterfowl predation.

- Continue to eradicate mute swans and sick wildlife.

- Continue to collect non-native turtles, such as red-eared sliders, and transfer to licensed holders.

- Continue to capture feral cats and turn over to animal shelters.

- Continue to relocate beaver from impoundments to other areas of the refuge to prevent undesired flooding and associated damage to waterways or impoundments.

- Continue to perform control of nesting resident Canada geese.

- Continue to monitor and control unauthorized releases of wildlife on the refuge.

Alternative B: Enhance Biological Diversity and Public Use Opportunities

Introduction

Alternative B, the preferred alternative, is the alternative the Planning Team intends to recommend to our Regional Director for implementation. This alternative includes an array of management actions that, in our best professional judgment, work best towards achieving the refuge purposes, the vision and goals for the refuge, the mission of the Refuge System, and State and regional conservation plans. Alternative B is intended to balance the conservation of forest, non-forested and open water habitats with management of grassland and brushland habitats while enhancing compatible wildlife dependent recreational opportunities. Select habitats would be reconfigured and maintained to create large (greater than 50 acres), contiguous patches to promote wildlife use, increase connectivity, and decrease fragmentation. We believe that the actions proposed under this alternative will allow the refuge to make the most significant ecological contribution possible at the local and landscape levels within the GSW, Northern Piedmont Region, and the Refuge System. Lastly, alternative B addresses the Refuge System's mandate to consider managing refuge habitat under the BIDEH policy (601 FW 3).

The habitat types we describe support a wide variety of federal trust resources, including the federally threatened bog turtle, federally endangered Indiana bat, waterfowl, and a variety of birds of conservation concern identified in BCRs 28 and 29 and PIF Physiographic Areas 9 and 10. For each habitat type objective, we identify "focal species" whose life and growth requirements would guide management activities in that respective habitat type. Focal species were selected because they are federal trust resources, identified as priorities in local or regional resource planning documents, or Great Swamp NWR provides significant habitat for populations of those species. Focal species represent species whose habitat needs, in our professional opinion, broadly represent the habitat requirements for a majority of other federal trust species and native wildlife and plants dependent on that respective habitat type.

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Under alternative B, the hunt program would be expanded by permitting archery for deer and by opening turkey hunting. Wildlife observation and photography would be enhanced by creating trails, providing additional parking opportunities, expanding the Wildlife Tour Route, and constructing observation towers. We would expand Visitor Center hours and increase the number of environmental education and interpretation programs on and off the refuge. We would work to increase our presence in regional urban centers and to increase programs to bring urban youth to the refuge.

Figure 3-3 illustrates the habitat management strategies of alternative B and figure 3-4 illustrates the public use strategies.

GOAL 1: Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species and priority conservation species.

Discussion

Wetlands are critical natural resources because they perform a variety of important functions, including improvement of water quality through nutrient cycling, prevention of shoreline erosion, flood attenuation, groundwater recharge, and critical habitat for a diversity of plant and animal species, as well as providing aesthetic and recreational opportunities (Balzano et al. 2002).

Since the 1780s, New Jersey has lost approximately 39 percent of its wetlands, from an estimated 1,500,000 acres to approximately 916,000 acres in the 1970s (Tiner 1985; Balzano et al. 2002). Approximately 20 percent of this loss likely occurred between the 1950s and 1970s (Balzano et al. 2002). Wetlands were drained primarily for crop production and pastures and filled for residential development, transportation, industrialization, and landfills. Despite the implementation of the Freshwater Wetlands Protection Act in 1987, wetlands are still being lost and disturbed in the State at a rate of approximately 150 acres per year between 1988 and 2001 (Balzano et al. 2002).

The Northern Piedmont Plains contain more than 9,880 acres (4,000 hectares or 15.4 square miles) of emergent wetlands, most of which occur in Great Swamp NWR, Hackensack Meadowlands, Black Meadows, and Saw Mill Creek Wildlife Management Area (NJDEP 2008a). As discussed in chapter 2, land uses that pre-date the refuge resulted in extensive logging to clear land for agriculture and for timber production, as well as extensive wetland ditching and draining. In the 1960s, refuge staff began plugging the previously constructed drainage ditches and creating short dikes with small water control structures in attempt to restore the previously drained wetlands. The refuge currently contains approximately 690 acres of non-forested wetlands and open water habitat, as well as 480 acres of impoundments (refer to objective 1.2 below for impoundments).

The emergent wetlands and open waters of the refuge provide vital wintering and breeding habitat for a variety of waterfowl. The emergent plant community also provides a rich environment for aquatic macroinvertebrates, which in turn provides an important food source for wildlife, especially waterfowl and wading birds. Between 1969 and the early 1980s, five impoundments with low level dikes and water control structures were constructed in order to provide wildlife habitat and influence plant composition and abundance. The refuge currently manages the impoundments for marsh habitat that contains a diversity of wetland vegetation similar to natural marsh habitat in northern New Jersey. Waterfowl breeding and foraging habitat has traditionally been a major focus of management at Great Swamp NWR and the protection of waterfowl is a key element of the refuge's original purpose. The primary objectives of the impoundments are to maintain and improve native emergent vegetation communities, to increase habitat diversity within a wetland, and to provide open water for the resting, staging and foraging activities of migratory waterfowl. Because of the water level differences within individual impoundments, often a single impoundment will help meet multiple objectives within the same year.

The refuge's impoundments encompass approximately 480 acres and are diverse, including areas of emergent, brushland and forested wetlands. Water levels are generally maintained between 6 to 12 inches; however, water levels can vary between 0 and 18 inches in some areas of the impoundments. Some impoundments are drawn down periodically (i.e., every 7 years) to alter plant composition and

thereby provide a diversity of habitats among the impoundments (USFWS 2003b). During a drawdown year, the water is drawn down for one growing season which allows annual plant species to germinate and mature. The residual seeds from these annuals provide migratory and resident waterfowl with a nutritious food source when the pool is re-flooded in late-summer/early fall. Dead and decomposing plants also provide food for many kinds of invertebrates that, in turn, provide a protein source for waterfowl, wading birds, shorebirds, and turtles, such as spotted turtles and wood turtles. The cover from the perennials, with scattered openings, provides ideal conditions for waterfowl broods and migrating waterfowl. Additionally, the interspersion of emergent vegetation and small irregular water areas results in habitat conditions suitable for marsh-nesting birds.

Since the primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl, maintaining a mixture of open water and open marsh will continue to benefit several waterfowl species listed as priorities (highest, high, or medium) in the BCR 28 and 29 Plans, including American black duck, Canada goose (migratory Atlantic), hooded merganser, mallard, wood duck, and other waterfowl species that comprise the many thousands of ducks that pass through the refuge during migration. These habitats also benefit other species, such as the pied-billed grebe, a species of management concern for the FWS in the Northeast region and a species of greatest conservation concern as listed under the NJWAP. Great Swamp NWR is recognized by the New Jersey IBA Program for providing breeding, foraging, and wintering habitat for various waterfowl species, including American black duck, mallard, northern pintail, American widgeon, and green-winged teal. Waterfowl was one of the important criteria utilized in designating Great Swamp NWR as an IBA.

In addition to migratory waterfowl, the refuge's non-forested wetlands and open waters provide habitat for a variety of birds, reptiles, and amphibians, including the bog turtle. The Northern population of the bog turtle is federally listed as a threatened species and State-listed as endangered.

Threats to the refuge's non-forested wetlands and open water habitats include: invasive species, particularly purple loosestrife and common reed; increased flow and sedimentation from upstream development; water quality degradation (i.e., non-point source pollution); altered hydrology due to historic ditching and channeling; flooding and drought; forest succession; and lack of occasional fire.

Under this alternative, we would evaluate the current impoundment management system and the benefits that are realized for waterfowl. Within three years, we would develop impoundment management recommendations based upon options for management including, maintaining current water management, creating additional open water, or other management options for the benefit of migratory waterfowl.

Objective 1.1 Tussock Sedge Wet Meadows

Within five years, maintain and restore a minimum of 40 acres of high quality, spring-fed, open wet meadow dominated by a mixture of native sedges, including tussock sedge (*Carex stricta*), with a 10-30 percent scrub/shrub component and hydric regime suitable for bog turtle.

Rationale

The Northern population of the bog turtle is a federally listed threatened species and listed as Endangered in the State of New Jersey. The New Jersey NHP's ranking system identifies the bog turtle as G3 (globally, either very rare and local throughout its range or found locally in restricted range or because of other factors making it vulnerable to extinction throughout its range) and S1 (critically imperiled in New Jersey because of extreme rarity) (Natural Heritage Program, 2008).

The NJWAP lists the species as a high priority with a goal to increase and stabilize the population in the Piedmont region of New Jersey. Among the contributing factors to the decline of bog turtles is habitat destruction due to development; illegal collection; wetland ditching, flooding and filling; water quality degradation; and forest succession or invasive species encroachment. Bog turtle populations inhabit areas on refuge, which are locally uncommon and unique. Bog turtles require open wet meadows, generally with a scrub/shrub component, with perennial groundwater seepage and typically several inches of mucky substrate (generally greater than 4 inches). Protection of this species' habitat will benefit other key refuge resources of concern, including spotted turtle, American woodcock, and various passerines, including but not limited to common yellowthroat, golden-winged warbler, song sparrow, swamp sparrow, and blue-winged warbler.

Among the contributing factors to the decline of bog turtles is habitat destruction due to development; illegal collection; wetland ditching, flooding and filling; water quality degradation; and forest succession or invasive species encroachment. Bog turtles require open wetlands, generally with a scrub/shrub component, with perennial groundwater seepage and typically several inches of mucky substrate (generally greater than 4 inches). These locally uncommon and unique areas are inhabited by Bog turtle populations on the refuge. Active management of these areas through suppression of vegetation succession and control of invasive species is necessary and will aid in providing basking habitat and increasing the probability of successful nesting.

Strategies

- Continue to conduct invasive species management, when and where necessary. Some examples of management include the release of *Galercucella* spp. beetles to control purple loosestrife and application of herbicides to control common reedgrass.

- Continue to maintain and restore, when necessary, bog turtle and wood turtle habitats.

- Continue to conduct vegetation and wildlife surveys, such as waterfowl banding data collection and bog turtle and wood turtle surveys to monitor trends, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys and research.

- Increase management and restoration of open, spring-fed wetlands for the purpose of benefitting the federally threatened bog turtle. Continue or increase, if necessary, monitoring of the bog turtle population.

- Where feasible, suppress woody plant succession to maintain emergent areas or restore emergent habitat to improve habitat diversity and wildlife visibility.

- Increase monitoring, early detection/rapid response (EDRR), and control of invasive species, especially in areas where change in management or land use occurs or emergent infestations develop and along dispersal corridors (roads, ditches, trails, etc.).

- Research the feasibility and risk of low density grazing for control of select woody and invasive vegetation.

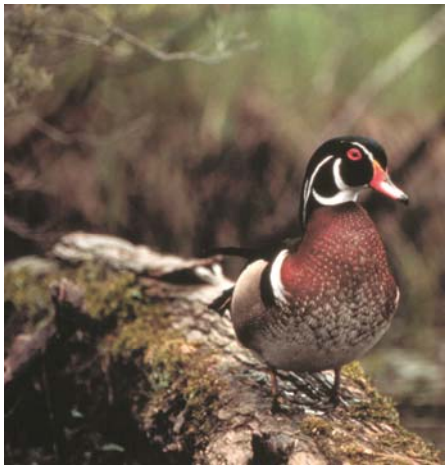
- Increase use of biological control, where possible and practical.

- Evaluate feasibility of future reintroduction of bog turtle hatchlings to increase population and genetic variability on the refuge.

Objective 1.2 Emergent Marsh – Migrating Waterfowl
Each year, maintain a minimum of 1,000 acres of spring (March-April) and fall (October-November) waterfowl migration and staging habitat consisting of shallow flooded wetlands (less than or equal to 12 inches of water) with a mix of native emergent vegetation and open water habitat, dominated by arrow arum (*Peltandra virginica*), cattail, bur-reed, woolgrass, bulrush, swamp rose mallow, buttonbush, millets (*Echinochloa* spp.), tussock sedge, duckweed (*Lemna* sp.), sedges, muskgrass (*Chara* spp.), spikerush (*Eleocharis* spp.), rice cutgrass (*Leersia oryzoides*), wild rice (*Sizania aquatica*), and pickerelweed (*Pontederia cordata*).

Rationale
The primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl. Historic management efforts to provide habitat for migratory waterfowl were successful; however, the five major impoundments require periodic removal of perennial vegetation to prevent plant succession, which leads to wetland habitat loss. Maintenance of emergence marsh also benefits some nesting waterfowl species, including mallard.

Maintaining a mixture of open water and open marsh will benefit several waterfowl species listed as priorities (highest, high, or medium) in the BCR 28 and 29 Plans, including American black duck, Canada goose (migratory Atlantic), hooded merganser, mallard, wood duck, among other waterfowl species that comprise the thousands of ducks that pass through the refuge during migration. Managing for open water/open marsh habitat will also benefit other species, such as the pied-billed grebe, a species of management concern for USFWS in the northeast region and a species of greatest conservation concern as listed under the NJWAP. Great Swamp NWR is recognized by the New Jersey IBA Program for providing breeding, foraging, and wintering habitat for various waterfowl species, including American black duck, mallard, Northern pintail, American widgeon, and green-winged teal. Waterfowl is one of the important criteria utilized in designating Great Swamp NWR as an IBA.



USFWS/James Prince

The refuge impoundments are extremely productive and dynamic habitats that provide nesting, feeding and roosting habitat for various waterbirds and shorebirds. The impoundments are especially important to migratory waterfowl. Numerous reptiles and amphibians rely on the impoundments as well. The impoundments provide a substantial percentage of the available habitat for less common or threatened nesting species, such as rails, bitterns, herons, wood ducks, hooded mergansers, and blue-winged teal, as well as a wide variety of more common birds (Byland 2001).

The impoundments are subject to short and long-term hydrological fluctuations (i.e., flooding, drought), as well as sedimentation and natural vegetation succession. As a result, the ratios of open

water and early successional habitat are variable. Under this alternative, refuge staff will evaluate each impoundment to determine the best management strategies that will benefit the refuge's priority wildlife species. Specifically, the staff will identify the factors that influence the habitats of each impoundment; determine the priority wildlife species that historically and currently rely upon each impoundment; utilize existing refuge specific data and recommendations from past studies; identify management constraints; and determine feasible management strategies that would either allow or impede vegetation succession. Most importantly, the staff will determine each impoundment's potential to make the greatest ecological contribution at a landscape scale.

Strategies

- Continue to manage impoundments as natural marsh habitat with similar vegetation and characteristics as marsh habitat in northern New Jersey.
    - Continue to maintain impoundments with minimal manipulation, except conduct draw-downs every 7 years to mimic a natural drought cycle.
    - Continue to conduct repair and/or maintenance of water control structures, as needed.

- Within 5 years, evaluate each impoundment's ecological contribution to waterfowl and other priority species (i.e., benefits, maintenance, seasonal use, and food availability). As necessary, use contractors, University researchers, or refuge staff to perform the evaluation.

    - Based on findings, develop and implement management strategies to maximize each impoundment's ecological contribution at a landscape scale.

- Continue to conduct invasive species management, when and where necessary, including increased monitoring and early detection. Some examples of management include the release of *Galercucella* spp. beetles to control purple loosestrife and application of herbicides to control common reedgrass.

- Continue to conduct vegetation and wildlife surveys, such as waterfowl banding data collection and bog turtle and wood turtle surveys to monitor trends, especially for species of conservation concern.

- Continue to capture and relocate beaver, when necessary, to prevent dam building and flooding in undesired areas.

Objective 1.3 Emergent Marsh – Breeding Marshbirds

Each year, provide a minimum of 700 acres of habitat for breeding marshbirds, including American bittern, consisting of an average mix of 50 to 70 percent vegetation and 30 to 50 percent open water with water depths often less than 4 inches (10 cm). Breeding habitats for American bittern consist of shallow marshes dominated by cattails, bulrushes, wild rice (*Zizania aquatic*), sedges, and arrow arum. Provide patches of nesting habitat ranging from 6.2 acres (2.5 hectares) to 27.2 acres (11 hectares) or larger, preferably within 98 feet (30 meters) of open water or aquatic bed vegetation habitat (USFWS 2001b). Larger patch sizes (greater than 27.2 acres) results in higher productivity (USFWS 2001b); therefore, emphasis will be placed on large patch sizes, wherever possible.

Rationale

The American bittern is listed as medium priority in BCRs 28 and 29. It is a species that is listed as Endangered (breeding) in New Jersey and is a species of regional conservation concern (USFWS). PIF Physiographic Area 9 identifies this species as a focal species, representing a suite of avian species that

utilize these habitats. Efforts to protect these habitats will also benefit other important refuge Resources of Concern species such as green heron, least bittern, black-crowned night heron, Virginia rail, king rail, sora rail, Northern harrier; and the spotted turtle. American bitterns have been found to nest in habitat that is 6.2 to 27.2 acres or larger (Gibbs et al. 1991, Gibbs and Melvin 1992, Gibbs et al. 1992). American bitterns breed primarily in freshwater wetlands containing tall, emergent vegetation of native species and avoid uniformly-aged stands of older, dense or dry vegetation (USFWS 2001b).

Some of the regional threats to bitterns include loss or degradation of habitat due to drainage, filling, and conversion to agriculture; vulnerability to habitat fragmentation, pesticides and contaminants; and non-native invasive plants, especially purple loosestrife and common reed (Mid-Atlantic/New England/Maritimes Waterbird Working Group 2006). Human activity at breeding sites may also deter bitterns from nesting or cause nest abandonment (Beans and Niles, 2003).

Strategies

- Continue to manage impoundments as natural marsh habitat with similar vegetation and characteristics as marsh habitat in northern New Jersey.
- Continue to maintain impoundments with minimal manipulation, except conduct draw-downs every 7 years to mimic a natural drought cycle.
- Conduct an evaluation of impoundment management options to determine the management regime that would provide the biggest benefit to migratory waterfowl.
- Continue to conduct repair and/or maintenance of water control structures, as needed.
- Continue to conduct invasive species management, when and where necessary. Some examples of management include the release of *Galercucella* spp. beetles to control purple loosestrife and application of herbicides to control common reedgrass.
- Continue to conduct vegetation and wildlife surveys, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys and research.

GOAL 2: Create and maintain an interspersion of brushland, grassland, and successional wet meadows comprised of native vegetation at various successional stages to enhance breeding and foraging habitat for priority species of conservation concern.

Discussion

The refuge contains approximately 840 acres of brushland habitats and 460 acres of early successional fields (Sneddon 2008). Brushland habitats are cut approximately every eight years to prevent it from succeeding toward immature forest habitat. Early successional fields are mowed (some annually and the others every two or four years) to prevent succession toward brushland habitat. The American woodcock, a key early successional management species, is a USFWS priority species that has responded well to the staggered rotational management at Great Swamp NWR. According to a USFWS Biological Review Report for Great Swamp NWR, the refuge's woodcock data (singing route surveys between 1985 and

2006) indicated relatively stable populations relative to declining statewide populations (USFWS 2006). Under the refuge's current Upland Management Plan (1988), a total of 477 acres were targeted specifically for woodcock management with four cover type needs (singing grounds, feeding, nesting, and roosting cover). Areas were identified to be cut on a staggered rotation to provide field, brush, and early successional stages. An additional 131 acres were targeted for brushland habitat to increase wildlife diversity (USFWS 2006).

In addition to American woodcock, management of these habitat types also benefit a suite of species at the refuge, including Eastern towhee, prairie warbler, yellow-breasted chat, blue-winged warbler, willow flycatcher, Northern harrier, Baltimore oriole and rose-breasted grosbeak. Wood turtles and Eastern box turtles also utilize the refuge's early successional habitats for foraging and basking.

Although some obligate grassland nesting bird species benefit from maintaining early successional fields, management objectives are not based on these species. Great Swamp NWR Biological Review (2006) stated that the size and habitat structure of the refuge's early successional fields are such that they will not attract significant numbers of grassland nesting birds. The latter typically require open habitats in excess of 100 acres that are free of hedgerows and other visual impediments.

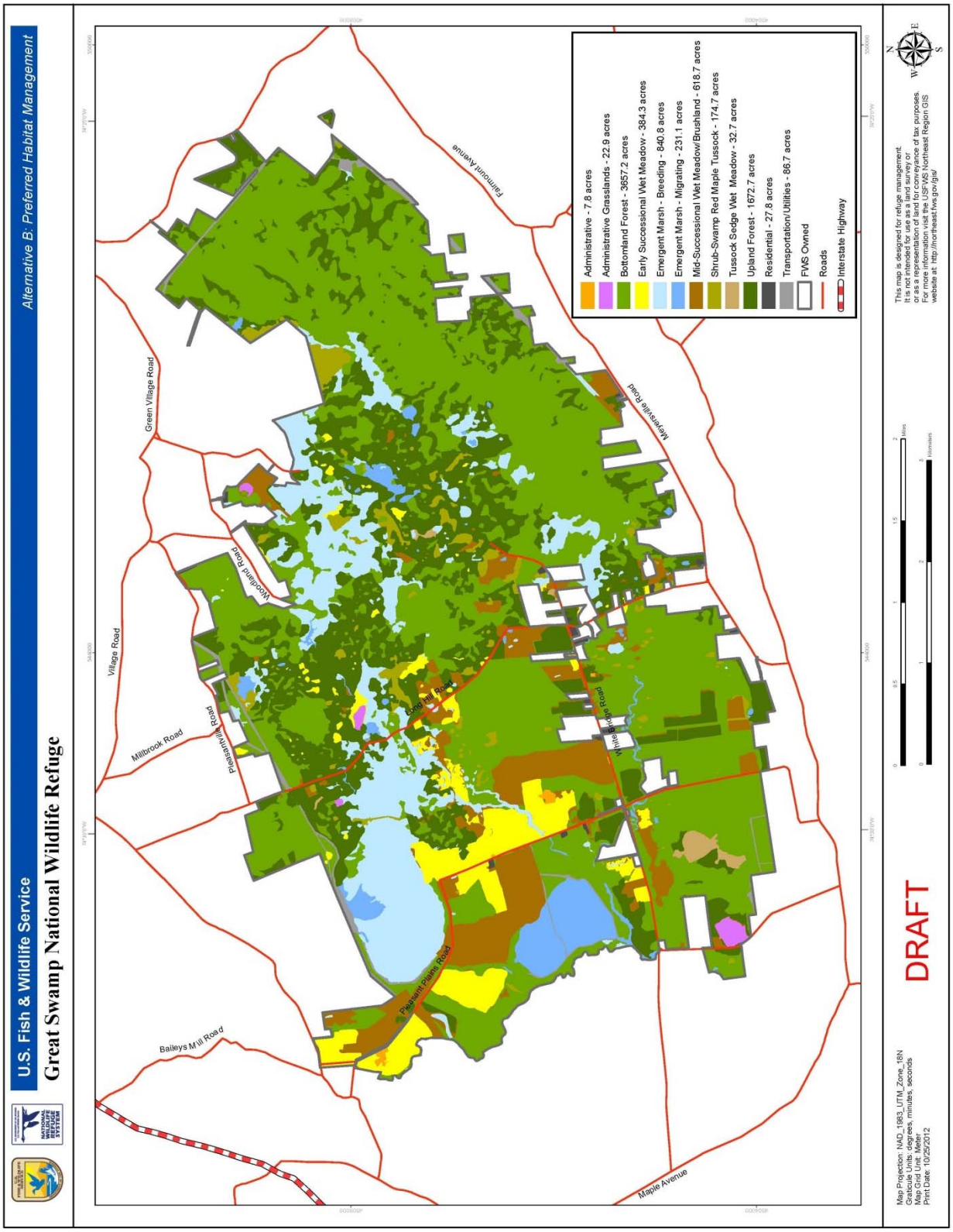
Due to maintenance requirements for remediated landfills, the refuge's remediated landfills must be periodically mowed to keep the sites in a permanent state of early plant succession. This assures that the underlying substrate remains intact and also provides habitat for species that use early successional fields.

Objective 2.1 Mid-Successional Wet Meadows/Brushland – Woodcock Nesting/Foraging & Blue-Winged Warbler Nesting

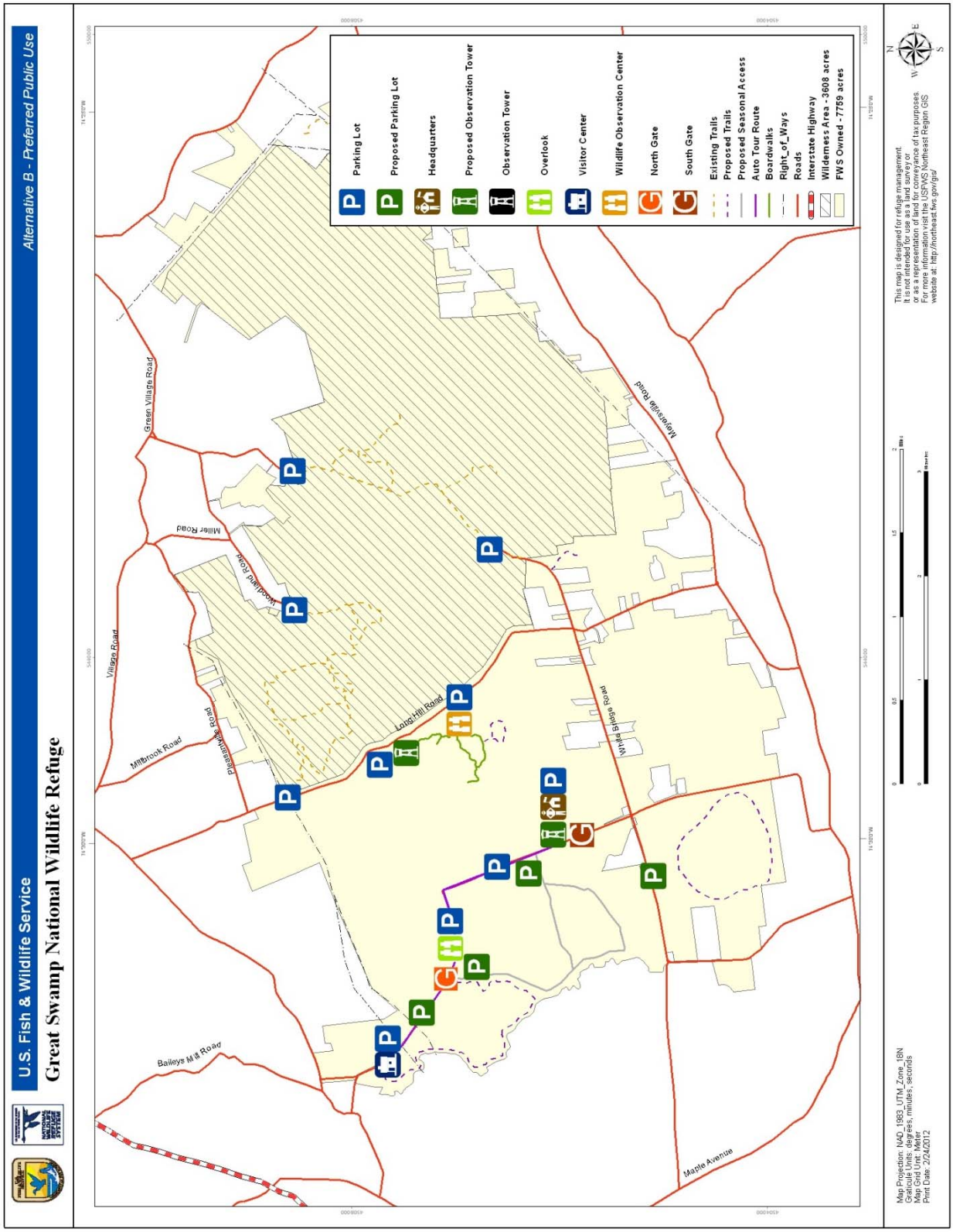
Continue to provide 500 acres of mid-successional wet meadow habitat (shrubs up to 6 feet in height at cover densities of approximately 70 percent) dominated by native species containing a mixture of shrubs and herbaceous vegetation throughout the refuge to provide foraging and breeding habitat for brushland and wet meadow-dependent birds, such as, American woodcock for nesting/brood cover and blue-winged warblers for nesting habitat. American woodcock nesting cover is ideally located within 300 feet of the male's courtship habitat (USFWS 2001c). Courtship habitats should be greater than 2.9 acres (1.2 hectares) in size and consist of open fields, pastures or brushland/forest clearings (USFWS 2001c). Nesting territories of the blue-winged warbler should range from 24 to 123 acres (10 to 50 hectares) in size (USFWS 2001d).

Rationale

A range of habitat types are included under successional wet meadow habitat, ranging from densely vegetated primarily herbaceous meadows to brushy old fields. These habitats support many species of high priority bird species in BCR 28 and 29 Plans, including American woodcock, blue-winged warbler, field sparrow, Eastern towhee, and Northern harrier.



Map 3-3: Anticipated habitat types under Alternative B



Map 3-4: Proposed public use facilities under alternative B.

Land use changes have reduced the amount of early-successional habitats (such as brushlands and grasslands) in the Northeastern United States (Oehler, 2003). Regional threats to these habitats include forest succession, multiple mowings in a single growing season and clearing for agriculture, residential, and other urban uses. As early-successional habitats have declined so have those bird species which are dependent on those habitats. Blue-winged warbler and woodcock are two species that require successional areas for reproduction. Displaying male woodcocks and nesting individuals require successional habitats with various successional stages of woody vegetation.

The American woodcock is listed as a highest priority species in BCR 28 and a high priority species in BCR 29. Significant population declines have been observed since surveys were first implemented in the mid-1960s (Woodcock Task Group et al. 2008). According to the American Woodcock Conservation Plan, New Jersey's population of singing males has declined by 83 percent since the early 1970s (Palmer 2008). The woodcock is also listed as highest priority (Tier IA) in both PIF Physiographic Areas 9 and 10. A Tier IA designation indicates a species has "*High Continental Concern and High Regional Responsibility*" (i.e., conservation in this region is critical for overall health of this species). The blue-winged warbler is a species of USFWS national and regional conservation concern and is of the highest priority in BCR 28 and medium priority in BCR 29. This warbler is listed in Tier IA in PIF Physiographic Area 9 and high priority (Tier IB) in PIF Physiographic Area 10. A Tier IB designation indicates a species has "*High Continental Concern and Low Regional Responsibility*" (i.e., species for which this region can contribute to rangewide conservation objectives where the species occurs). Both of these species have been identified as PIF focal species for their association with a suite of avian species occupying successional habitats.

Strategies

Management of All Brushland Habitats

- Continue to conduct invasive species management, when necessary.
- Continue to periodically conduct breeding bird surveys in brushland communities to identify species and monitor trends, especially for birds of conservation concern.
- Re-evaluate all existing artificial nesting and roosting structures and only maintain those required to meet the biological needs of priority conservation species. Remove artificial structures for species whose populations are now stable; however, consider maintaining a select number of structures for wildlife observation, photography, and interpretive purposes.

Management of Actively Managed Brushland Habitats:

- Where appropriate, use prescribed burning to maintain desired stage of succession.
- In conjunction with objective 2.3, cut select fr agmented brushland fields mo re frequently to regress back to grasslands, where appropriate to create larger blocks of grassland habitat.
- Increase monitoring, early detection, and control of invasive species, especially in areas where change in management or land use occurs and along dispersal corridors.
- Perform rotational mowing and cutting on two to six year cycles to maintain desired stage of succession and prevent succession to forest habitat.

Objective 2.2 Early Successional Wet Meadows –Northern Harrier Foraging & American Woodcock Foraging/Displaying

Continue to provide 460 acres of early-successional field habitat dominated by native vegetation to provide wintering/foraging habitat for the Northern harrier and displaying/foraging habitat for American woodcock. Wet meadow habitat patches should be greater than 2.9 acres (1.2 hectares) in size to provide courtship habitat for American woodcock (USFWS 2001c) and greater than 2.47 acre (1 hectare) in size to provide foraging habitat for Northern harrier (USFWS 2001e). Additionally, 150 acres of these habitats should be maintained adjacent to riparian areas to support the refuge's wood turtle population.

Rationale

Prior to the Revolutionary War and through the early-1900s, much of the GSW was logged and cleared for agriculture, primarily "foul meadow" hay. Grassland species, such as Eastern meadowlarks, bobolinks, upland sandpipers, woodchucks, and voles increased as hayfields and pastures expanded during the early 19th century (Foss 1992; Foster and Motzkin 2003). Repeated attempts at draining, ditching, and stream alteration occurred in the Great Swamp Basin through the mid-1900s. Failure to effectively drain and manage flooding of the swamp eventually caused farming to be abandoned as unprofitable and too difficult to maintain and many farmers moved away. By the 1940s and 1950s, many of the remaining farmhouses were occupied by non-farming families, commuters, and local business owners, and abandoned farm fields began to naturally re-vegetate. After the establishment of the refuge, acquired fields that were managed for haying when in private ownership were continued to be managed as grasslands or early-successional wet meadows with shrub cover ranging from 6 to 60 percent, depending upon mowing frequency (Sneddon 2008).

Some refuge grasslands provide an ecological benefit to a variety of wildlife, including grassland birds, insect pollinators, and threatened or endangered species, such as wood turtles. The large grasslands, such as those near the Visitor Center also provide a unique visitor experience by providing exceptional wildlife viewing opportunities. Under alternative B, these highest quality grasslands will be enhanced for both wildlife and viewing by the removal of hedgerows and obstructions that create predator perches and reduce the availability of nesting areas for grassland birds. This alternative will improve the vegetation quality of these grasslands by evaluating and implementing ways to manage the flora, such as burning or plantings, to maximize their native ecological diversity and productivity.

Many of the small isolated refuge grassland areas along Pleasant Plains Road and Long Hill Road do not support obligate grassland birds or priority species, have less ecological value as grasslands, and do not provide specific benefits to refuge visitors. The lack of suitability of these smaller grassland fragments for obligate grassland breeding birds (OGBBs) is reflected in grassland bird surveys (Little 2001; Little 2004). Under alternative B, grasslands (and managed brushlands; see alternative b, objective 2.2) that do not currently support obligate grassland bird species or other priority species, such as American woodcock would be allowed to undergo natural succession. Based upon their limited patch size and location, allowing natural forest succession within these open areas will improve adjacent core forest health. Specifically, closure of these forest gaps will reduce brown–headed cowbird brood parasitism, invasive species establishment, and other impacts associated with edge effects (see Alternative B - Preferred Habitat Management map).

The Biological Review (2006) recommended that the refuge not be specifically managed for OGBBs, such as grasshopper or savannah sparrows, based on the relative size (less than 20 acre) of most grassland

patches. Many of the OGBBs that occur on the refuge are occasional because they require large tracts of land (at least 50 acres) to support a breeding population, with grasslands over 100 acres being most optimal. Short-eared owl, for example, often prefer areas of 124 acres (50 hectares) or larger for both breeding and wintering habitat (Tate 1992; Dechant et al. 1999; USFWS 2001j). With respect to OGBBs which generally prefer upland habitats, the quality of grassland habitat of Great Swamp NWR is further reduced by the interspersion of wetlands and seasonal standing water in many areas.

The grassland fields provide food for various rodents, green browse for wildlife, and suitable hunting areas for raptors and other predators. The fields are frequently used by various songbirds, including the eastern bluebird. In 1976, the refuge began a bluebird nest box program. There are approximately 160 boxes on the refuge, which are maintained primarily by volunteers. Great Swamp NWR has one of the largest breeding populations of bluebirds in New Jersey because of this highly successful nest box program.

Threats to the refuge's grassland habitats include invasive species, particularly multiflora rose; succession to brushland or forest; and altered hydrology due to historic trenching, ditching and channelization. Some on-site early successional upland grasslands have management constraints due to the presence of remediated landfills and must be maintained as open fields as part of the O&M requirement.

The American woodcock is listed as a highest priority species in BCR 28 and a high priority species in BCR 29. The woodcock is also listed as highest priority (Tier 1A) in both PIF Physiographic Areas 9 and 10. Woodcock require fields in early succession for male courtship display, which have been monitored on the refuge since 1968 (see chapter 2, section 2.6.3). The Northern harrier is listed as Endangered (breeding) in New Jersey and regularly utilizes open meadows at the Great Swamp for foraging. Additional State-listed raptors such as the Cooper's hawk, short–eared owl and American kestrel utilize these open habitats at the refuge for foraging. The wood turtle is a State-listed Threatened species that specifically utilizes patchworks of forest, wetland and successional habitats adjacent to streams. Box turtles, a State-listed Special Concern species, also regularly utilize these habitats. The NJWAP has set a goal of maintaining or increasing all of these species in the Piedmont Region of New Jersey.

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Great Swamp NWR currently provides exceptional open field habitat for these species. Rotational mowing is conducted in late-fall and winter months, and is required to inhibit woody growth and maintain grassy conditions for nesting songbirds, foraging raptors, and displaying/nesting woodcock. Ongoing management of Great Swamp's successional fields is required for continued use by these species.

In addition to the ecological benefits stated above, the consolidation and reduced fragmentation of grasslands and open areas will result in a long-term reduction of financial and staff resources. Small fragmented fields at the refuge, some of which contain wetlands, are often time consuming to maintain. The resources required for the regular management of each fragment could be

utilized elsewhere to greater ecological or visitor benefit. Based upon current estimates, it takes four to nine staff weeks to manage fields each season.

As part of a reallocation of staff and volunteer time, box nesting programs of stable species, particularly the bluebird nest box program, will be evaluated and reduced as necessary. As mentioned in alternative A, objective 2.1, the bluebird program at the refuge has been highly successful and popular among the public and volunteers since 1976. As a result of its success at the refuge and elsewhere, bluebird populations have stabilized and the species is not prioritized under any relevant State or regional wildlife plans. Due the popularity of this historically important program, some amount of highly visible bluebird boxes will continue to be maintained in grasslands strictly for public viewing, educational, and interpretive opportunities. The maintenance of 160 bluebird boxes, however, is time consuming and the volunteer hours dedicated to their management may be more effectively utilized for management of priority species.

One of the most highly effective ways to manage and improve grassland habitats is through the use of prescribed burning. The Refuge System began using prescribed burning on wildlife refuges in the 1920s, and although other agencies ceased to use this practice during the 1930s due to the perception that all fire was “bad,” some refuges continued to burn. The Refuge System has been recognized by other agencies as a pioneer in developing and implementing scientifically-based prescribed burn plans for managing habitat and protecting wildlife (USFWS 2002b). Prescribed burning is a carefully planned and executed process. It is a cost effective and efficient tool used to restore, rejuvenate, and maintain wildlife habitat on refuges (USFWS 2008f; USFWS 2012a). Fire is known as a unique ecological process that shapes habitat structure and function, and under carefully planned conditions, it can mimic the ecological role of past fires (USFWS 2002b; USFWS 2012b). Prescribed burning benefits both human and wildlife communities. Controlled burning returns nutrients to the soil, removes dead and overgrown vegetation that can fuel large, damaging wildfires, and aids in plant germination. Fire also maintains meadow and grassland habitats, creates open water in marshes, and controls pests, disease, and non-native species, such as honeysuckle and autumn olive (USDA 2007; USFWS 2008f; USFWS 2012c). Some plant species, such as switchgrass, bluestem, and Indiangrass, rely on fire for reproduction and survival. These plant species provide nesting habitat for various migratory birds, including savannah sparrow, bobolinks, eastern meadowlarks, upland sandpipers, and some waterfowl, such as mallards and blue-winged teal (USFWS 2012c). Prescribed burns also benefit rare “secretive marsh birds,” including bitterns, rails, and sparrows (USFWS 2011d). Without periodic fire, national wildlife refuges are more vulnerable to the effects of invasive species, climate change, and severe wildfires (USFWS 2012b).

It is understood that the creation or improvement of expansive grasslands at Great Swamp NWR may not result in substantial population increases of obligate breeding grassland bird populations. This is in part due to the high individual spatial requirements of OGBBs relative to the maximum amount of available refuge grasslands, and the general lack of grasslands within the regional landscape of the New Jersey Piedmont region (USFWS 2006e). Nevertheless, this alternative acknowledges the value of maintaining the highest quality refuge grasslands in the largest contiguous blocks possible for both ecological and wildlife viewing purposes. Creation of large, contiguous patches of grasslands will increase our potential to provide habitat for some OBGGs based on the documented patch size requirements. Alternative B improves the ecological conditions of the refuge’s grassland habitat for documented grassland bird species, raptors, wildflowers, and insect pollinators while avoiding impacts to other prioritized habitats.

Strategies:

- Reconfigure vegetative communities in the Management Area to maximize patch size, reduce fragmentation, and optimize wildlife use and value. Concentrate on consolidation of the largest upland grassland patches adjacent to Pleasant Plains Road. Perform rotational mowing on one to four year rotational basis.

- When necessary, continue to conduct invasive species management, such as biological control of purple loosestrife, manual removal of Japanese stiltgrass, and herbicide treatment of common reedgrass.

- Continue to conduct vegetation and wildlife surveys, such as breeding bird surveys, to document species and trends.

- Continue to cooperate with partners, students, and volunteers, such as New Jersey Audubon Society, to conduct vegetation and wildlife surveys and research.

- Continue to cooperate with partners, such as the Friends of Great Swamp, to maintain and monitor existing artificial nesting and roosting structures. Reevaluate all existing artificial nesting and roosting structures and only maintain those required to meet the biological needs of priority conservation species. Remove artificial structures for species whose populations are now stable; however, consider maintaining a select number of structures for wildlife observation, photography, and interpretive purposes.

- Introduce prescribed burning as a habitat management tool, where possible.

- Over the short and long term, quantitatively evaluate the ecological results of habitat reconfiguration. Evaluations include pre- and post-management habitat and species surveys of consolidated grasslands, successional scrub-shrub, and forest.

- Where feasible, eliminate hedgerows that are less than 25 feet wide to create larger grassland patch sizes.

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- Research the feasibility and risk of low density grazing for control of select invasive species.

- Perform native wildlife plantings with focus on increasing plant and invertebrate diversity.

- Maintain high quality grasslands around the Visitor Center for wildlife viewing, photography, and environmental interpretation opportunities.

Objective 2.3 Shrub-Swamp and Red Maple-Tussock Sedge Wooded Marsh

Maintain 800 acres of seasonally or semi-permanently flooded tussock-sedge wooded marsh dominated by native species, including red maple saplings and tussock sedge, and lesser areas of shrub-swamp containing a variety of shrubs including alders, buttonbush, swamp rose, black willow, Southern arrowwood, highbush blueberry, sweet pepperbush, and dogwood species, with greater than 50 percent woody vegetation to provide important nesting and migratory habitat for passerines and other bird species. Wooded marsh habitats, particularly riparian shrub habitat areas, should be greater than 1.7 acre (0.7 ha) to support nesting willow flycatcher (Walkinshaw 1966).

Rationale

Shrub-swamp and wooded marsh habitat types range from naturally maintained, seasonally wet scrub-shrub wetlands to permanently or semi-permanently flooded tussock sedge wooded marsh, containing shrubs and young trees growing on hummocks. The willow flycatcher is listed as an FWS Bird of Conservation Concern and a Species of Regional Conservation Concern. This species is also listed as Tier IB in PIF Physiographic Area 10. Additionally, a goal for increasing the population has been set in the Piedmont Region under the NJWAP. The willow flycatcher generally nests in riparian sites that are moist, shrubby areas often with standing or running water, generally containing willows (*Salix* spp.). In the central and Eastern United States, this species utilizes both wet and dry upland sites. Nests are generally close to the ground in the crotches of shrubs or small trees near water (Audubon Society 2009).

These naturally occurring shrub habitats support many species of high priority in BCR 28 and 29 Plans for nesting and/or during migration, including blue-and golden-winged warblers, Canada warbler, field sparrow, and Eastern towhee. In addition to birds, herptile and mammal resources of concern will benefit from the preservation of these habitats. Spotted turtles will also utilize these habitats for foraging.

In the United States, brushland habitats are found in natural systems, as well as in human altered systems, such as old fields and utility right-of-ways. Brushland habitats are characterized by low, multi-stemmed woody vegetation in young or stunted stages of succession. These habitats may be densely clustered or consist of a mosaic of low woody cover interspersed with herbaceous cover (USDA 2007). Trees may be present, but are widely spaced or scattered. Habitats consisting of woody shrubs and herbaceous plants have structural diversity that provides nesting sites, escape cover, and food for wildlife (Oehler et al. 2006). The edges of scrub-shrub habitats also provide hunting areas for predatory birds, such as kestrels (USDA 2007).

Early successional wildlife habitats have become critically rare in much of the eastern United States, especially in the Northeast, primarily due to land use changes (DeGraaf and Yamasaki 2003; Oehler 2003). Regional threats to these habitats include forest succession, multiple mowings in a single growing season, invasive species, and clearing for agriculture, residential, and other urban uses. Early successional habitats are less common than they were in pre-settlement times in several regions of the Northeast, specifically southern and south-coastal New England and the coastal mid-Atlantic region. The landscape of the Northeast is dominated by man-altered habitats and human uses; therefore, maintaining early-successional habitats similar to pre-settlement levels is not possible (DeGraaf and Yamasaki 2003).

In comparison to grassland species, the refuge has much greater potential to support and expand viable breeding populations of regionally prioritized shrub-nesting birds. Populations of nesting field sparrow, willow flycatcher, American woodcock, blue-winged warbler, eastern kingbird, brown thrasher, and eastern towhee are all established at the refuge (USFWS 2006e; Little 2001; Little 2004). These species are

typically capable of nesting at higher densities than OGBBs. The conversion of the many remaining less than 20 acre grassland habitats into forest habitats or areas of various stages of woody succession will more effectively contribute to the on-site population of these shrub nesting species, as well as highly prioritized forest species, such as wood thrush (see alternative B, objective 3.1). In spite of the regional prioritization of shrub and forest habitats and species at the refuge, certain grassland habitats on the refuge have high ecological value for avian fauna.

As discussed above under alternative A, objective 2.2, the American woodcock is identified as highest priority in BCR 28 and a high priority in BCR 29; a high continental concern and high regional responsibility for both PIF Physiographic Regions 9 and 10; and a priority in the North American Shorebird Plan for the Atlantic Flyway. The NJWAP sets a population goal for the Piedmont Region to increase this species. Woodcock was also identified as a priority in the North American Shorebird Plan for the Atlantic Flyway. The American woodcock, a key early successional management species, is a FWS priority species that has responded well to the staggered rotational management at Great Swamp NWR. One important contribution to the regional landscape is the refuge's support of a stable American woodcock population, which uses the refuge's patchwork of grassland, scrub-shrub, forest and wetland habitats. Preservation of grassland habitat staging areas under alternative B in conjunction with nesting habitat improvements will create habitat conditions that would support woodcock. According to the American Woodcock Conservation Plan (Wildlife Management Institute 2008), a landscape-level approach to woodcock management involves using management units of 500 to 1,000 acres (202.3 to 404.7 hectares), which should support approximately 500 woodcock. Ideally, several units should be located within 1 to 2 miles (1.6 to 3.2 km) of each other to allow interchange of birds. Within management units, habitat treatments should be centered on broad-leaved deciduous or on deciduous brushland wetlands where moist soils are found. By locating (where allowable) treatments across wet areas or streams, suitable woodcock habitat will be created along a moisture gradient that will provide a consistent supply of earthworms throughout summer. Even-age forest management treatments of more than or equal to 5 acres (2 hectares) will stimulate sprouting of shade-intolerant species to create ideal woodcock habitat. Short rotation cutting cycles of no more than 20 years ensures that forested habitat will not become too mature and will not experience a decline in woodcock use.

According to a Biological Review Report for Great Swamp NWR, the refuge's woodcock data (singing route surveys between 1985 and 2006) indicated relatively stable populations relative to declining statewide populations (USFWS 2006). Under the refuge's current Upland Habitat Management Plan (1988), a total of 477 acres were targeted specifically for woodcock management with four cover type needs (singing grounds, feeding, nesting, and roosting cover). Areas were identified to be cut on a staggered rotation to provide field, brush, and early successional stages. An additional 131 acres were targeted for brushland habitat to increase wildlife diversity (USFWS 2006). In addition to American woodcock, management of these habitat types also benefit a suite of wildlife species at the refuge. According to the Biological Review Report (2006), field surveys suggest that the refuge supports fair numbers of brushland birds, including willow flycatcher, eastern kingbird, gray catbird, brown thrasher, eastern towhee, indigo bunting, and field sparrow.

Natural brushlands are among the most endangered ecosystems in the United States (DeGraaf and Yamasaki 2003). The refuge contains approximately 55 acres of natural brushlands. The refuge's naturally occurring shrub-swamp and wooded marsh habitat types range from seasonally wet brushland wetlands to permanently or semi-permanently flooded tussock sedge wooded marsh, containing shrubs

and young trees growing on hummocks. These naturally occurring brushland habitats support many bird species of high priority in BCR 28 and 29 Plans during nesting and/or during migration, including blue- and golden-winged warblers, Canada warbler, field sparrow, willow flycatcher, and Eastern towhee. The golden-winged warbler, currently being considered for federal listing, occasionally utilizes the refuge. In addition to birds, priority herptiles (e.g., wood turtle, spotted turtle, bog turtle and Eastern box turtle and blue spotted salamander) and mammal (e.g., Indiana bat, little brown bat, and Northern long-eared bat) resources of concern benefit from these habitats.

Most wildlife associated with natural brushland and early successional habitats were once considered generalist species; however, these species have since been determined to be specialists in vegetation structure or area requirements (DeGraaf and Yamasaki 2003). One hundred thirty nine (139) species of reptiles, amphibians, birds, and mammals either prefer (17 species) or use (122 species) brushland and old field habitats (Oehler et al. 2006). Of 40 bird species associated with shrubland habitats, 22 are experiencing significant population declines in the eastern United States (Oehler et al. 2006). A few species in the region are limited to non-forested habitat types, including the northern harrier, savannah sparrow, and vesper sparrow (DeGraaf and Yamasaki 2003). Certain brushland bird species have not adapted to suburban conditions, such as brown thrashers, eastern towhees, and field sparrows, and as a result, are now declining across the region (DeGraaf and Yamasaki 2003). In addition, 58 species of butterflies and moths in the Northeast are dependent upon shrublands, 56 of which are considered rare (Oehler et al. 2006).

As discussed under alternative A, objective 2.2, early successional wildlife habitats have become critically rare in much of the eastern United States, especially in the Northeast, due to land use changes (Oehler 2003). Natural brushlands are among the most endangered ecosystems in the United States (DeGraaf and Yamasaki 2003). As early-successional habitats have declined, so have those bird species that are dependent upon those habitats. Under this alternative, the refuge would continue to manage approximately 55 acres of natural brushlands. In addition, the refuge would consolidate the actively managed brushland habitats to create large (greater than 50 acre) patches. Small or isolated brushland patches that are difficult and costly to manage will be allowed to naturally succeed. The consolidation and reduced fragmentation of managed brushlands will result in improved habitat value for wildlife and a long-term reduction in maintenance costs.

The consolidation of the actively managed brushland habitats will benefit populations of regionally prioritized brushland bird species, including American woodcock, blue-winged warbler, prairie warbler, yellow-breasted chat, Eastern towhee, and field sparrow. Blue-winged warbler and American woodcock are two species that require successional areas for reproduction.

The blue-winged warbler is a species of national and regional conservation concern and is of the highest priority in BCR 28 and medium priority in BCR 29. This warbler is listed in Tier IA in PIF Physiographic Area 9 and high priority (Tier IB) in PIF Physiographic Area 10. A Tier IB designation indicates a species has "*High Continental Concern and Low Regional Responsibility*" (i.e., species for which this region can contribute to rangewide conservation objectives where the species occurs). The blue-winged warbler is somewhat of a generalist species that utilizes a variety of successional habitats that generally contain clumped shrubs and saplings. This species has a relatively large nesting territory, ranging from approximately 25 to 124 acres (USFWS 2001i); therefore, the consolidation of actively managed scrub-shrub habitat will benefit breeding populations of the blue-winged warbler. Both the blue-winged warbler

and American woodcock have been identified as PIF focal species for their association with a suite of avian species occupying successional habitats.

Prescribed burning is a cost effective and efficient tool used to restore, rejuvenate, and maintain wildlife habitat on refuges (USFWS 2008f; USFWS 2012a). Fire is known as a unique ecological process that shapes habitat structure and function, and under carefully planned conditions, it can mimic the ecological role of past fires (USFWS 2002b; USFWS 2012b). The objective of burning scrub-shrub habitats is to remove much or all of the standing vegetation and accumulated leaf litter, while leaving the rootstock and seed bank intact. With careful planning and execution, frequency and intensity of burns can be adjusted to achieve the desired plant structure (USDA 2007).

Strategies

Management of All Brushland Habitats

- Continue to conduct invasive species management, when necessary.
- Continue to periodically conduct breeding bird surveys in brushland communities to identify species and monitor trends, especially for birds of conservation concern.
- Re-evaluate all existing artificial nesting and roosting structures and only maintain those required to meet the biological needs of priority conservation species. Remove artificial structures for species whose populations are now stable; however, consider maintaining a select number of structures for wildlife observation, photography, and interpretive purposes.

Management of Actively Managed Brushland Habitats:

- Where appropriate, use prescribed burning to maintain desired stage of succession.

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- In conjunction with objective 2.1, cut select fragmented brushland fields more frequently to regress back to grasslands, where appropriate to create larger blocks of grassland habitat.
- Increase monitoring, early detection, and control of invasive species, especially in areas where change in management or land use occurs and along dispersal corridors.
- Perform rotational mowing and cutting on two to six year cycles to maintain desired stage of succession and prevent succession to forest habitat.

GOAL 3: Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Discussion

Prior to European settlement, the composition and density of forests within the region may have been modified through fires

set by Native Americans. Several land surveys conducted in the area in the early 1700s documented tree species such as swamp white oak, maple, poplar, beech, elm, and ash (Harris and Ziesing 2010). Prior to the Revolutionary War and through the early-1900s, much of the GSW was logged and cleared areas were then used for agriculture. By the mid-1800s, a majority of the lowest elevations in the basin may have been logged, and according to an 1899 report prepared by the New Jersey State Geologist, "cutting was most severe about 1850, and from 1850 to 1860 was the period of maximum deforestation" (Collins and Anderson, 1994). During the late-1800s, Great Swamp's woodlands were further logged. Repeated attempts of draining, ditching and stream alteration occurred through the mid-1900s; however, failure to effectively drain and manage flooding of the swamp eventually caused farming to be unprofitable and too difficult to maintain; therefore, many farmers moved away. By the 1940s and 1950s, many of the remaining farmhouses became occupied by non-farming families, commuters, and local business owners, and abandoned farm fields began to re-vegetate.

As discussed in section 2.1.5, the soil disturbances caused by agriculture resulted in soil homogeny (mixing) and depletion of key elements, such as carbon and nitrogen, which can last for decades or longer (Momsen 2007). In addition, late season harvests left agricultural soils exposed to harsh winter weather and subject to erosion. These soil impacts may have influenced current vegetation structure and composition. The dichotomy of vegetation patterns in the eastern (Wilderness Area) and western portions (Management Area) of the refuge reflect, in part, the differences in historic land use and land cover. The eastern portion of the present day refuge, while disturbed through logging, was not subject to the intensive soil and hydrologic alteration that resulted from agricultural practices. The western portion of the refuge has undergone soil disturbance from the clearing, ditching, and plowing associated with farming. As a result, the present day Wilderness Area vegetation patterns are consistent with the influence of post-glacial deposits that characterize the geologic history of the region. The pin-oak swamps and other vegetation communities of the western portion of the refuge more reflect post-colonization agricultural use (Momsen 2007).

The Northern Piedmont Plains contains approximately 82,780 acres (33,500 hectares or 129.3 square miles) of forest, including upland, wetland and riparian habitats (NJDEP 2008a). The largest patches of forested land occur in a scattered network of public natural lands, with the largest patch in Great Swamp NWR (NJDEP 2008a). The largest contiguous bottomland forested areas are located within the Wilderness Area of the refuge. These areas are dominated by red maple in the canopy. The Management Area of the refuge contains a mosaic of tracts of bottomland forest habitat, primarily in the southwestern and western portions of the refuge. The majority of upland forested areas are centrally-located on the refuge and are dominated by American beech and oak species. Small upland "islands" of hardwood forest, dominated by American beech and chestnut oak, are also scattered throughout bottomland forest habitats within the Wilderness Area.

Loss of forested land and forest fragmentation due to development are two primary reasons for the decline in many forest-dependent bird species. Fragmentation of forested areas by means of development isolates stands from the main forest complex, increasing the amount of edge habitat and decreasing the amount of forest interior habitat. Negative effects associated with forest habitat fragmentation are well documented for breeding birds. Most forest interior species will only nest within a forest "core" that is at least 295 feet (90 meters) from the nearest forest edge. In addition, the forest core must be a minimum of about 25 acres (10 ha) in size (Dawson *et al.* 1993). Large tracts of contiguous forested areas are necessary to support breeding populations of migratory songbirds (Robbins, *et al.* 1989; Robinson *et. al.,* 1997) as well as forest dwelling raptors (Bosakowski *et al.* 1992; Bosakowski, 1994).

Fragmented forests are characterized by high levels of edge-related nest predation, brood parasitism, or both and prove undesirable for many area-sensitive species. In addition, forest fragmentation can facilitate the spread of exotic invasive plant species that can dramatically change the habitat structure of the forest.

According to the 2008 NatureServ report, Great Swamp NWR contains approximately 4,550 acres of bottomland forest. The most contiguous bottomland forested areas are located within the Wilderness Area of the refuge (i.e., southeastern portion of refuge). These areas are dominated by red maple in the canopy. The Management Area of the refuge contains a mosaic of large tracts of bottomland forest habitat, primarily in the southwestern and western portions of the refuge. Based upon the 2008 NatureServ report, the refuge contains approximately 1,794 acres of upland hardwood forest. A majority of the upland forested areas are centrally-located on the refuge and are dominated by American beech and oak species. Small upland "islands" of hardwood forest, dominated by American beech and chestnut oak, are also scattered throughout bottomland forest habitats within the Wilderness Area.

Active management of forested areas in the Management Area consists primarily of invasive species control (i.e, Japanese barberry and Japanese stiltgrass) and selective thinning to encourage understory growth. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques due to legal constraints, very little management occurs in these areas since this area historically experienced less land alteration and as a result, has experienced minimal presence of invasive species

Forests of Great Swamp NWR are known to support several priority resources of concern, including Indiana bat, barred owl, and various forest dependent birds (i.e., wood thrush). The Indiana bat is a federally and State-listed endangered species; the NJWAP has been targeted for increase in Piedmont populations of this species. The refuge is documented as having maternal roost colonies for Indiana bat in New Jersey (Kitchell 2008). Maternal roosts are typically established in agricultural areas with fragmented forests. Roosting by Indiana bat occurs within the Management and Wilderness Areas of the refuge where an interspersion of forests, brushland, open water, and wet meadow exists (Kitchell 2008). Foraging occurs primarily in and around forested habitats that include pole-stage mixed-oak forest, floodplain forest, upland forest, and forested wetlands (Butchkoski and Hassinger 2002; Gardner et al. 1991; Humphrey et al. 1977; Murray and Kurta 2004; Romme et al. 2002, Sparks et al. 2005). Pregnant or lactating bats forage primarily within wooded or riparian corridors, streams, associated floodplain forests, and impounded bodies of water; however, they will sometimes use hedgerows, upland forest, early successional fields, and croplands (Kitchell 2008). Refer to section 2.6.1 for additional details on the habitat preferences and requirements of the Indiana bat.

The barred owl is a State–listed threatened species, which also has been targeted for increase in Piedmont populations in the NJWAP. Forests within Great Swamp NWR support a significant population of this species. Barred owls require large tracts of undisturbed forest dominated by mature and old growth stands and high canopy cover (Bosakowski et al. 1987; Bosakowski 1989). Barred owls prefer older stands but earlier stages of forest succession will be used if a suitable number of large diameter trees or snags is present (Allen 1987). In eastern North America, barred owls generally maintain established territories year-round with home ranging from 213 to 914 acres in size (Beans and Niles 2003). Although the barred owl is most often associated with densely forested woodlands, this species is not restricted to specific vegetative associations in their foraging activities. These owls have been documented foraging for amphibians traveling to and from vernal pools (Kenney and Burne 2002). Deciduous forests, especially riparian and

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lowland areas, are the most frequently recorded forest types for nesting throughout North America. A typical nest tree is tall, decadent, and has a suitable cavity or a nest site greater than 25 feet above the ground (Allen 1987). Barred owls have been known to use hawk nests when tree cavities are not available (Beans and Niles 2003). Owl sites were located a considerable distance (mean = 2,204 feet) from houses and other buildings (Bosakowski and Smith 1997), showing a significant avoidance of human disturbance and habitat alteration in northern New Jersey. This species demonstrates long-term site fidelity in areas that remained undisturbed (Bent 1937; Bosakowski et al. 1987).

The refuge supports various forest-interior breeding birds including wood thrush, eastern wood peewee, scarlet tanager, veery, and red-eyed vireo. The wood thrush is of the highest rank in BCR 28 and a high priority in BCR 29. Both PIF Physiographic Areas 9 and 10 designates this species as the highest (IA) priority. Wood thrush is listed as both a Bird of Conservation Concern and a Species of Regional Concern for the USFWS. Robbins (1979) estimated that a minimum area of 247 acres is required to support a viable breeding population of wood thrush. The forest patches required by this species for successful reproduction result in the protection of numerous other migratory and breeding forest interior birds at Great Swamp NWR.

The forest complex at Great swamp NWR is extremely important for large volumes of migratory songbirds, including but not limited to Cerulean warbler, Canada warbler, Prothonotary warbler, Louisiana waterthrush, veery, Cooper's hawk, red-headed woodpecker, Acadian flycatcher, and eastern screech owl.

Objective 3.1 Woodland Vernal Pool Habitat

Maintain and enhance 300 acres of vernal pool habitat (i.e., vernal pool and surrounding buffer) for blue-spotted salamander and other obligate vernal pool species, and where possible, maintain a 1,000-foot vegetated buffer around each vernal pool (NJDEP 2004). Buffers should consist of native vegetation and vernal pools should contain approximately 1 to 4 feet of isolated seasonal standing water with a 10 to 30 percent shrub component.

Rationale

The refuge contains approximately 35 acres of vernal pool habitat. Vernal pools are essential habitat for portions of the life cycles of many species, and are also the favored habitat for considerably more species, particularly amphibians, that use them for breeding and foraging in an area of reduced predation (Kenney and Burne 2002). Vernal pool habitats support many other priority species, including spotted turtles and wood turtles, and may occasionally be utilized by barred owls for foraging. Vernal pools are indispensable to biodiversity both locally and globally. In New Jersey, seven species are dependent on vernal pools (i.e., obligate vernal pool species), including the blue-spotted salamander and wood frog (NJDFW 2008). In New Jersey, threats to vernal pool habitat include development, which often results in filling and clearing of surrounding vegetation; change in hydrology due to irrigation wells; overuse of fertilizers and pesticides; and mosquito control efforts (biological, chemical, and hydrological changes). Roadways near vernal pool habitats also contribute to high mortality due to vehicular traffic during annual migrations by amphibian species. Protection, maintenance, and enhancement of vernal pools, as well as the surrounding vegetated buffer, is critical for vernal pool-dependent wildlife. The refuge's vernal pools are monitored annually in

early spring for amphibian presence and reproduction as part of an on-going USGS study. Habitat management of the vernal pools includes tree thinning and installation egg mass attachment sites, such as logs.

The blue-spotted salamander is a State listed endangered species. Additionally, this species is listed in the NJWAP; however, it is not identified for the Piedmont Region. The blue-spotted salamander breeds during late winter and early spring in woodland vernal pools, marshes, swamps, and drainage ditches. Blue-spotted salamander larvae develop for about 2 to 4 months in a vernal pool before metamorphosing into terrestrial juveniles. The terrestrial adult utilizes rotting logs and deep humus for cover around vernal pools and in forested wetlands, slightly above the water level (Kenney and Burne).

Vernal pool habitats support many other priority species, including spotted turtles and wood turtles, and may occasionally be utilized by barred owls for foraging. Additionally, the wood duck, a high priority species in BCR 29, may also utilize vernal pools as nesting habitat. The spotted turtle is a State-listed species of Special Concern and a goal for maintaining the population has been established in the Piedmont Region under the NJWAP. Research has demonstrated that vernal pools provide important foraging areas for spotted turtles (Colburn, 2004). Spotted turtles spend considerable amounts of times in vernal pools during early spring (March and April) feeding on amphibian eggs, invertebrates, and other sources of food. These turtles also utilize vernal pools for basking and breeding (Kenney and Burne).

The wood turtle is a State-listed Threatened species. Additionally, a goal for increasing the population has been set in the Piedmont Region under the NJWAP. The wood turtle is a riparian species and typically uses a mosaic of wetland and upland habitats in the vicinity of its stream habitat; however, this species often uses vernal pools located in the vicinity of streams during early spring to feed on amphibian eggs, larvae, and invertebrates (Kenney and Burne).

The barred owl is a State-listed Threatened species and a goal for increasing the population has been set in the Piedmont Region under the NJWAP. In Northern New Jersey, barred owls inhabit mature, mixed deciduous wetland or riparian forests and prefer flat, lowland terrain (Beans and Niles, 2003). Nocturnal owls have been documented foraging for amphibians traveling to and from vernal pools (Kenney and Burne).

Strategies

- Continue to protect all known vernal pools and maintain surrounding intact forest. Map locations of, and protect any new vernal pools located on the refuge. Evaluate newly identified vernal pools for presence of indicator species (i.e., fairy shrimp, wood frogs, and blue-spotted salamanders).

- Continue to conduct population surveys (i.e., egg mass counts of blue-spotted salamanders and wood frogs) at vernal pools to monitor trends in indicator species activity.

- Perodically inventory and monitor snags. Continue to allow dead trees and snags to persist (i.e., no cutting or removal), to provide additional microhabitats (e.g., natural cavities), for various wildlife species, including bats, woodpeckers, owls, and other wildlife species, as well as future cover and egg site attachment sites for amphibians.

- Continue to monitor, maintain, and restore vernal pool habitat, where practical. Document the extent that invasive plants are occurring in vernal pool habitat and carry out targeted control when necessary. Enhance condition of poor-quality vernal pools [i.e., add thin, long branches and twigs to provide amphibian egg laying sites, maintain large woody debris, brush piles, and rock piles in surrounding forest to provide moist protected cover for adult amphibians, and carry out habitat restoration activities (i.e., native shrub plantings and tree girdling to open the canopy, create snags, and increase percentage of shrub cover) as needed].

Objective 3.2 Riparian Corridors

Where practical, maintain a minimum of a 492 foot (150 meter) wide (Fischer 2000) buffer of riparian corridor along all of the streams on the refuge, including floodplain and swamp forest, dominated by native species, such as American sycamore, pin oak, American elm, and Southern arrowwood, to maintain connectivity of mature bottomland hardwood forest and riverine habitat; to protect the water quality of the Great Brook, Loantaka Brook, Black Brook, Primrose Brook and the Passaic River; to provide roosting and foraging habitat for Indiana bat; and to provide nesting habitat for barred owl, wood duck, wood turtle, and other species of conservation concern.

Rationale

Riparian corridors, including floodplain and swamp forest habitat types, support numerous forest dependent bird species, bat species, and freshwater fisheries. The Indiana bat, a State- and federally listed endangered species, utilizes riparian corridors at Great Swamp NWR for foraging and roosting (see Objective 3.3 for additional information and details on habitat use) (Kitchell 2008). The barred owl is a State-listed threatened species. Additionally, a goal has been established by the NJWAP to increase the barred owl population in the Piedmont region of New Jersey (see Objective 3.3). The State-threatened wood turtle utilizes the aquatic portions of the riparian corridor for foraging and reproduction. The wood turtle also utilizes submerged riparian root systems for brumation and are found in mid-successional forest dominated by oaks, red maple and black birch. Wood turtles have declined in many historic sites in New Jersey due to habitat loss and stream degradation (Beans and Niles, 2003). Wood turtles generally require undisturbed pollutant-free habitats, often at least 0.5 miles away from development (Beans and Niles, 2003). The wood duck has long been historically and successfully managed at Great Swamp NWR and is associated with the refuge purpose. Wood ducks are a cavity-nesting species that may nest in forests typically within 600 feet of slow moving streams or other standing water. The wood duck is a species listed as high priority in BCR 29 and the NJWAP seeks to maintain populations of this species within the Piedmont. Additional forest bird resources of concern that utilize riparian forest habitats at Great Swamp NWR for foraging and/or nesting include Louisiana waterthrush, red-headed woodpecker, hooded merganser, Cooper's hawk, rose-breasted grosbeak and yellow-throated vireo. The cerulean warbler and over a dozen other warbler species identified on the Great Swamp Resources of Concern list may also utilize the riparian habitats during migration.

In addition to preventing water quality degradation through nutrient, sediment and pollutant control, riparian corridors allow wildlife to move between habitat patches. The best corridors are those that are the widest possible and those that connect the largest patches of habitat. Forest interior and neotropical migrant birds, although able to disperse effectively, have been found to have a higher probability of using wider corridors (Keller, *et al*. 1993). Hodges and Krementz (1996) recommend that the minimum corridor width be no less than 330 feet (100 meters) in width.

The improvement, stabilization, protection and maintenance of riparian corridors will also benefit aquatic fauna, particularly freshwater fisheries and macroinvertebrate species. Riparian vegetation species provide an important food base for benthic organisms that break down fallen organic matter, making this material available to other aquatic organisms. Riparian vegetation shades stream corridors, which provides suitable trout habitat while supplying adequate root mass for bank stabilization. The native brook trout (*Salvelinus fontinalis*), a refuge resource of concern, depends on small, cold and clear streams. Brook trout cannot tolerate temperatures greater than 77.5 degrees Fahrenheit (25.3 degrees Celsius), with a maximum temperature for self-sustaining populations at about 66.2 degrees Fahrenheit (19 degrees Celsius) (Detar 2007). One resident fish species, commonly found in streams of the refuge, typically associated with brook trout is the blacknose dace (*Rhinichthys atratulus*) (Hiawatha National Forest Draft Environmental Impact Statement 2005). The protection and improvement of stream health and aquatic resources will contribute to biodiversity of the refuge.

These riparian corridor habitats of Great Swamp NWR may be interspersed with patches of shrub and emergent wetland, including the floodplain pool association (see Chapter 3 for a full description). The floodplain pool association is a narrow herbaceous community located between streams and the adjacent forested habitat. The floodplain pool association may be particularly important for a variety of aquatic amphibians and is identified as globally imperiled (Sneddon, 2008).

Strategies

- Continue to conduct invasive species management, as necessary.
- Continue to allow dead trees and snags to persist (i.e., no cutting or removal), which would provide additional microhabitats (e.g., natural cavities), for various wildlife species, including bats, woodpeckers, owls, and other wildlife species.
- Continue selective cutting using chainsaws or other techniques.
- Continue to maintain existing Atlantic white cedar plantings.
- Continue to maintain wood duck boxes and perform nest box checks.

Monitoring Elements:

- Inventory and monitor snags for wood ducks.
- Continue to conduct vegetation and wildlife surveys, such as Indiana bat surveys, to monitor trends, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys, such as bat emergence counts.

Objective 3.3 Bottomland Forest

For the life of the plan, maintain 3,700 acres of mature and late successional stages of bottomland forest consisting of a mix of native vegetation of pin oak, red maple, swamp white oak, shagbark hickory, black gum, American elm, sweet gum, and green ash in the canopy with understories of Southern arrowwood,

hornbeam, and sweet pepperbush at varying densities. Target high priority areas for removal of invasive plants, based upon level of threat and potential for re-colonization, and prevent the establishment of invasive species in unaffected areas to maintain biodiversity and ecosystem health. Bottomland forest patches should be large and contiguous (with other patches of both wetland and upland forest) to the greatest extent practicable. Patches in excess of 700 acres should be maintained at the refuge to provide ideal nesting habitat for barred owl, wood thrush and numerous other forest interior breeding species. Maintenance of mature bottomland forest, containing both dead and dying trees, will also provide roosting habitat for Indiana bat and other bat species.

Rationale

The Indiana bat is a federally and State-listed endangered species. Additionally, a goal for increasing this population was also set for the Piedmont Region under the NJWAP. Great Swamp NWR is documented as having one or more maternal roost colonies for Indiana bat in New Jersey (Kitchell 2008). Maternal roosts are typically established in agricultural areas with fragmented forests. Roosting by Indiana bat occurs within the Management and Wilderness areas of the refuge, where an interspersion of forests, shrubland, open water, and wet meadow exists (Kitchell 2008). Roost trees are found within a variety of forested habitats, including wetlands and riparian areas, and primarily include snags or nearly dead trees with peeling or exfoliating bark. Primary roost trees are of large diameter (greater than 22 inches dbh) in open areas with high exposure to sunlight, while alternate roosts are generally smaller in diameter and located within forest interior (Kitchell 2008). Foraging occurs primarily in and around forested habitats that include pole-stage mixed-oak forest, floodplain forest, upland forest, and forested wetlands (Butchkoski and Hassinger 2002, Gardner et al. 1991, Humphrey et al. 1977, Murray and Kurta 2004, Romme et al. 2002, Sparks et al. 2005). Pregnant or lactating bats forage primarily within wooded corridors, streams, associated floodplain forests and impounded bodies of water, but will sometimes use hedgerows, upland forest, early successional fields and along croplands (Kitchell 2008).

The barred owl is a State-listed threatened species, which has also been given a goal of increasing Piedmont populations in the NJWAP. Barred owls require large tracts of mature interspersed wetland and upland forest. In eastern North America, barred owls generally maintain established territories year-round, with home ranging from 213 to 914 acres (86 to 370 ha) in size (Beans and Niles, 2003). Forests within Great Swamp NWR support a significant population of this species.

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The wood thrush is of the highest rank in BCR 28 and is a high priority in BCR 29. Both PIF Physiographic Areas 9 and 10 designate this species as the highest (IA) priority. Wood thrush is listed as both a Bird of Conservation Concern and a Species of Regional Concern for the USFWS. Robbins (1979) estimated that a minimum area of 247 acres (100 ha) is required to support a viable breeding population of wood thrush. The protection of forest patches of sufficient size and connectivity results in the protection of numerous other migratory and breeding forest interior bird species at Great Swamp NWR, including but not limited to Cerulean warbler, Canada warbler, Prothonotary warbler, Louisiana waterthrush, veery, Cooper's hawk, red-headed woodpecker, Acadian flycatcher, and Eastern screech owl. Red-shouldered hawks are listed as endangered (breeding) in New Jersey and have

been recorded nesting in Great Swamp NWR, but were not chosen as a focal species due to the limitations on forest expansion. Additionally, the maintenance of large tracts of forested land for barred owl will benefit red-shouldered hawk.

In the early 1900s, the wood duck population was reduced to exceedingly low levels due to over harvesting. The Migratory Bird Treaty Act, harvest regulations, and management actions have allowed the wood duck population to increase dramatically. In the Northeast, wood duck populations have increased in response to recovering beaver populations, the use of artificial nesting boxes, and increasing amounts of mature cavity trees. Approximately 7,800 juveniles are produced annually in nest boxes at all Region 5 refuges combined, or 0.24 percent of the fall population of juvenile birds. Great Swamp NWR contains approximately 200 wood duck nest boxes that are primarily maintained and monitored by volunteers (USFWS 2006e). The overall contribution of the wood duck box program should be assessed to determine the refuge's contribution to the local population. Volunteer resources may be more valuable and beneficial in other management programs, such as invasive species detection and control. Although wood ducks are ranked a "high priority" in BCR 29, the refuge contains high quality snags and mature cavity trees which provides natural habitat for many cavity dwelling or snag-dependent species, including wood ducks, red-headed woodpeckers, screech owls, and bats. Continuation of the wood duck box program may no longer be necessary.

Threats to bottomland forest in New Jersey include habitat fragmentation; invasive species, especially Japanese stiltgrass; development and associated encroachment; change in hydrology (i.e., increase in flooding, siltation, erosion) due to development; browsing pressure by white-tailed deer; forest succession to a climax stage (impediment to regeneration); and parasites, disease, and infestations, such as gypsy moth, Dutch elm disease, bacterial leaf scorch, and chestnut blight.

Active management of forested areas in the Management Area consists primarily of invasive species control (i.e., Japanese barberry and Japanese wisteria) and selective thinning to encourage understory growth. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques, very little management occurs in these areas since this area historically experienced less land alteration and as a result has fewer occurrences of invasive species.

Strategies

- Continue to conduct invasive species management, as necessary.
- Continue to allow dead trees and snags to persist (i.e., no cutting or removal), which would provide additional microhabitats (e.g., natural cavities), for various wildlife species, including bats, woodpeckers, owls, and other wildlife species.
- Continue selective cutting using chainsaws or other techniques.
- Reconfigure vegetative communities to maximize patch size, reduce fragmentation, and optimize wildlife use and value.
- Increase monitoring and early detection of forest disease and pests, including sudden oak death syndrome and emerald ash borer.

- Where feasible and practical, use feathered edges to create softer transitions between forest and adjacent habitats.

- Evaluate the ecological value of the wood duck box program to determine its contribution to the local population.

  - Identify and remove boxes that are not generally productive, attract non-desirable species, are prone to dump nesting, or are subject to high predation.

  - Less valuable boxes that become old and dilapidated should not be replaced.

  - Combine box removal activities with public outreach effort, emphasizing the importance of high quality snags for cavity nesting species, including wood ducks, red-headed woodpecker, and bats.

  - Consider maintaining a select number of structures for the purpose of providing wildlife observation, photography, and interpretative opportunities.

Monitoring Elements:

- Continue to conduct vegetation and wildlife surveys, such as Indiana bat surveys, to monitor trends, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys, such as bat emergence counts.

Objective 3.4 Mature Upland Forest

Provide 1,700 acres of mature-late successional upland forest dominated by native species of oak, hickory and beech to benefit migratory breeding birds, including Eastern wood pewee, scarlet tanager and wood thrush. Focus forest management and restoration on parcels within 500 acre blocks of forest or more, if possible, with an emphasis on those parcels with minimal edge habitat, and maintain forests in close proximity to one another.

Rationale

The Eastern wood pewee is a high priority species in BCR 29, a moderate priority in BCR 28, and a high regional priority in PIF Physiographic Area 9. Additionally, a goal to increase the population of this species was set for the Piedmont Region under the NJWAP. The Eastern wood pewee is a generalist species that occupies primarily deciduous, evergreen, and mixed woodland types, but will also utilize open, park-like conditions on xeric sites with limited canopy cover and low shrub densities (Robbins and others, 1989; McCarty 1996). This species will also utilize small forest fragments; however, it may require a minimum amount of forest in the landscape (60 to 90 percent with optimal levels between 80 and 90 percent in 0.62 mile radius).

The scarlet tanager is a moderate priority in BCR 28, highest priority in PIF Physiographic Area 9, and high priority in PIF Physiographic Area 10. A goal to increase the population of this species was set for the Piedmont Region under the NJWAP. This species prefers mature forest, especially where oaks are common, but may occur in young successional woodlands. Scarlet tanagers prefer to nest in large trees with horizontal limbs and small branches (Mowbray, 1999; Stokes, 1983). Notably, as the amount of forest

in the surrounding landscape block decreases below 70 percent, the minimum area required by tanagers increases as the amount of forest in the landscape is reduced.

The wood thrush is of the highest rank in BCR 28 and is a high priority in BCR 29. Both PIF Physiographic Areas 9 and 10 designate this species as the highest (IA) priority. Refer to *Objective 3.3 – Bottomland Forest* above for additional details and habitat requirements.

Threats to upland forests in New Jersey include habitat fragmentation; invasive species, especially Japanese barberry and garlic mustard; urban sprawl, development and associated encroachment; browsing pressure by white-tailed deer and forest succession to a climax stage (impediment to regeneration); and parasites, disease, and infestations (i.e., gypsy moth, Dutch elm disease, bacterial leaf scorch, and chestnut blight).

Large tracts of contiguous forested areas are necessary to support breeding populations of migratory songbirds (Robbins et al. 1989; Robinson et al. 1997), as well as forest dwelling raptors (Bosakowski et al. 1992; Bosakowski 1994). Most forest interior species will only nest within a forest "core" that is at least 295 feet from the nearest forest edge. In addition, the forest core must be a minimum of about 25 acres in size (Dawson et al. 1993). Multiple regional plans stress the importance of developing larger contiguous or core mature forest patches within the regional landscape (Northern Piedmont Plains). Under this alternative, various forest interior species would directly benefit from the consolidation of forest habitat, including wood thrush, scarlet tanager, Acadian flycatcher, and a number of warblers (e.g., Canada warbler, cerulean warbler, black-and-white warbler, and Kentucky warbler, among others).

Loss of forested land and forest fragmentation due to development are two primary reasons for the decline in many forest-dependent bird species. Fragmentation of forested areas by means of development isolates stands from the main forest complex, increases the amount of edge habitat, and decreases the amount of forest interior habitat. Negative effects associated with forest habitat fragmentation are well documented for forest interior breeding birds (Whitcomb et al. 1981; Robinson et al. 1995). Fragmented forests are characterized by high levels of edge-related nest predation and brood parasitism, and prove undesirable for many area-sensitive species, including Arcadian flycatcher, Louisiana waterthrush, prothonotary warbler, wood thrush, veery, and scarlet tanager (Rich et al. 1994; Robinson et al. 1995). In addition, forest fragmentation can facilitate the spread of invasive plant species that can dramatically change the habitat structure of the forest. Under this alternative, we propose to consolidate habitats into larger patch sizes, which will reduce fragmentation and edge effects and associated ecological impacts.

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Feathered edges, also known as cut-back borders, may be used to create a softer ecotonal transition between mature forest and adjacent habitat types like grassland, scrub-shrub, or wetland. In general,

feathered edges are at least 50 feet wide with a rough, irregular edge composed of various young trees, shrubs, vines, and herbaceous plants (Arbuthnot 2008; USDA undated). Feathered edges can serve as important travel and dispersal corridors, and can reduce fragmentation effects (Arbuthnot 2008). Feathered edges provide important nesting, foraging, and escape cover for a variety of wildlife species. In addition, feathered edges improve flowering plants for pollinators and soft mast producing shrubs for wildlife food (Oehler et al. 2006; USDA undated).

Active management of forested areas in the Management Area consists primarily of invasive species control (i.e., Japanese barberry and Japanese wisteria) and selective thinning to encourage understory growth. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques, very little management occurs in these areas since this area historically experienced less land alteration and as a result has fewer occurrences of invasive species.

Strategies

- Continue to conduct invasive species management, as necessary.
- Continue to allow dead trees and snags to persist (i.e., no cutting or removal), which would provide additional microhabitats (e.g., natural cavities), for various wildlife species, including bats, woodpeckers, owls, and other wildlife species.
- Continue selective cutting using chainsaws or other techniques.

Monitoring Elements:

- Continue to conduct vegetation and wildlife surveys, such as Indiana bat surveys, to monitor trends, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys, such as bat emergence counts.

GOAL 4 Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Objective 4.1 (Hunting)

Similar to alternative A, objective 4.1; however, provide additional hunting opportunities to the public and promote awareness regarding the ecological benefits of hunting.

Rationale

Hunting is one of the six priority public uses to receive enhanced consideration on National Wildlife Refuges in accordance with the Refuge Improvement Act of 1997 and as such needs to be considered at each refuge. If deemed compatible, refuges have a proactive responsibility to provide safe, high-quality public hunting opportunities. Hunting is recognized in the Refuge System as a healthy, traditional outdoor past time, and is deeply rooted in our American heritage.

Hunting opportunities within Northern New Jersey and particularly in the vicinity of Great Swamp NWR are continually reduced by expanding land development and loss of hunting opportunity. As a result of the local reduction of available hunting lands, the demand for hunting on public lands has increased. During the USGS visitor survey, 24 percent of those surveyed identified hunting as an activity they have participated in at the refuge during the past 12 months. With this in mind, the refuge seeks to provide this quality experience to all interested participants, including groups that have limited hunting access or opportunity, such as youths and disabled individuals.

Under this alternative, the refuge would provide two separate and distinct white-tailed deer hunting seasons, including a fall archery (bow) season each October and a firearm season each November. Archery provides the refuge with an additional tool for deer management that does not disrupt current levels of access or reduce the refuge experience for non-hunting visitors. The refuge also proposes the addition of spring wild turkey (*Meleagris gallopavo silvestris*) hunt, which would include a one-day youth hunt at the end of April followed by a regular hunt during a one-week period in late May. Spring turkey hunting would be conducted within the framework of New Jersey State regulations, federal regulations in 50 CFR pertaining to the upland game hunting, and refuge-specific regulations. Season dates and bag limits would be managed to ensure that refuge hunts are compatible with the principles of sound wildlife management and otherwise in the public interest, and would be modified, as needed, on an annual basis. Allowing turkey hunting at the refuge will provide a new and sustainable wildlife-dependent recreational opportunity to the public without interference or additional limits on other wildlife-dependent uses of the refuge.

Fall archery hunting would be allowed on approximately 5,000 acres of the refuge, or about 65 percent of the total area (7,735 acres), which includes the Wilderness Area east of Long Hill Road and Management Area south of White Bridge Road, with exception of land designated as “Safety Zone” or “No Entry.” Firearm hunting would continue to be allowed on approximately 6,376 acres of the refuge, or about 82 percent of the total area, which includes the Wilderness and Management Areas, with exception of land designated as “Safety Zone” or “No Entry.” Similar to archery hunting, wild turkey hunting would be allowed on approximately 5,000 acres of the refuge or about 65 percent of the total area, which includes the Wilderness Area east of Long Hill Road and Management Area south of White Bridge Road with exception of land designated as “Safety Zone.”

The additional Great Swamp NWR hunting opportunities provided under the preferred alternative would expand wildlife-dependent recreational opportunities without reducing access or other non-hunting wildlife opportunities at the refuge. Hunting opportunities at the refuge would be designed to provide the widest range of opportunities with safe, high-quality hunting conditions. These conditions include reasonable harvest expectations, low hunter densities with few conflicts between hunters, relatively undisturbed wildlife, and limited disruption from or use of mechanized equipment.

As is done with the existing hunting program at the refuge, populations of hunted wildlife will be closely and regularly monitored. Parameters of the hunt, including seasons and limits, will be adjusted as needed to maintain healthy populations of hunted wildlife (see alternative A, Objective 4.1).

Strategies

In addition to Alternative A, Objective 4.1:

- Within 2 years, provide a fall archery hunt for white-tailed deer, which will precede the current shotgun and muzzleloader season. This hunt would occur within the Wilderness Area and on refuge lands south of White Bridge Road. The target goal is to maintain levels of deer at 18 to 20 per square mile.

- Within 2 years, open a spring wild turkey hunt for gobblers (males) in the Wilderness Area and areas south of White Bridge Road. The hunt would sustain low daily densities of hunters. There would be no fall hunt for wild turkey.

- Provide a one-day youth hunt for turkey during the spring season

- Collect data on the refuge's turkey population through regular winter and spring counts and by collecting data.

- Use data about the turkey population to set initial bag limits and revise over time as necessary.

- The additional hunts proposed would not result in changes to public access such as additional trail closures of the refuge to the non-hunting visitors.

- Coordinate with Somerset and Morris County EECs to synchronize hunting periods to maximize deer harvest and avoid use conflicts.

- Promote outreach and education programs to increase understanding of the impacts of overabundant deer and other species and the role hunting can play in wildlife management and outdoor recreation.

- Provide additional hunting opportunities for various sectors of the population including veterans and disabled individuals (days, access, hunting blinds, etc.).

Objective 4.2 (Fishing)
Same as alternative A, objective 4.2.

Objective 4.3 (Wildlife Observation, Photography and Public Access)
In addition to alternative A, objective 4.3, enhance or expand the variety of wildlife observation and photography opportunities and improve the quality of access while minimizing user conflicts and impacts to wildlife.

Rationale
Wildlife observation and nature photography represent two of the six priority public uses ("Big Six" public uses) identified in the National Wildlife Refuge System Improvement Act of 1997. The refuge offers many opportunities to view and photograph wildlife, plants, and habitats. The refuge permits the public to use several different modes of access to facilitate opportunities for wildlife observation and photography. The permitted modes of access have been determined to minimize user conflicts and impacts to the refuge's resources.

During the first CCP scoping period, individuals and members of various organizations expressed interest in expanding public access through the creation of new trails and parking areas; maintaining existing trails, boardwalks, and blinds; and improving and maintaining the WOC, access roads, and Pleasant Plains Road.

The FWS is constantly trying to achieve a balance between protecting wildlife and offering a quality visitor experience.

Under this alternative, we propose to extend existing trails, provide limited access to existing service roads, and create new trails; provide additional parking and pull-offs; expand the Wildlife Tour Route; and construct observation towers. Providing increased opportunities for the public on the refuge promotes visitor appreciation and support for refuge programs as well as habitat conservation efforts in the GSW and region.

Strategies

- Expand Wildlife Tour Route from Great Brook Bridge to the Visitor Center.
- Provide additional pull-offs or parking opportunities along the Wildlife Tour Route and White Bridge Road for additional wildlife observation and photography opportunities.
- Evaluate and determine ways to encourage visitors to explore the refuge beyond the Visitor Center, such as the Wilderness Area, WOC, Wildlife Tour Route, and the Headquarters.
- Create additional pollinator gardens within areas viewable to the public for pollinators to promote awareness of native plants and pollinators.
- Construct two observation towers for viewing and teaching opportunities of impoundments and moist soil units. Observation towers would be located near the display pond by the Headquarters and at the WOC.
- Construct additional trails at the Visitor Center for wildlife viewing and educational opportunities.
- Increase communication between individuals staffing the WOC and the Visitor Center during high visitation periods to better direct visitors, reduce overcrowding, and improve visitor's experiences.
- Increase maintenance of or renovate blinds at the WOC, when necessary, to improve visitors' experience.
- Increase connectivity of Wilderness Area trails to provide additional access opportunities to visitors.
- Coordinate with partners to provide refuge visitors with additional access opportunities (i.e., closed areas, after-hours tours, etc.) by taking advantage of existing programs, such as the Raptor Trust's Owl Prowl.
    - Consider jointly sponsoring events with partners.

Objective 4.4 (Non-Wildlife Recreational Opportunities)
Same as alternative A, objective 4.4.

Objective 4.5 (Environmental Education)

Moderately expand standard-based educational opportunities, programming, and materials for all educational levels; and increase opportunities for urban populations.

Rationale

Environmental education is identified in the National Wildlife Refuge System Improvement Act of 1997 as a priority public use ("Big Six" public use). Environmental education in the Refuge System incorporates on-site, off-site, and distance-learning materials, activities, programs, and products that address the audience's course of study, the mission of the Refuge System and the management purposes of the refuge. The goal of environmental education is to promote awareness of the basic ecological foundations for the interrelationships between human activities and natural systems. Through curriculum-based environmental education, both on- and off-refuge, refuge staff and partners hope to motivate students and other persons interested in learning the role of management in maintaining healthy ecosystems and conserving our fish and wildlife resources.

Under this alternative, the refuge would work to expand its Visitor Services staff to increase and improve environmental education programming. This would allow the refuge to reach more teachers and students each year and develop new multidisciplinary programs that meet State curricula standards. In addition, the Visitor Center hours of operation would also be expanded under this alternative. The Visitor Center is currently open four days a week, specifically Thursdays-Fridays (noon to 4 PM) and Saturdays-Sundays (10 AM to 4 PM). The Friends of Great Swamp Nature Shop, which is located in the Visitor Center and staffed solely by volunteers, is also open during these times.

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The refuge would continue to encourage volunteers and partners to provide on- and off-site programs and environmental education materials. In addition, the refuge would create new and enhance existing partnerships with educational institutions, county education centers, and other organizations. The internship program would also be expanded by providing additional opportunities for students to gain a valuable learning experience and to help meet college employment program requirements.

Strategies

- Increase Visitor Services staff to four full-time employees.

- Increase environmental education opportunities by providing up to five programs per year at the refuge and three programs per year off the refuge.

- Within 3 years, provide at least 2 on-site environmental education opportunities for nearby urban communities, such as Morristown or Newark.
    - Provide programs that raise awareness of the Service mission and share how the conservation of natural resources is important to the local urban community.

  - Include a continuum of nature experiences for students and urban residents that moves from awareness to engagement.
  - Highlight the value of wildlife that lives in urban areas, and foster connections between wildlife and urban residents.

- Work with local urban communities, to secure grant funding in support of environmental education, including transportation and programming.

- Develop a special relationship with an urban school or class and host a series of on-site and off-site events over the course of a school year.

- Translate refuge brochures and website into Spanish.

- Work with partners like Boy/Girl Scouts, NJ Audubon, TNC, Passaic River Coalition, local colleges to promote visits by organized urban youth groups/clubs (birding club, AP biology class, scout troops, etc.).

- Rotate refuge display among urban schools and follow-up with an on or off-site visit.

- Expand partnership opportunities with county Environmental Education Centers and The Raptor Trust to increase educational opportunities and promote the Great Swamp NWR within the local community.

- Secure grants through National Fish and Wildlife Foundation and others to increase the number of programs offered.

- Work more closely with partner institutions to provide additional curricula-based classes and educational resources.

- Reach out to community colleges, colleges, and universities to promote refuge-based educational programs as part of their curriculum and employment experience requirements.

- Increase opportunities share interns with partners to provide a broader educational experience and to stimulate interest and motivation.

- Increase refuge internship program to accommodate six to eight interns per year, including biological, visitor services, and maintenance interns. Expand internship opportunities beyond the summer months.

- Develop one new multidisciplinary program every 2 years that meets State curricula standards and relates to current events and issues, such as global conservation, climate change, aquatic resources, biology, and pests and diseases.

Objective 4.6 (Environmental Interpretation)
Moderately expand environmental interpretation to incorporate more informal educational opportunities to reach a greater and more diverse audience, especially in the New Jersey-New York metropolitan area.

Rationale

Environmental interpretation is identified in the Improvement Act as a priority public use ("Big Six" public use). Interpretation is an educational activity aimed at revealing relationships, examining systems, and exploring how the natural world and human activities intertwine. One of its goals is to stimulate additional interest and positive action. Interpretation is both educational and recreational in nature. That is, participants voluntarily become involved in interpretive activities because they enjoy them, and in the process, they learn about the complex issues confronting fish and wildlife resource managers. Although audiovisual media, exhibits, demonstrations, and presentations are often advantageous and necessary components in interpretation, the program emphasizes first-hand experience with the environment.

As discussed above under Alternative B, Objective 4.5, additional staff would be requested under this alternative, which would allow the refuge to enhance its environmental interpretation program. Additionally, the operational hours of the Visitor Center would be expanded, which would provide visitors access to exhibits, displays, and audiovisual media that serve to educate the public about the refuge's resources. Expanded operational hours would also allow for additional opportunities and more flexible schedules for demonstrations, presentations, and other interpretative programs at the Center. Expanding the Visitor Center hours would allow the refuge to reach more visitors and promote increased usage during non-peak visitation periods.

Strategies

- Increase Visitor Services staff to four full-time employees.
- Expand the Visitor Center's operational hours to 7 days per week year round.
- Increase environmental interpretation opportunities by providing up to five programs per year at the refuge and three per year off the refuge.
- Promote the Visitor Center through a variety of media to increase awareness of the FWS mission, refuge purposes, and refuge resources.
- Use the USGS Visitor Survey and other sources to guide environmental interpretation based on public interest, current events, refuge or FWS priorities, and ongoing refuge management.
- Expand opportunities for first-hand wildlife connections that inspire, instill appreciation, and raise awareness. When possible, provide or sponsor opportunities with partners.
- Collaborate with partners to promote outreach in urban and minority communities.
- Provide temporary moveable interpretative signage to inform visitors on the purpose and benefit of management activities, such as rotational mowing and Hydro-Axing.
- Increase interpretative programs about climate change and its impact upon wildlife and vegetation communities.
- Use, promote, and provide interpretative programs about the benefits of green technology.

- Increase the use of technology, such as Q-R tags, on interpretive materials to provide visitors with additional information about the refuge's resources.

GOAL 5 Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and surrounding landscape.

Objective 5.1 (Volunteers and Partnerships)
Same as alternative A, objective 5.1, but with the following additional strategies.

Rationale
Partnerships and volunteers are vital to refuge management by providing labor, knowledge, and enthusiasm for biological, public use, and maintenance programs beyond what could be provided by staff alone. Partners and volunteers also facilitate public outreach and provide many environmental interpretation and education programs. Under Alternative B, the existing volunteer program and partnerships would be expanded to encourage learning and study of the refuge, increase volunteer participation, and promote coordination between partners, volunteers, and the refuge.

Strategies
- Identify groups and individuals in the urban community with whom to partner to conserve more wildlife and accomplish conservation efforts previously unachievable.

- Promote awareness and coordination between volunteers, organizations, and refuge and increase volunteer participation (e.g., host biannual meetings).

- Partner with Morris and Somerset County tourism boards to promote eco-tourism at the refuge.

- Expand partnerships with educational institutions, such as Morris and Somerset County Community Colleges, Drew University, Fairleigh Dickinson University, College of Saint Elizabeth's, and Rutgers University, to promote formal educational uses and study of the refuge.

- Promote Heritage Trail, similar heritage resources, and "Crossroads of the American Revolution National Heritage Area."

- Within 2 years, establish partnerships with two local private companies to sponsor an intern or refuge event, or adopt a trail for maintenance.

Objective 5.2 (Public Outreach)
Expand outreach in such a way that increases visitation and usage without negatively impacting the diversity of wildlife, plants, or vegetation communities on the refuge.

Rationale
Expanding public outreach would improve recognition of and appreciation for the refuge, the Refuge System, and the FWS among neighbors, local leaders, conservation organizations, and elected officials, thereby generating support for conservation in the region. Outreach can take many forms, including off-site

exhibits and displays; news media relations; internet, intranet, and Listservers; partnerships; environmental education; memberships in professional and community organizations; and Congressional relations.

Because of its location in a highly urbanized and populated area, the refuge has the potential to reach out to millions of children and adults making Great Swamp NWR the ideal place to implement the Refuge System's new "Urban Refuges" initiative. New Jersey is the most densely populated state in the country with an estimated 1,195 people per square mile (US Census Bureau 2011a). New York City, the most populated city in the U.S. (8,175,133), is located approximately 35 highway miles from the refuge. Philadelphia, the fifth most populated city in U.S. (1,526,006), is located approximately 80 highway miles from the refuge (US Census Bureau 2011b). The top five most populated cities in New Jersey are located within 30 highway miles, including Newark, Jersey City, Paterson, Elizabeth, and Edison. The New Jersey-New York metropolitan area is very racially diverse and Hispanics or Latinos (of any race) are the dominant minority group in New Jersey, making up 17.7 percent of the State population (US Census Bureau 2011c). Public outreach will benefit communities in the greater New Jersey-New York metropolitan area by raising awareness, instilling appreciation, and educating individuals about the unique natural resources found on the refuge and about current environmental issues.

In recent years, the use of wireless communications and the internet have become primary methods of communication. The volume of wireless data traffic in the U.S. grew by 50 percent from the end of 2009 to June 2010. By 2015, it is estimated that 98 percent of U.S. mobile web traffic will come from smart phone users and the number of wireless internet users will increase from 84 million to nearly 160 million (CTIA 2011). The first cell phone "app" was launched in July 2008. Since then, more than 500,000 "apps" have become available from numerous providers (CTIA 2011). For example, an "app" entitled *myRefuge Maps* provides maps and information about bird watching, trails, and historic sites at participating National Wildlife Refuges, including Great Swamp NWR. Under this alternative, the refuge would embrace these types of communications as methods of public outreach. Use of the internet (i.e., refuge website), cell phone "apps", and social media websites (such as, but not limited to, Facebook, Twitter, Google+, YouTube) would allow the refuge to reach individuals in the local community, in the New Jersey-New York Metropolitan Area, and across the world.

Strategies

- Expand the use of web cams for viewing wildlife to reach a broader audience and instill interest.
- Re-establish the Youth Conservation Corps summer program as a tool for outreach and recruitment of urban and minority youths.
- Promote public awareness in neighboring communities and develop partnerships to address important environmental issues such as the spread of invasive plant species and the availability of native plant alternatives.
- Develop a "virtual refuge tour" to reach a broader audience on the internet with the goal of encouraging visitation.
- Improve design of and information contained on the refuge's website.
- Increase media and publicity by promoting the refuge in local and regional papers, such as the Chatham Patch.

- Reach out to minority groups and partner with organizations in the New Jersey-New York metropolitan area to raise awareness and appreciation.

- Develop cell phone applications ("apps") to provide tours and maps.

- Develop a "Watershed Wagon" or mobile visitor center similar to Silvio O. Conte NWR's "Watershed on Wheels" to reach out to communities and schools throughout the area.

- Create educational videos to reach a broader audience on the internet, such as "You Tube" videos.

Objective 5.3 (Climate Change)

Increase efforts to address global climate change through outreach, interpretation and education, refuge habitat planning and water management, partnerships, green technology, and maintenance.

Rationale

Worldwide scientific consensus tells us that our climate is changing and that these changes are already impacting our natural resources, as well as the people, communities, and the economies that depend on them. The observed changes in climate have been directly correlated to the increasing levels of carbon dioxide and other greenhouse gases in the atmosphere (USFWS et al. 2012). Signs of rapidly changing climate are unmistakably evident, including melting glaciers, more frequent and more intense heat waves and droughts, flowers blooming earlier, birds delaying their migrations, rising sea levels, and increases in global average air and ocean temperatures (USFWS et a.l 2012; IPCC 2007). Refer to section 2.1.7 for additional details and examples of climate change impacts.

In response to accelerating climate change, the FWS prepared a plan entitled "Rising to the Urgent Challenges of a Changing Climate: A Strategic Plan for Responding to Accelerating Climate Change in the 21st Century", which was finalized in September 2010 (USFWS 2010a). The primary purposes of the plan are to present a vision for accomplishing the FWS mission in the face of accelerating climate change, to provide direction for our organization and its employees, and to define our role within the context of the Department and the larger conservation community (USFWS 2010a). The plan calls for the FWS and its partners to face challenges, lay the foundation for science-based decision making in the future, and take actions now to ensure that our nation's fish and wildlife resources will thrive in the years to come.

In 2009, Congress urged the CEQ and the Department to develop a national, government-wide climate adaptation strategy to assist fish, wildlife, plants, and related ecological processes in becoming more resilient, adapting to, and surviving the impacts of climate change (USFWS et al. 2012). In a cooperative effort among federal, State, and Tribal governments, the FWS prepared a draft plan entitled "National Fish, Wildlife, and Plants Climate Adaptation Strategy," which was released for public review and comment in January 2012. The purpose and overarching goal of the plan is to provide a nationwide, unified approach, reflecting shared principles and science-based practices, to protect the nation's biodiversity, ecosystem functions, and sustainable human uses of fish, wildlife, and plants in a changing climate (USFWS et al. 2012). The plan provides a basis for sensible actions that can be taken now, in spite of uncertainty that exists about the specific impacts of climate change, and presents guidance about what actions are most likely to promote natural resource adaptation. In the context of climate change, adaptation is defined as an

"adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (USFWS et al. 2012).

In accordance with the Adaptive Management Implementation Policy [522 Department Manual (DM) 1], all Department bureaus and offices are encouraged to incorporate adaptive management strategies into their land and resource management decisions. Adaptive management is defined as "a process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become more understood" (DOI 2008). Environmental assessments are necessary to determine resource status, promote learning, and evaluate progress toward achieving objectives whenever using adaptive management.

Climate change poses significant new challenges for refuge managers, natural resource professionals, legislators, and other decision makers. However, each year, more is being learned on how the climate will change, its impacts on our natural resources, and how future management and policy decisions will affect these impacts (USFWS et al. 2012). Although there is much uncertainty in terms of climate change, adaptive management is structured in way that new information can be incorporated into decision-making over time without delaying needed management actions. Adaptive management actions must be made using the best science-based information available while always striving to improve our knowledge and management capabilities.

According to the 2010 to 2011 USGS Visitor's Survey of Great Swamp NWR, approximately 80 percent of those surveyed indicated that future generations will benefit from addressing climate change impacts to fish, wildlife, and habitats in the present and that addressing these issues will improve their quality of life. While 62 percent of visitors surveyed felt that the catastrophic effects of climate change have not been overemphasized, 39 percent of visitors felt that there is too much scientific uncertainty to adequately understand the specific effects of climate change on fish, wildlife and habitats. These results indicate that visitors generally grasped the seriousness of and supported actions to address climate change impacts to ecological systems. More than half of visitors (51 percent) indicated that their experience would be enhanced if Great Swamp NWR provided information about how they could help address the effects of climate change on fish, wildlife, and their habitats. Alternative B strategies address the visiting public's general concern for the issue tempered with the need for a clearer understanding of impacts. In essence, under this alternative, Great Swamp NWR will continue to focus on the importance of the issue while collecting the best on-site and regional data available and will adapt educational and management strategies accordingly.

Strategies

In addition to alternative A, objective 5.3:

- Increase education and awareness programs about climate change.
- Monitor for climate change-related species impacts, disease, and vegetation shifts. If feasible, establish a "Citizen Science Program" to assist in the collection of data through citizen participation, while immersing the public into the scientific process.
- Use adaptive management and mitigation, if practical and necessary, to protect native plants, wildlife, and habitats, especially resources of conservation concern.

- Increase monitoring, early detection, and control of invasive species that may increase as a result of climate change.

- Stay informed, current, and educated on climate change and share such information with partners and the public.

Objective 5.4 (Wilderness Area)

In addition to alternative A, objective 5.4, expand the existing designated Wilderness to include an additional 161 acres of bottomland forest.

Rationale

Although a portion of the refuge is already designated as Wilderness Area, Refuge System planning policy requires that we conduct a wilderness review during the CCP process. A wilderness review is the process we follow to identify and recommend for Congressional designation Refuge System lands and waters that merit inclusion in the NWPS. The results of the wilderness review are included as appendix B. The results of the wilderness review determined that approximately 161 acres of bottomland forest, contiguous with the southwestern portion of the present day Wilderness Area, meet the eligibility criteria for a WSA, as defined by FWS wilderness policy (610 FW 4). See section 3.1.23 above for details regarding the wilderness review process and appendix B for the results of our wilderness review.

Strategies

In addition to strategies identified under alternative A, objective 5.4:

- As part of the wilderness review, recommend the addition of 161 acres to the existing Wilderness Area.

- Manage the recommended area as Wilderness until designated or released by Congress.

Objective 5.5 (Nuisance Wildlife Control)

Similar to alternative A, objective 5.5, but with the following additional strategies.

Rationale

The term nuisance wildlife is often associated with an animal that causes or has potential to cause damage to property, presents a threat to public health or safety, or causes an annoyance within, under, or upon a building. An animal that results in negative impacts to other wildlife species or their habitat may also be considered nuisance wildlife. Nuisance wildlife species can be native, non-native, or feral, and are often adapted to living in fragmented habitat and in close proximity to humans. Certain species are periodically problematic at the refuge, such as raccoons, Canada geese, beavers, and feral cats. Management or control of nuisance wildlife may be required to prevent impacts to other wildlife (i.e., predation, competition, and spread of disease) or habitat (i.e., undesired flooding or excessive herbivory).

People that intentionally or accidentally feed, provide shelter, or release rehabilitated, feral, or other wild animals onto or near the refuge can perpetuate ecological impacts associated with nuisance wildlife. Promoting awareness about the ecological effects of nuisance wildlife may help prevent or reduce the frequency of problematic wildlife that occur as a result of human actions.

Strategies

- Promote public awareness regarding the ecological impacts of nuisance wildlife.

Alternative C: Emphasis on Maximizing Natural Regeneration

Introduction

The overall management strategy of alternative C focuses on the recognition that refuge habitats and wildlife populations are not ecologically independent from the surrounding landscape and that by taking a long-term regional perspective, the refuge can best contribute to higher conservation priorities at greater scales. As a result, management direction is primarily derived from regional plans and directives including relevant BCR and PIF plans, and the NJWAP, which prioritizes forest and successional shrub habitats in the Northern Piedmont Plains region of the State. By allowing Great Swamp NWR plant communities to return to post-glacial, pre-colonial conditions to the maximum extent possible, alternative C best fits the FWS BIDEH policy (601 FW 3). This policy provides guidance on maintaining or restoring the BIDEH of the Refuge System (see chapter 1, section 1.3.2).

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Under this alternative, natural succession or regeneration will be allowed to occur to the maximum extent practical to best recreate the pre-colonial natural communities of the refuge (see Figure 3-5). Although a similar strategy is employed in alternative B, alternative C maximizes regeneration to include an additional 284 acres of various plant communities. When compared to alternative B, several additional areas of actively managed scrub-shrub habitats would be allowed to naturally succeed in the vicinity of refuge headquarters, along Pleasant Plains Road, and along White Bridge Road. Similar to alternative B, large patches of consolidated grasslands and managed brushlands will be maintained along Pleasant Plains Road, which will benefit refuge priority resources (e.g., American woodcock) while providing wildlife viewing opportunities to the public. Active management would continue in areas known to support priority refuge resources, including bog turtle, woodcock, and other species that rely on a particular stage of succession for all or part of its life cycle. Hedgerows and forest corridors within grassland patches would be removed.

Under this alternative, we would conduct a comprehensive analysis of the impoundments to determine the best option for habitat management for these lands. The review would include options for management including, allowing the impoundments to revert to natural conditions. In particular this evaluation would include how the lands fit into the larger landscape and which habitat management option would provide the best conservation benefits to regional and landscape level priority species and habitats.

More than the other alternatives, alternative C maximizes the refuge's role in forest carbon sequestration and provides other regional forest management benefits. The refuge will actively work within regional partnerships dedicated to addressing climate change, habitat loss, and water and air quality impacts.

In addition to its ecological significance, alternative C significantly reduces labor costs and the impacts associated with the periodic mechanical clearing required to maintain open habitats. Management of many

small, open grassland tracts, particularly in wetland environments, can be time consuming and monopolize staff resources that may be better used in other management practices.

USFWS/George Gentry

GOAL 1: Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species and priority conservation species.

Objective 1.1 Tussock Sedge Wet Meadows
Within five years, maintain and restore a minimum of 75 acres of high quality, spring-fed, open wet meadow dominated by a mixture of native sedges, including tussock sedge, with a 10 to 30 percent scrub/shrub component and hydric regime suitable for bog turtle.

Rationale
See alternative B, objective 1.1.

Strategies
The strategies for this objective will be the same as those listed in alternative B, objective 1.1. However, they will be expanded to include an additional 35 acres, for a total of 75 acres, as depicted in map 3-5.

Objective 1.2 Emergent Marsh – Migrating Waterfowl
Each year, maintain a minimum of 250 acres of spring (March through April) and fall (October through November) waterfowl migration and staging habitat consisting of shallow flooded wetlands (less than or equal to 12 inches of water) with a mix of native emergent vegetation and open water habitat, dominated by arrow arum, cattail, bur-reed, woolgrass, bulrush, swamp rose mallow, buttonbush, millets, tussock sedge (*Carex stricta*), duckweed, sedges, muskgrass, spikerush, rice cutgrass, wild rice, and pickerelweed.

Rationale
See alternative B, objective 1.2. However, the number of acres of emergent marsh under this alternative would likely be reduced as existing emergent marsh is allowed to naturally succeed to breeding marshbird, successional wet meadow and brushland habitat types.

Strategies:
Same as alternative B, objective 1.2, but on a reduced scale as seen in map 3-5.

Objective 1.3 Emergent Marsh – Breeding Marshbirds
Each year, provide a minimum of 900 acres of habitat for breeding marshbirds, including American bittern, consisting of an average mix of 50 to 70 percent vegetation and 30 to 50 percent open water with water depths often less than 4 inches (10 cm). Breeding habitats for American bittern consist of shallow marshes dominated by cattails, bulrushes, wild rice, sedges, and arrow arum. Provide patches of nesting habitat ranging from 6.2 acres (2.5 hectares) to 27.2 acres (11 hectares) or larger, preferably within 98 feet (30 meters) of open water or aquatic bed vegetation habitat (USFWS 2001b). Larger patch sizes (greater than

27.2 acres) results in higher productivity (USFWS 2001b); therefore, emphasis will be placed on large patch sizes, wherever possible.

Rationale
See alternative B, objective 1.3.

Strategies
Same as alternative B, objective 1.3. However, additional acres of this habitat would be available as additional emergent marsh succeeds to the vegetation cover and water depths outlined in this objective.

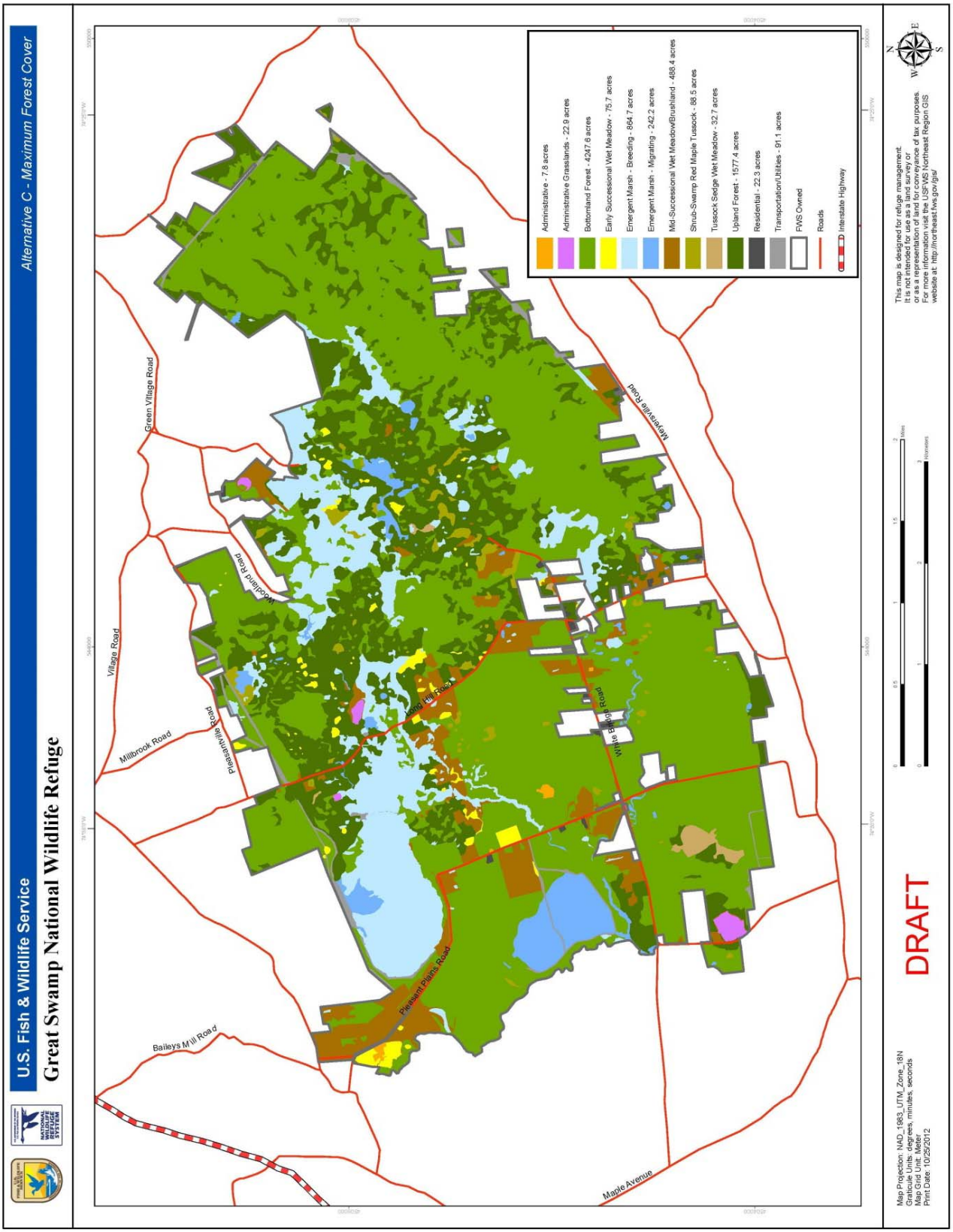
GOAL 2: Create and maintain an interspersion of brushland, grassland, and successional wet meadows comprised of native vegetation at various successional stages to enhance breeding and foraging habitat for priority species of conservation concern.

Discussion
The refuge contains approximately 840 acres of brushland habitats and 460 acres of early successional fields (Sneddon 2008). Brushland habitats are cut approximately every eight years to prevent it from succeeding toward immature forest habitat. Early successional fields are mowed (some annually and the others every 2 or 4 years) to prevent succession toward brushland habitat. The American woodcock, a key early successional management species, is a USFWS priority species that has responded well to the staggered rotational management at Great Swamp NWR. According to a USFWS Biological Review Report for Great Swamp NWR, the refuge's woodcock data (singing route surveys between 1985 and 2006) indicated relatively stable populations relative to declining statewide populations (USFWS 2006). Under the refuge's current Upland Management Plan (1988), a total of 477 acres were targeted specifically for woodcock management with four cover type needs (singing grounds, feeding, nesting, and roosting cover). Areas were identified to be cut on a staggered rotation to provide field, brush, and early successional stages. An additional 131 acres were targeted for brushland habitat to increase wildlife diversity (USFWS 2006).

In addition to American woodcock, management of these habitat types also benefit a suite of species at the refuge, including Eastern towhee, prairie warbler, yellow-breasted chat, blue-winged warbler, willow flycatcher, Northern harrier, Baltimore oriole and rose-breasted grosbeak. Wood turtles and Eastern box turtles also utilize the refuge's early successional habitats for foraging and basking.

Although some obligate grassland nesting bird species benefit from maintaining early successional fields, management objectives are not based on these species. Great Swamp NWR Biological Review (2005) stated that the size and habitat structure of the refuge's early successional fields are such that they will not attract significant numbers of grassland nesting birds. The latter typically require open habitats in excess of 100 acres that are free of hedgerows and other visual impediments.

Due to maintenance requirements for remediated landfills, the refuge's remediated landfills must be periodically mowed to keep the sites in a permanent state of early plant succession. This assures that the underlying substrate remains intact and also provides habitat for species that use early successional fields.



Map 3-5. Anticipated habitat types under alternative C.

Objective 2.1 Mid-Successional Wet Meadows / Brushland – Woodcock Nesting/Foraging and Blue-Winged Warbler Nesting

Provide 500 acres of mid-successional wet meadow habitat (shrubs up to 6 feet in height at cover densities of approximately 70 percent) dominated by native species containing a mixture of shrubs and herbaceous vegetation throughout the refuge to provide foraging and breeding habitat for brushland and wet meadow-dependent birds. For example, this habitat is utilized by American woodcock for nesting/brood cover and by blue-winged warblers for nesting habitat. American woodcock nesting cover is ideally located within 300 feet of the male's courtship habitat (USFWS 2001c). Courtship habitats should be greater than 2.9 acres (1.2 hectares) in size and consist of open fields, pastures or brushland/forest clearings (USFWS 2001c). Nesting territories of the blue-winged warbler should range from 24 to 123 acres (10 to 50 hectares) in size (USFWS 2001d).

Rationale

See alternative B, objective 2.1.

Strategies

Same as alternative B, objective 2.1.

Objective 2.2 Early Successional Wet Meadows – Northern Harrier Foraging and American Woodcock Foraging/Displaying

Provide 75 acres of early-successional field habitat dominated by native vegetation to provide wintering/foraging habitat for the Northern harrier and displaying/foraging habitat for American woodcock. Wet meadow habitat patches should be greater than 2.9 acres (1.2 hectares) in size to provide courtship habitat for American woodcock (USFWS 2001c) and greater than 2.47 acre (1 hectare) in size to provide foraging habitat for Northern harrier (USFWS 2001e). Additionally, 150 acres of these habitats should be maintained adjacent to riparian areas to support the refuge's wood turtle population.

Rationale

See alternative B, objective 2.2.

Strategies:

Same as alternative B, objective 2.2, but on a reduced scale as seen in map 3-5.

Objective 2.3 Shrub-Swamp and Red Maple-Tussock Sedge Wooded Marsh

Maintain 100 acres of seasonally or semi-permanently flooded tussock-sedge wooded marsh dominated by native species, including red maple saplings and tussock sedge, and lesser areas of shrub-swamp containing a variety of shrubs including alders, buttonbush, swamp rose, black willow, Southern arrowwood, highbush blueberry, sweet pepperbush, and dogwood species, with greater than 50 percent woody vegetation to provide important nesting and migratory habitat for passerines and other bird species. Wooded marsh habitats, particularly riparian shrub habitat areas, should be greater than 1.7 acre (0.7 ha) to support nesting willow flycatcher (Walkinshaw 1966).

Rationale

See alternative B, objective 2.3.

Strategies

Same as alternative B, objective 2.3, but on a reduced scale as seen in map 3-5.

GOAL 3: Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Discussion
See alternative B, goal 3.

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Objective 3.1 Woodland Vernal Pool Habitat
Maintain and enhance 300 acres of vernal pool habitat (i.e., vernal pool and surrounding buffer) for blue-spotted salamander and other obligate vernal pool species, and where possible, maintain a 1000-foot vegetated buffer around each vernal pool (NJDEP 2004). Buffers should consist of native vegetation and vernal pools should contain approximately 1-4 feet of isolated seasonal standing water with a 10 to 30 percent shrub component.

Rationale
See alternative B, objective 3.1.

Strategies
Same as alternative B, objective 3.1.

Objective 3.2 Riparian Corridors
Where practical, maintain a minimum of a 492 feet (150 meter) wide (Fischer 2000) buffer of riparian corridor, including floodplain and swamp forest, dominated by native species, such as American sycamore, pin oak, American elm, and Southern arrowwood, to maintain connectivity of mature bottomland hardwood forest and riverine habitat; to protect the water quality of the Great Brook, Loantaka Brook, Black Brook, Primrose Brook and the Passaic River; to provide roosting and foraging habitat for Indiana bat; and to provide nesting habitat for barred owl, wood duck, wood turtle, and other species of conservation concern.

Rationale
See alternative B, objective 3.2.

Strategies
Same as alternative B, objective 3.2.

Objective 3.3 Bottomland Forest
Within 15 years of plan implementation, maintain 3,700 acres and restore approximately 600 acres of mature and late successional stages of bottomland forest consisting of a mix of native vegetation of pin oak, red maple, swamp white oak, shagbark hickory, black gum, American elm, sweet gum, and green ash in the canopy with understories of Southern arrowwood, hornbeam, and sweet pepperbush at varying densities. Target high priority areas for removal of invasive plants, based upon level of threat and potential for re-colonization, and prevent the establishment of invasive species in unaffected areas to maintain biodiversity and ecosystem health. Bottomland forest patches should be large and contiguous (with other

patches of both wetland and upland forest) to the greatest extent practicable. Patches in excess of 700 acres should be maintained at the refuge to provide ideal nesting habitat for barred owl, wood thrush and numerous other forest interior breeding species. Maintenance of mature bottomland forest, containing both dead and dying trees, will also provide roosting habitat for Indiana bat and other bat species.

Rationale
See alternative B, objective 3.3.

Strategies
Same as alternative B, objective 3.3, but with an additional 600 acres of restored forest, as seen in map 3-5.

Objective 3.4 Mature Upland Forest
Provide 1,600 acres of mature to late successional upland forest dominated by native species of oak, hickory and beech to benefit migratory breeding birds, including Eastern wood pewee, scarlet tanager and wood thrush. Focus forest management and restoration on parcels within 500-acre blocks of forest or more, if possible, with an emphasis on those parcels with minimal edge habitat, and maintain forests in close proximity to one another.

USFWS

Rationale
See alternative B, objective 3.4.

Strategies
Same as alternative B, objective 3.4, but with 100 fewer acres of mature upland forest than alternative B, as seen in map 3-5.

GOAL 4 Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Objective 4.1 (Hunting)
Same as alternative A, objective 4.1.

Objective 4.2 (Fishing)
Same as alternative A, objective 4.1.

Objective 4.3 (Wildlife Observation, Photography and Public Access)
Same as alternative A, objective 4.3, except eliminate less used or dead end trails in the Wilderness Area.

Rationale
The refuge currently provides approximately 8.5 miles of trails in the Wilderness Area. Under this alternative, select dead end or less used trails would be eliminated through natural succession. Elimination of these trails would reduce unnecessary fragmentation and the potential for inadvertent introduction of invasive species. In addition, there would be fewer occurrences of visitors getting lost on the less used trails, which become overgrown with vegetation.

Strategies
Within 10 years of CCP approval:

- Eliminate less used or dead end trails in wilderness area.

Objective 4.4 (Other Non-Wildlife Recreational Opportunities)
Same as alternative A, objective 4.4.

Objective 4.5 (Environmental Education)
Same as alternative A, objective 4.5.

Objective 4.6 (Environmental Interpretation)
Same as alternative A, objective 4.6.

GOAL 5: Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and surrounding landscape.

Objective 5.1 (Volunteers and Partnerships)
Same as alternative B, objective 5.1:

Objective 5.2 (Public Outreach)
Similar to alternative B with more emphasis on forest habitats and related issues.

Rationale
In conjunction with the volunteer and partnership strategies employed under alternative B, objective 5.2, public outreach under this alternative would concentrate on the importance of forest resources and their contribution to regional ecology. The rationale of alternative C, objective 5.3 provides the climate related focus for public outreach under this alternative.

Strategies:
In addition to the strategies identified under alternative B and within 5 years of CCP approval:

- Develop programs that focus on the problem of forest fragmentation, the importance of forest dependent species, and the refuge's role in carbon sequestration as a climate change mitigation tool.

- Coordinate and work with adjacent parks and agencies containing forest habitats to create a coherent regional approach to providing information about managing and promoting the ecological role of mature forest.

Objective 5.3 (Climate Change)
Same as alternative B, objective 5.3.

Objective 5.4 (Wilderness Area)
Same as alternative B, objective 5.4.

Objective 5.5 (Nuisance Wildlife Control)
Same as alternative A, objective 5.5.

Alternative D: Focus on Expansion of Priority Public Uses

Introduction
Great Swamp NWR is uniquely located in one of the most urban and densely populated areas in the United States. As a result, the refuge is an ideal conduit to reaching a diverse public, segments of which may be under-served and have limited access to outdoor and wildlife-oriented opportunities. Its unique potential to reach urban populations is reflected in one of the refuge's original purposes as an "outdoor laboratory" for the "people of the heavily populated surrounding area" (see section 1.5). Great Swamp NWR is an ideal place to implement the Refuge System's new "Urban Refuges" initiative. With this in mind, alternative D prioritizes a multitude of methods for maximizing priority public uses while minimizing impacts to wildlife (see figure 3-6).

Under alternative D, the refuge would increase visitor and program participant numbers; maximize the demographic diversity of visitors and program participants; provide a greater variety of quality wildlife-oriented public and volunteer opportunities and programs; and increase outreach and publicity to promote conservation, the refuge, and the Refuge System purpose.

In addition to programmatic changes, this alternative emphasizes, to a greater extent than alternative B, the expansion of infrastructure, including the creation of new trails, observation towers, and parking lots, and the installation of new signage in ways to better attract and retain visitors. As with all alternatives, changes in infrastructure would still be performed in conjunction with careful monitoring and with full consideration of the needs of wildlife resources (see introduction of chapter 3). Trails systems throughout the refuge would be better connected by trail additions and certain management roads would be open to public access. Additional areas would be evaluated for future trail opportunities.

Other differences between alternative D and the preferred alternative relate to differences in the allocation of resources, such as the priorities for staffing, increased marketing efforts, and changes and increases to the volunteer program.

Biological objectives, including the configuration, proportions, and acreages of varying habitats within the Management Area of the refuge, are generally the same as to those proposed under the preferred alternative B. Under alternative D, however, there is more emphasis placed on managing for open habitats popular for wildlife observation, particularly open water and grasslands. The most notable management

difference under alternative D is the proposed maintenance (vegetation suppression) of open water habitat within impoundments located west of Pleasant Plains Road. Open water habitats are popular among refuge visitors seeking waterbird observation opportunities. Under this alternative, grassland configuration (consolidation), size, and proportions remain the same as alternative B as both habitat and public use goals are met through the improvement of grassland habitat patches on the refuge.

This alternative further emphasizes the use of emerging technologies and aggressively expands partnerships for conservation initiatives, such as global climate change. Under this alternative, promotion of the refuge and Refuge System are given additional emphasis.

Alternative D incorporates all priority public uses of the refuge to the greatest extent practicable. Most notably, fishing opportunities, which are not authorized under any other alternative, would be provided in select areas of the refuge. The refuge's hunting program would be expanded as described under alternative B.

This alternative relies heavily on data collected from the USGS Visitor Survey (Sexton et al. 2012), as well as comments received during the public CCP scoping process, to provide manageable objectives that address the concerns and desires of refuge visitors and volunteers.

GOAL 1 Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species and priority conservation species.

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Objective 1.1 (Non-forested Wetlands and Open Water)
Same as alternative A, objective 1.1.

Objective 1.2 (Impoundments)
Given the existing limits of the impoundments, within 10 years, increase percent open water habitat for all of the impoundments to provide resting, breeding, staging, and foraging habitat for migrating waterfowl and to provide additional public viewing opportunities. These areas would be configured to maximize wildlife observation and environmental interpretation opportunities

Rationale
The conservation of North American waterfowl, particularly the restoration of associated wetland habitats, has been a major focus of the FWS for decades (USFWS 1993). A primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl (see chapter 1, section 1.5).

The original NAWMP was signed by the United States and Canada in 1986 and by Mexico in 1994. The plan was created in response to substantial declines in waterfowl populations observed during the mid-1980s (ACJV 2005). As it was realized that a collaborative effort is the most effective way to provide waterfowl habitat conservation, those involved with the NAWMP created regional joint ventures that allow partners to pool resources to meet common goals (ACJV 2005). The ACJV Waterfowl Implementation Plan, which applies to the Atlantic flyway in which the refuge lies, resulted from these newfound partnerships. The plan describes a 15-year strategy to restore and sustain waterfowl populations by protecting, restoring and enhancing waterfowl habitat. Among their initial considerations was the protection of 50,000 acres of black duck migration and wintering habitat in the region (ACJV 2005). This consideration eventually became incorporated into a broad objective of protecting 945,000 acres, restoring 35,633 acres and enhancing 121,740 acres of waterfowl habitat (ACJV 2005).

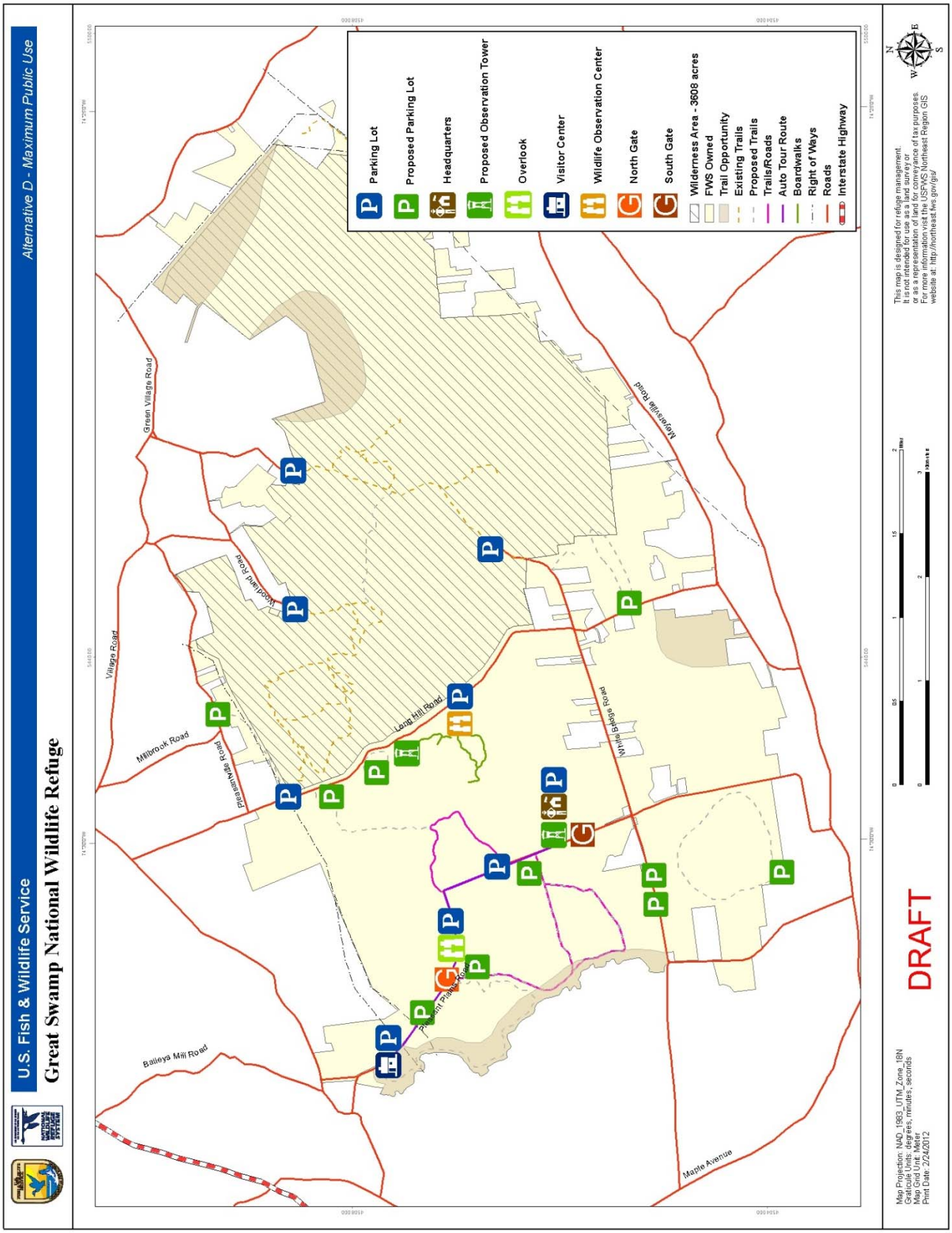
Great Swamp NWR supports a variety of waterfowl during some phase of their annual life cycle. The American black duck, which is a common migrant and occasional breeder at Great Swamp NWR, is among the highest priority in BCR 28 and is a medium priority in BCR 29. As mentioned above, this species is a major conservation focus of the ACJV. Other waterfowl species that utilize the refuge for foraging or resting during migration include mallard, green-winged teal, American wigeon, Northern pintail, gadwall, Northern shoveler, blue-winged teal, and bufflehead. The most common waterfowl nesting on the refuge are wood duck, mallard, Canada goose, and the occasional hooded merganser, a State-Special Concern species.

During the first CCP scoping period, the public expressed concerns regarding the preservation of open water habitats. Several comments specifically addressed sedimentation and vegetation succession issues within impoundments and an increasing inability to observe waterfowl and other wildlife in these areas. This objective addresses the public's concern about the loss of waterfowl viewing opportunities by both managing habitat and increasing open water access. It should be stressed that suitable habitat for waterfowl consists of a mix of open water and emergent vegetation; therefore, management efforts that propose to improve waterfowl viewing for the public must be carefully implemented and considered to prevent adverse impacts to the refuge's waterfowl. This objective acknowledges the refuge's responsibility to preserve waterfowl habitat under the ACJV, and as part of Great Swamp NWR's original purpose (see chapter 1, section 1.3.2).

Strategies

Within 10 years of CCP approval:

- Expand open water habitat to promote waterfowl use and viewing, primarily by manipulating water levels in existing impoundments as opposed to dredging out sediment and root masses, which would be more expensive, time-consuming, and disruptive to wildlife.



Map 3-6. Proposed public use facilities under alternative D.

- Control vegetation and potentially raise water levels in all impoundments to create additional open water.

- In conjunction with two proposed observation towers (see alternative B, objective 4.3), provide additional signage or improvements to existing signage at accessible emergent wetland habitats to raise awareness on waterfowl, waterbirds, marshbirds, and herptiles, and open water habitats in general.

- Expand public access to view currently off-limits open water sites by allowing seasonal non-vehicular access along certain service roads in the Management Area (see alternative D, objective 4.3).

GOAL 2 Create and maintain an interspersion of scrub-shrub, grasslands, and successional wet meadows comprised of native vegetation at various successional strategies to enhance breeding and foraging for priority species

Objective 2.1 (Grasslands)
Same as alternative A, objective 2.1, except increase signage emphasizing pollinators and grassland bird species.

Strategies
Same as alternative A, objective 2.1, except increase signage emphasizing pollinators and grassland bird species.

Objective 2.2 (Scrub-Shrub/Brushland)
Same as alternative A, objective 2.2.

GOAL 3 Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Objective 3.1 (Forest)
Same as alternative A, objective 3.1.

GOAL 4 Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Objective 4.1 (Hunting)
Same as alternative B, objective 4.1.

Objective 4.2 (Fishing)
Provide opportunities for safe, high quality fishing experiences on the refuge.

Rationale

Alternative D is the only alternative that considers opening the refuge to fishing. The Refuge Improvement Act identifies fishing as a priority public use within the Refuge System and as such, the activity should receive elevated consideration as goals and objectives are created. Sport fishing is a traditional and accepted form of wildlife-dependent recreation within the Refuge System. As a result, Great Swamp NWR has carefully considered ways that a warm water fishery could be provided on the refuge that would be compatible with refuge purposes. Provided it is conducted in accordance with State and refuge regulations, recreational fishing will provide a new wildlife-dependent opportunity to the visiting public with minimal impact to sensitive wildlife resources. This alternative employs several strategies, including changes to existing resource use, new access, expanding partnerships, increasing monitoring on potential wildlife impacts, and promoting responsible fishing through education. Fishing access to the Wilderness Area was initially considered but ultimately dismissed due to safety and access issues. Evidence of unauthorized fishing has been observed at the refuge. By providing and publicizing safe, legal, and ecologically responsible opportunities for fishing coupled with enhanced enforcement, we will seek to reduce or eliminate unauthorized fishing on the refuge.

Fishing presents an opportunity to reach a larger and more diverse audience. If promoted properly, a refuge fishing program will be an effective tool for reaching children from locally urban or disadvantaged environments that have limited access to fishing resources.

The refuge is in a unique position to provide high quality environmental education through this program by combining knowledgeable staff and volunteers with easily accessible fishing opportunities. Enhancing the existing borrow pond behind Refuge Headquarters would create a safe, accessible, and controlled environment for fishing with limited impact to sensitive wildlife. This additional resource will be of particular value in attracting school, clubs, or Scout groups and will also serve as a catalyst for new weekend or family events.

Fish surveys conducted at the refuge (see chapter 2, section 2.6.6) demonstrate that our open waters do support a small number of larger warm water predatory species considered popular game fish in New Jersey. These include chain pickerel, largemouth bass, black crappie, carp, catfish, and yellow perch.

Strategies

Within 5 years of CCP approval:

- Consider expanding and enhancing the existing borrow pond near headquarters for fishing opportunities. The pond would be stocked with hearty native warm water species, such as yellow perch, chain pickerel, pumpkinseed and red-breasted sunfish.

- Open select areas of the refuge to fishing to attract visitors of various demographic backgrounds. In addition to evaluating the feasibility of an on-site fishing pond at the Refuge Headquarters, we would evaluate the ponds off of Pleasant Plains Road for potential to be opened to fishing. A trail for fishing access would also be considered at the confluence of Black Brook and the Passaic River near White Bridge Road.

- Evaluate the impacts of fishing on the refuge (e.g., aquatic invasives, bait fish, wildlife disturbance, and litter). Any proposed action at the refuge involving the introduction of fishing will be carefully

monitored to minimize impacts at the refuge. Changes to access hours or locations, or other practices would be mandated if specific impacts are observed as a result of the change in the fishing policy.

- Development of the above mentioned fishing opportunities would be conducted in partnership and consultation with the New Jersey Division of Fish and Wildlife. All State fishing laws regarding licenses and bag limits would apply to the refuge. The refuge would utilize the Division's expertise in promoting fishing.

- Increase refuge enforcement to prevent fishing in unauthorized areas and to ensure responsible and legal fishing practices in authorized areas.

Objective 4.3 (Wildlife Observation, Photography and Public Access)

Maximize wildlife observation, photography opportunities, and trail access to the greatest extent practicable to increase visitation and appreciation of the refuge and the Refuge System in ways compatible with wildlife protection.

Rationale

Wildlife observation and photography are identified by the FWS as priority public uses at Great Swamp NWR. The importance of wildlife observation and photography as an activity at Great Swamp is reflected in the data collected during recent visitor surveys.

The USGS Visitor Survey (Sexton et al. 2012) identified wildlife observation (64 percent), including bird watching (62 percent), as the most common use by visitors of the refuge during the course of a year. Hiking (57 percent) and photography (36 percent) were the next most common uses identified during the survey. The visitor survey also indicates that access to activities (such as hiking, bird watching, wildlife and observation opportunities), access to observation structures, and photography opportunities are considered "very important" to their refuge experience. The importance of wildlife observation is also reflected in the numerous comments received from the survey that reference positive wildlife observation or nature observation experiences.

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During the first CCP scoping period, several comments requested that the refuge provide additional observation opportunities in the vicinity of the Visitor Center. Approximately 60 percent of the visitors to the refuge utilize the Visitor Center during their visits. With the clear importance of wildlife observation among refuge visitors, this objective seeks to provide the greatest amount of access for observation and photography opportunities without creating additional negative wildlife impacts.

In order to create a more complete and unique visitor experience at Great Swamp NWR that will attract and retain visitors, this objective utilizes a combination of improved infrastructure and staffing, increased access, and expanded programs.

The strategies of this objective are designed to make visitors aware of the full range of access and resources at the refuge by proposing basic technological improvements at the Visitor Center. The refuge seeks to create new wildlife experiences by providing unique viewing perspectives and access to habitats that currently have limited public viewing options.

In addition, this objective includes the evaluation of a Visitor Center pond that would provide a unique opportunity for teaching aquatic ecology through instructor or volunteer guided observation in an accessible and controlled setting.

By providing controlled seasonal pedestrian public access to impoundments along existing service roads, Great Swamp NWR will provide new opportunities for the public to observe wildlife without the cost or environmental impacts of new trail creation. Observation of open water and waterfowl in particular has been identified as "important" to some visitors during the first CCP scoping period. In addition, pedestrian access to service roads is occasionally requested by the public and trespass along service roads is a matter of law enforcement concern.

By connecting the Blue and Orange trail systems within the Wilderness Area, all current trails and trailheads would be connected thereby allowing individuals to more easily access this secluded portion of the refuge . Driving among trailheads would be reduced and hiking opportunities would be expanded to include the full 8.5 miles of the trail system. The addition of new trails and use of existing management roads would allow adventurous visitors to travel on foot through multiple habitat types between the Visitor Center and the Wilderness Area at certain times of the year.

Strategies

In addition to the strategies identified under alternative B:

- Expand and enhance the interactive touch-screen maps of the refuge and neighboring areas at the Visitor Center. The maps will facilitate the visitor's ability to access the refuge's public resources and highlight unique opportunities offered by nearby partners, such as the Morristown National Historical Park, Morris and Somerset County Environmental Education Centers, and The Raptor Trust.

- Construct a pond near the Visitor Center for additional wildlife observation and educational opportunities.

- Staff and/or the Friends of Great Swamp NWR will develop and host wildlife photography programs or tours.

- Evaluate the need for and potential impacts of increasing parking opportunities at the WOC. Overall under this alternative, 5 to 10 new parking areas would be established. Additions include parking areas established under alternative B, plus additional parking areas primarily along major roads within the refuge (see Alternative D: Maximum Public Use Figure).

- Evaluate other potential improvements or expansions to the WOC, including renovations and maintenance of WOC restrooms, wildlife blinds, and boardwalks.

- Expand the existing refuge foot trail system to a maximum of 21.2 miles to maximize access without significantly impacting wildlife or habitats. In addition to the foot trails proposed under alternative B (see alternative B, objective 4.3), alternative D seeks to add additional trails to provide public access to previously inaccessible management ponds, marsh habitats and wet meadows, and new portions of the Wilderness Area.

- Evaluate additional areas for future trail opportunities. These include four areas along the border of the refuge including an area near the Passaic River, two within the Wilderness Area, and one area south of White Bridge Road (see map 3-6).

- Provide limited seasonal pedestrian access to service roads around Pools 3A and 3B west of Pleasant Plains Road. These areas would be closed to the public during migration or other time periods where wildlife may be sensitive to disturbance. Seasonal access restrictions would be well posted and enforced.

Objective 4.4 (Non-Wildlife Recreational Opportunities)

Maximize non-wildlife dependent recreational uses to the greatest extent practicable to increase visitation and refuge appreciation while minimizing impacts to wildlife.

Rationale

These activities, though not directly related to wildlife, are low-impact opportunities that may draw visitors, provide new and unique public access experiences, and ultimately promote appreciation of the refuge, its wildlife, and the Refuge System. Once determined to be compatible and appropriate, these activities would be carefully implemented and evaluated to minimize impacts to refuge resources.

Within the 2010-2011 USGS Visitor Survey, canoeing and kayaking opportunities were requested. In addition, although biking is currently permitted on Pleasant Plains Road and other township roads that traverse the refuge, a bike path was also requested. Biking is not permitted in the Wilderness Area. Amongst those surveyed, a majority of visitors rated water trail opportunities for kayak or canoe as “somewhat” or “very important” with relatively neutral satisfaction (Sexton et al. 2012). Interest in these activities was also identified during the first CCP scoping period in the form of public comment. Within the refuge, kayaking and canoeing is permitted on Great Brook up to the bridge. Kayaking and canoeing is permitted within the Passaic River and Black Brook. The refuge has no jurisdiction to prevent kayaking or canoeing from occurring on these rivers. As with fishing, allowing this activity with restrictions may minimize unauthorized canoeing or kayaking.

A number of comments in the USGS Visitor Survey expressed interest in accommodations for biking. While some visitors expressed interest in specific trails for biking, many simply expressed concerns about biker and auto conflicts and safety.

Strategies
Within 5 years of CCP approval:

- Consider constructing a paved bike trail along the gravel section of Pleasant Plains Road.

Objective 4.5 (Environmental Education)
Provide the maximum number of standard-based educational opportunities through a variety of methods in collaboration with partners and volunteers.

Rationale
Over 80,000 students are enrolled in the public schools of Morris County alone (County of Morris, 2010). As a result of its position as a rich environmental resource within a heavily populated setting, the refuge has the unique opportunity to provide effective field and classroom standards-based educational opportunities to both educators and schoolchildren.

Through educational programs the refuge will provide excellent science teaching opportunities to a variety of students of varying ages and backgrounds. The refuge staff are well qualified to provide supportive services to teachers and students who are required to meet specific science oriented objectives in the New Jersey Core Curriculum Standards (2009). Science topics include earth science and a basic understanding of the nature and impacts of climate change, as well as basic ecological concepts including species interactions, species population studies, and human impacts on ecosystems.

In addition to providing expertise on State-mandated subject matter to local schools, developing a consistent classroom presence among regional schools is a highly efficient way to maximize promotion of the refuge and the Refuge System. By providing standards-based education to schools, we create an excellent vehicle to secure grant funding from scientific and educational organizations that will in turn maintain and expand educational opportunities to students and teachers.

Strategies
In addition to the strategies described under alternative B, perform the following strategies.

Within 5 years of CCP approval:

- Increase staff involvement in Standards-based educational programs to eight per year.
- Expand and/or reconfigure the "Swamp-in-a-Box" program.
- Refuge staff and volunteers will provide five environmental education programs at schools.
- Consider "America's Great Outdoors" (AGO) program, "No Child Left Inside," and possibly the environmental literacy plan to help schools meet these State-mandated criteria.
- Consider hosting formal district or State-approved continuing education programs or certifications for teachers at the refuge.

Objective 4.6 (Environmental Interpretation)

Expand environmental interpretation to the greatest extent practicable, including increased staff time and resources.

Rationale

Same as alternative B, objective 4.6.

Strategies

In addition to the strategies described under alternative B, perform the following strategies:

Within 5 years of CCP approval:

- Promote awareness on the differences between refuges, State, county, and municipal facilities.
- Each year, host or attend five Career Days at local schools to promote wildlife, conservation, and natural resource professions.
- Use traveling exhibits on and off the refuge to provide information about and encourage visitation to the refuge.

GOAL 5 Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and surrounding landscape.

Objective 5.1 (Volunteers and Partnerships)

Same as alternative B, objective 5.1, but with the following additional strategies.

Rationale

By utilizing the various strengths of our local partners, such as the cultural resources and knowledge of the Morristown National Historical Park or the avian programs and resources of The Raptor Trust, the refuge can provide a wider variety of educational and cultural opportunities to its visitors. The refuge will in turn provide wildlife-oriented opportunities to visitors of these partner facilities that may have previously not visited or utilized the refuge.

In addition, by working with various partners such as assisted living facilities or various interest groups, opportunities are created to promote conservation, the refuge, and the Refuge system with new demographic groups. This is of particular importance in educating the public on regional and global conservation issues, such as water quality, watershed management, and global climate change.

By partnering with the Friends of Great Swamp NWR to expand the organization, we can both provide new volunteer opportunities to existing members and expand the variety of management and public use opportunities proposed under this alternative without incurring prohibitive costs or drains on resources. Additional volunteer effort will specifically allow Great Swamp NWR to increase Visitor Center hours, provide more interpretation at the WOC, and increase the number of interpretive tours hosted at the refuge.

Strategies:
Within 5 years of CCP approval:

- Use a variety of methods including partnerships with schools or senior organizations, new technologies such as social media networks, and the aggressive expansion of the Friends program to increase volunteer hours to facilitate the development of new programs.

- Consider expanding partnerships with assisted living facilities to promote environmental education and interpretation in adults over 55.

- Increase partnerships to include organizations watershed-wide and regionally, especially urban and minority partners.

- Partner with various interest groups, such as cultural resource groups, school biology clubs, Scout troops, or the private sector to promote refuge use.

Objective 5.2 (Public Outreach)
Maximize public outreach to promote the refuge and refuge purposes.

Rationale
Same as alternative B, objective 5.2.

Strategies
In addition to the strategies described under alternatives A and B, perform the following strategies:

Within 5 years of CCP approval:

- Increase staff involvement and presence in public outreach events to five programs per year.

- Produce five press releases per year.

- Conduct three TV or radio interviews per year.

- Produce three podcasts per year.

- Increase use of social media by creating Facebook and Twitter accounts.

Objective 5.3 (Climate Change)
Increase efforts to address global climate change through research, partnerships, and monitoring.

Rationale
By partnering with volunteers to collect information on the timing of plant and animal phenology (budding, fruiting and leafing of various tree species; bird migration, nesting, fledging; etc.) citizen scientists will be engaged in the process of collecting vital ecological data and can make a significant contribution to our understanding of climate change phenomena. For additional information see alternative B, objective 5.3.

Strategies

Within 5 years of CCP approval:

- Develop partnerships with scientists and scientific organizations to participate climate change research on the refuge and disseminate information on climate change to the public.
- Apply for grants to conduct long-term climate change monitoring.
- Participate in Project Budburst which will allow the public to directly participate in the scientific process in a meaningful way by collecting and sharing climate change data.
- Use the Wilderness Area as a natural control and compare it to more intensively managed areas on the refuge and beyond.

Objective 5.4 (Wilderness Area)

Same as alternative B, objective 5.4.

Objective 5.5 (Nuisance Wildlife Control)

Same as alternative B, objective 5.5.

Table 3-2. Comparison of alternatives

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 1.1: Non-Forested Wetlands and Open Water	1,000 acres	N/A	N/A	Same as A
Objective 1.1: Tussock Sedge Wet Meadow	N/A	Restore 40 acres	Restore 75 acres	N/A
Objective 1.2: Impoundments	485 acres	Evaluate impoundment management for highest habitat benefits	Evaluate impoundment management for highest habitat benefits	In addition to A: Determine methods for providing additional open water for wildlife viewing
Objective 1.2: Emergent Marsh – Migration	N/A	Maintain 1,000 acres	Maintain 250 acres	N/A
Objective 1.3: Emergent Marsh – Breeding	N/A	Maintain 700 acres	Maintain 900 acres	N/A
Objective 2.1: Grasslands	375 acres	N/A	N/A	Same as A
Objective 2.1: Mid-successional wet meadows/ brushland	N/A	Maintain 500 acres	Same as B	N/A
Objective 2.2: Scrub-shrub	315 acres	N/A	N/A	Same as A
Objective 2.2: Early successional wet meadows	N/A	Maintain 460 acres	Maintain 75 acres	N/A
Objective 2.3: Shrub-swamp and Red-maple tussock sedge wooded marsh	N/A	Maintain 800 acres	Maintain 100 acres	N/A
Objective 3.1: Forest	6,000 - 6,500 acres	N/A	N/A	Same as A
Objective 3.1: Vernal pools	N/A	Protect 35 acres	Protect and enhance 300 acres	N/A

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 3.2: Riparian corridor	N/A	Maintain and restore 500 foot buffer along all streams	Same as B	N/A
Objective 3.3: Bottomland forest	N/A	Maintain 3,700 acres	In addition to B: restore 600 acres	N/A
Objective 3.4: Upland forest	N/A	Maintain 1,700 acres	Maintain 1,600 acres	N/A
Objective 4.1: Hunting	Current 5-day firearms season	In addition to current deer season, provide turkey hunting and archery deer hunting	Same as A	Same as B
Objective 4.2: Fishing	No fishing allowed on refuge	Same as A	Same as A	Provide fishing opportunities
Objective 4.3: Wildlife observation, photography, and public access	1.5 miles of boardwalk and 3 observation blinds at WOC. Wildlife tour route. 8.5 miles of Wilderness Area trails. South Gate open during daylight hours. North Gate open during visitor center hours	In addition to A: expand wildlife tour route north to the visitor center. Provide additional pull offs and parking opportunities along the tour route and White Bridge Road. Construct 2 additional observation towers overlooking the impoundments and moist soil unit.	Same as A, except: Eliminate dead end trails in the Wilderness Area.	In addition to B: Establish 5-10 additional parking areas. Expand foot trails to include existing management roads.

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 4.4: Non-wildlife dependent recreation	Jogging, bicycling, horseback riding, and leashed dogs allowed on Pleasant Plains Road. Virtual geocaching allowed. Cross-country skiing and snowshoeing allowed.	Same as A	Same as A	In addition to A: Evaluate potential bike trail along Pleasant Plains Road.
Objective 4.5: Environmental education	Continue existing environmental education programs (25 in 2011). Continue to provide "Swamp-in-a-box".	In addition to A: Provide an additional 2 opportunities per year for regional urban schools. Every 2 years, develop a new multidisciplinary program that meets State standards.	Same as A	In addition to B: Provide 3 additional opportunities per year for regional urban schools.
Objective 4.6: Environmental interpretation	Continue existing interpretive programs Kiosks and interpretive displays. Self-guided wildlife tour route	In addition to A: Expand visitor center operation to 7 days a week. Provide an additional 5 interpretation programs per year on-site and 3 per year off-site.	Same as A	In addition to B: Use traveling exhibits to expand interpretation opportunities beyond the refuge.

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 5.1: Volunteers and partnerships	Maintain existing partnerships: Friends of Great Swamp Great Swamp Watershed Association Raptor Trust, Morris and Somerset County Environmental Education Centers, NJDEP, and others	In addition to A: Expand partnerships to include Morris and Somerset county tourism boards. Develop partnerships with local educational institutions.	Same as B	In addition to B: Expand partnership to include the local senior population. Partner with local private sector companies.
Objective 5.2: Public outreach	Web site, outreach events as available.	Same as A	In addition to A: Develop programs that focus on forest fragmentation issues.	In addition to B: Increase staff presence at public outreach events. Conduct 3 TV or radio interviews per year. Produce 3 podcasts per year.
Objective 5.3: Climate change	Continue use of green technology.	Increase efforts through outreach, interpretation, partnerships, additional green technology, and maintenance.	Same as B	In addition to B: Develop partnerships with science organizations to participate in climate change research on the refuge. Participate in Project Cloudburst. Use the Wilderness area as a natural control for experiments in the local area.

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 5.4: Wilderness area	Monitor and maintain wilderness character of the Wilderness Area.	In addition to A: recommend designation of an additional 1CM acres of Wilderness.	Same as B	Same as B
Objective 5.5: Nuisance wildlife control	Control and/or eradicate nuisance wildlife, such as raccoons, mute swans, non-native turtles, feral cats, beaver, and resident Canada geese.	In addition to A: Promote public awareness of the ecological impacts of nuisance wildlife.	Same as A	Same as B