U.S. Fish and Wildlife Service Draft Programmatic Environmental Assessment for Use of Genetically Engineered Agricultural Crops for Natural Resource Management on National Wildlife Refuges in the Southeastern United States

U.S. Department of the Interior
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Chapter I. Introduction, Purpose and Need, and History of Agricultural Practices in the Southeastern United States

Introduction

National wildlife refuges (NWRs or refuges) in the Southeastern United States (U.S. and Southeast) of the U.S. Fish and Wildlife Service (Service) have historically hosted and provided foraging habitat and sanctuary for the millions of waterfowl that migrate through and winter in North America. Many refuges use agriculture as a natural resource management tool to produce high-energy food sources for meeting waterfowl and other wildlife objectives as well as to control invasive species, and maintain and maximize early-succession natural vegetation communities. Agriculture is used on approximately one percent (1%) of the refuge lands in the Southeast with most usage occurring in the Lower Mississippi Alluvial Valley, eastern North Carolina, and the Tennessee River Valley, which occur along the major migratory waterfowl flyways (Appendix B).

Prior to substantial clearing and drainage in the late nineteenth and early twentieth centuries, large, unbroken expanses of bottomland hardwood, freshwater emergent, and coastal wetlands were available for use by waterfowl (Dahl 1990, 2011; Schummer et al. 2012). In the last 100 years, wetland loss, habitat fragmentation, introduction of exotic plant and animal species, and disruption of natural hydrological and fire processes have drastically reduced habitat for wildlife in the Southeast. In the current, human-modified landscape, remaining habitat must be actively managed to sustain historical population levels for wildlife species. Before anthropogenic modification, the entire system was more resilient in the face of natural disturbances such as fire, drought, flooding, and tropical storms. Wildlife now must depend on a disproportionately smaller proportion of NWRs, and other conservation lands to provide habitat resources in a matrix of unsuitable areas. Many wildlife species have adapted to the loss of natural food sources by feeding on cultivated grains (Baldassarre and Bolen 1984, Delnicki and Reinecke 1986, Combs and Fredrickson 1996), but waste grain has declined substantially in harvested fields on private lands in the Southeast due to the changing and increasingly efficient agricultural practices (Manley et al. 2004, Foster et al. 2010).

Since at least the 1930s, natural resource managers have used agriculture as a method to supplement natural foods for wildlife on lands devoted to conservation. This practice was adopted on NWRs early in the twentieth century. Initially, the intended beneficiaries of agricultural practices were migrating and wintering game species. Now, it is widely recognized that supplementary planted foods can be valuable for a wide variety of game and nongame species (Donalty et al. 2003). NWRs also use agricultural practices in a wide variety of natural resource management activities, such as restoring native grassland habitats, managing moist-soil units, and invasive species control.

Purpose and Need for Action

The Service, a bureau of the U.S. Department of the Interior, is the federal agency primarily responsible for the conservation, protection, and enhancement of fish and wildlife populations in the United States. A critical component of the Service's mission is to manage the National Wildlife Refuge System (NWRS), which is the world's largest system of lands managed primarily for wildlife conservation. The NWRS is comprised of over 568 units covering over 850 million acres throughout the fifty states and U.S. territories. The mission of the NWRS is:

> *"...to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."*

To attain a NWR's CCP's wildlife management objectives, the Service must efficiently and effectively use a variety of management tools, including agriculture, within a changing landscape while protecting biological integrity, diversity, and environmental health. Refuges in the southeast have historically used agriculture to provide food and habitat for the tens of millions of ducks, geese, swans, and cranes during migration and wintering periods as well as for other wildlife species. Agriculture also has been used to manage invasive or undesirable species, maintain and maximize early-succession natural vegetation communities, and satisfy other wildlife objectives.

The purpose of this Programmatic Environmental Assessment (PEA) is to evaluate the use of genetically engineered crops (GECs) on NWRs in the southeast in order to meet wildlife management objectives and achieve the specific goals of a NWR's Comprehensive Conservation Plan (CCP), Habitat Management Plan (HMP), and other national and international conservation initiatives, including the North American Waterfowl Management Plan (USDOI EC ENRM 2012)(NAWMP). In addition, to determine if the action meets policies governing these uses on NWRs such as the Service's Biological Integrity, Diversity, and Environmental Health Policy (USFWS 2006a) (BIDEH) Department of the Interior's Pesticide Use Policy (517 DM 1), the Service's Integrated Pest Management Policy (569 FW 1), and other applicable policies (e.g., 620 FW 2 Cooperative Agriculture Use; 603 FW 1 Appropriate Use; and/or 603 FW 2 Compatibility)[1].

The need for use of GECs in refuge agricultural practices in the southeast is to:

- Allow refuges to meet management goals that cannot be reached through the use of traditional crop varieties alone;
- Reduce the number and amount of pesticides used in refuge agriculture practices;
- Minimize agricultural footprint required to meet refuge goals and objectives;
- Ensure refuges have an economically feasible method of implementing agricultural practices;
- Minimize physical, biological, socioeconomic, and cultural impacts while achieving refuge goals and objectives; and
- Ensure that we can meet refuge goals and objectives while adhering to applicable laws and policies.

This PEA is intended to provide a programmatic evaluation of the use of GECs on NWRs within the southeast. In the future, the Service will undertake individual project-level environmental reviews of the use of GECs on specific refuges via tiering to this analysis.

Decision Framework

Based on this PEA, the Regional Director for the Southeast will:

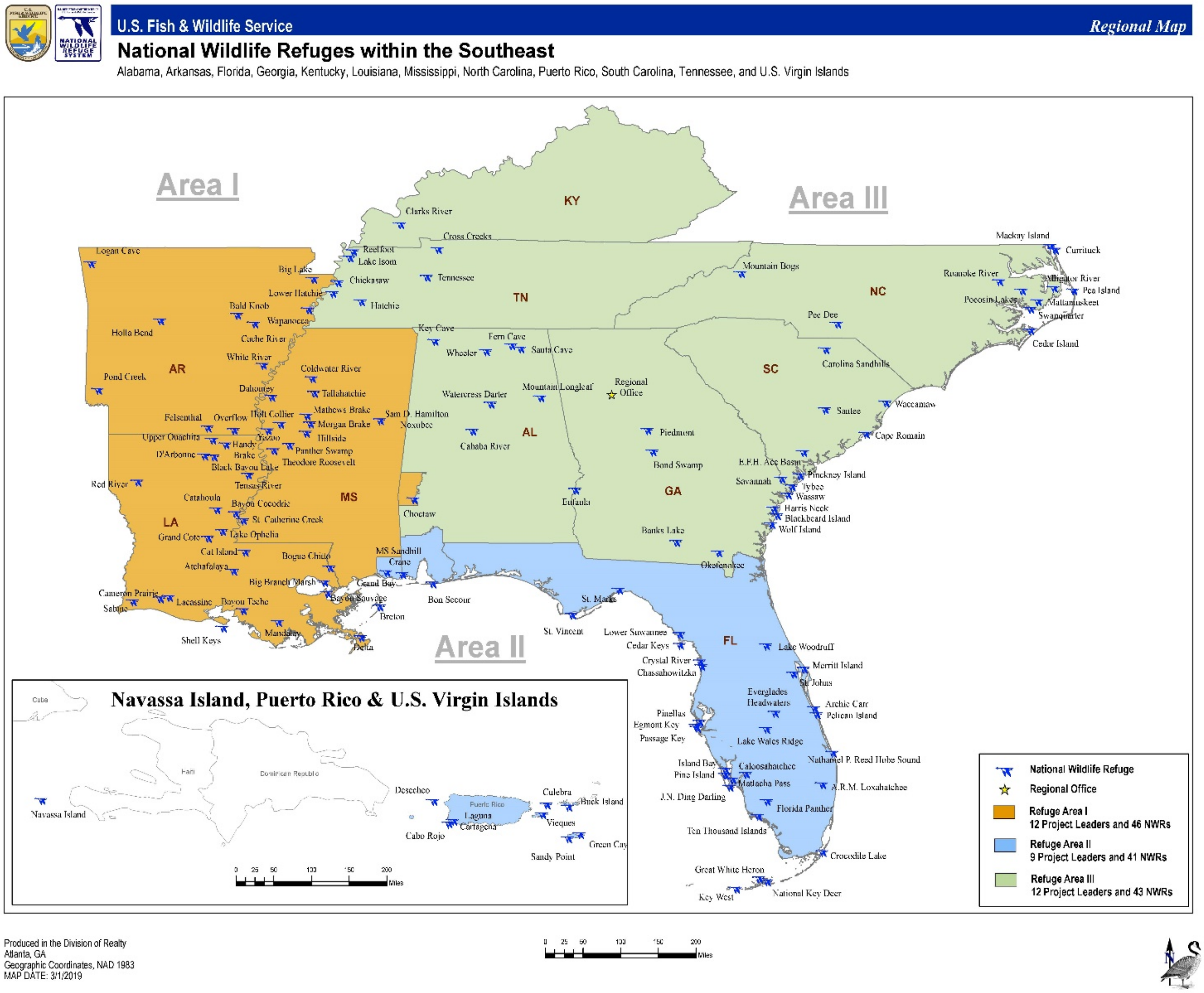
- Select an alternative regarding the use of GECs on NWRs in the southeast; or
- Determine if the selected alternative is a major federal action that would significantly affect the quality of the human environment thus requiring preparation of an

[1] In 2011, the Service's use of GECs was challenged in a lawsuit filed by three non-profit organizations. In accordance with a court-approved settlement, the Service discontinued use of GECs on refuges at the end of the 2012 farming season and agreed to refrain from such use until ninety (90) days after completing an appropriate NEPA analysis. The Service began developing a Programmatic Environmental Assessment in 2013, but suspended preparation pursuant to a July 2014 memorandum from the Service's Chief of NWRS announcing that the use of GECs on NWRs nationwide would be phased out by January 2016. Via an August 2, 2018, memorandum, the Principal Deputy Director of Service rescinded the July 2014 memorandum and directed the Service to determine the appropriateness of the use of GECs on a case-by-case basis in compliance with applicable authorities, including, but not limited to NEPA.

Environmental Impact Statement in accordance with the National Environmental Policy Act, 42 U.S.C. § 4321 et seq. (NEPA).

Current NWR management practices will be reviewed and compared to a preferred alternative. In accordance with NEPA, each alternative was evaluated based on associated environmental consequences, including biological, physical, social, and economic impacts, as well as on the effectiveness of the alternative to support the mission of the NWRS and the purposes for which NWRs were established.

Figure 1. U.S. Fish and Wildlife Service, Southeastern United States.



Authority, Legal Compliance, Compatibility, and Policy

The NWRS Administration Act of 1966, as amended, 16 U.S.C. 668dd-668ee, (Administration Act) is the core statute guiding management of the NWRS. The National Wildlife Refuge System Improvement Act of 1997,16 U.S.C. § 668dd(a)(2), (Improvement Act), another authority governing the management of refuges, made important amendments to the Administration Act mandating that each NWR must be managed to:

- fulfill the mission of the NWRS;
- fulfill the specific purposes for which the NWR was established;
- consider the needs of wildlife first;
- complete a Comprehensive Conservation Plan for each NWR,
- fulfill the requirements of the NWR's comprehensive conservation plan;
- maintain the biological integrity, diversity, and environmental health of the NWR; and,

- recognize that wildlife-dependent recreation activities, including hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation, are legitimate and priority public uses and allow the NWR manager to determine compatible public uses.

Under the Improvement Act, the Service may allow a use on a NWR when it is determined to be appropriate and compatible with the purposes for which the NWR was established and to further the mission of the NWRS. To implement the Act, the Service developed policy and guidance on determining whether a refuge use is appropriate (USFWS 2006b) and compatible with the purpose for which the refuge was established (USFWS 2000). Refuges are also managed consistent with a number of other laws, regulations, policies, and executive orders that, along with policies on appropriateness and compatibility, may be found on the Service's website at: https://www.fws.gov/refuges/policiesandbudget/.

Current policies governing uses on refuges are the Service's Biological Integrity, Diversity, and Environmental Health Policy (USFWS 2006a) (BIDEH) and Integrated Pest Management Policy (USFWS 2010a) (IPM Policy) as well as the Southeast Region's Genetically Engineered Crop Use Guidance (Regional GEC Guidance, Appendix C, USFWS 2006a, 2010b). The BIDEH provides policy for maintaining and restoring, where appropriate, the biological integrity, diversity and environmental health of the NWRS. It also is an additional directive for refuge managers to follow in achieving refuge purposes and the NWRS's mission by providing for the consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges. BIDEH also provides refuge managers with an evaluation process to analyze their refuge and recommend the best management direction to prevent further degradation of environmental conditions and, where appropriate and in concert with refuge purposes and the NWRS mission, restore lost or severely degraded components.

The BIDEH Policy was amended in 2006, to delegate decision-making authority on the use of GECs to the Chief of the NWRS in each region (USFWS 2006a, 2010a). Among the conditions for authorizing GEC use on a refuge was the requirement that IPM strategies incorporate the most effective combination of mechanical, chemical, biological, and cultural control and consider the effects of the strategies on the environmental health of each NWR (USFWS 2010a). Secondly, the amendment provided that GECs could be used on a NWR only when deemed essential to accomplishing the purpose for which the NWR was established.

Pursuant to the BIDEH policy amendment, the Southeast's Chief of NWRS developed Regional GEC Guidance (Appendix C, USFWS 2010b) authorizing the use of GECs when essential to accomplishing NWR goals and objectives and when implemented in accordance with other Regional and National Policies. The Southeast's policy further limited GEC use to crops that had been evaluated and deregulated by the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture (USDA) in accordance with the Plant Protection Act (7 U.S.C. §§ 7701-7786) and its associated regulations at 7 C.F.R. Part 340, the U.S. Environmental Protection Agency (EPA), U.S. Department of Health and Human Services' Food and Drug Administration (FDA), and NEPA.

We also consider information and direction from other Federal agencies in this PEA such as the U.S. Department of Health and Human Service's Food and Drug Administration (FDA), the EPA and USDA's Animal and Plant Health Inspection Service (APHIS). The FDA has primary responsibility for ensuring the safety of human food and animal feed as well as the proper labeling and safety of all plant-derived foods and feeds. The EPA regulates pesticides, including plants with plant-incorporated protectants (pesticides intended to be produced and used in a living plant) as well as pesticide residue on food and animal feed to ensure public safety. APHIS, through its Biotechnology Regulatory Services program (BRS), regulates the introduction of certain genetically engineered organisms that may pose a risk to plant health.

Additional information on APHIS's regulatory process can be found at http://www.aphis.usda.gov/regulations/index.shtml. APHIS's NEPA documents analyzing the environmental impacts of specific GECs can be found at https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/permits-notifications-petitions/petitions/petition-status.

Agricultural Practices Used for Natural Resource Management

Administrative Models to Facilitate Agricultural Practices

The most commonly used administrative model for implementing agriculture on NWRs is through cooperative partnerships with private farmers where a NWR enters into a cooperative agreement authorizing a farmer to plant a crop on the NWR in exchange for leaving a portion of that crop (typically 25%) unharvested for NWR use (i.e., food for wildlife). The cooperative agreement model is economically efficient, practical, and is similar to arrangements used by many state natural resource agencies on wildlife management areas. Other models used to implement agriculture practices on NWRs are force account and contract farming. Under the force account model, agricultural activities are undertaken by NWR staff using Service-owned equipment. In contrast, contract farming is completed by non-Service staff for a fee. In the force account and contract models, costs of all agricultural activities (e.g., seed, fuel, pesticide, equipment, and staff costs) are borne by NWRs. Due to budget constraints, reductions in staff, efficiency, and effectiveness of cooperative farmers due to their experience, most refuges implement their agricultural practices through cooperative partnerships with private farmers.

Crop Varieties

When agriculture practices began on NWRs in the 1930s, agricultural technology was basic with respect to machinery and seed varieties. The seed industry began a transformation in the 1930s, however, with the development of commercially-viable hybrid seeds (Fernandez-Cornejo and Caswell 2006). During the early years of the NWRS, seed hybridization was in its infancy. Over time, farmers gradually shifted to the higher yielding hybrid varieties. The first genetically engineered varieties were released commercially for major crops (e.g., corn, cotton and soybeans) in the mid-1990s (Fernandez-Cornejo and Caswell 2006). The southeast developed and implemented a process for approving the use of Genetically Modified Crops on National Wildlife Refuges in the Southeastern U.S. in October of 2006 in accordance with the BIDEH policy.

The agricultural crops now commonly planted on NWRs in the southeast include corn, rice, soybean, grain sorghum, millet, buckwheat, and wheat. These crops provide nutritious seeds consumed by most species of waterfowl, cranes, and/or other wildlife. Vegetative material of wheat (green browse) is considered a desirable food for geese. Other crops that may be planted for specific wildlife management purposes are sunflower, cover crops (e.g., rye and clover), and canola, but their use is uncommon in the southeast. Currently, corn, soybean, and rice are the crops most commonly used on NWRs in the southeast. In the future, genetically engineered wheat, grain sorghum, and others may become available and appropriate for use in natural resource management activities on NWRs.

Use of GECs and non-GECs on NWRs

Prior to the mid-1990s, NWRs used conventional (i.e., non-GE) seed. Due to the increased use of GECs on private lands, NWRs began using GECs in accordance with the Southeast Region's Genetically Engineered Crop Use Guidance (Appendix C), to meet their objectives. Although conventional crop varieties have been genetically modified using selective breeding and other techniques, for the purposes of this PEA, a genetically engineered organism refers crops with specific gene insertions to produce a trait that does not naturally occur in the species. The first GEC used on NWRs in the southeast was corn inserted with genes from *Bacillus thuringiensis [Bt]* for resistance to insect pests such as corn borers (*Ostrinia nubilalis*), corn rootworm (*Diabrotica virgifera*), and corn earworm (*Helicoverpa zea*). The second GEC used on NWRs in the southeast was soybeans inserted to make crops tolerant to the application of the broad-spectrum herbicides, such as glyphosate (e.g., Roundup Ready ®) and glufosinate (e.g., LibertyLink ®).

Based on USDA's nationwide survey data, the percent of domestic soybean acres planted with genetically engineered varieties for herbicide tolerance (HT) rose from 17% in 1997 to 94% in 2014. Currently, approximately 90% of domestic corn acres are planted with HT seeds. Domestic *Bt*-corn acreage grew from approximately 8% in 1997 to 82% in 2018. Additionally, in 2018, 80% of corn acres were planted with stacked seeds, which have both HT and *Bt* traits (USDA ERS 2018).

Further information on the role of the EPA in evaluating the environmental effects of pesticides associated with GEC use can be found at https://www.epa.gov/regulation-biotechnology-under-tsca-and-fifra/overview-plant-incorporated-protectants.

Crop Rotation

Crop rotation is the planting of different crops in the same field over a period of successive years. This practice optimizes soil nutrition and fertility; reduces weeds, insects, and disease; controls volunteer crops in subsequent years; and, limits the potential for weeds to develop resistance to herbicides (Olson and Sander 1988, Hoeft et al. 2000, USFWS 2010a, Cartwright et al. 2006, McLeod and Studebaker 2006, Leikam and Megel 2007, USDA ERS 2010, Green and Owen 2011). Soybeans are used on NWRs primarily as a rotational crop with corn and rice and for weed control. Under the cooperative partnership model, soybeans are often a part of the crop harvested by the farmer. The planting of winter wheat or another cover crop following the harvest of soybeans is a common practice to provide green forage for migrating geese. With respect to use of GECs prior to 2013, the Regional GEC Guidance required rotation of a non-Roundup Ready ® GEC variety at least one of four years to reduce the likelihood of pests becoming resistant to this herbicide (Appendix C).

Tillage Practices

Soil tillage is used to prepare a seedbed for crop planting, reduce soil compaction, incorporate fertilizers and herbicides, manage water movement within and out of a production field, control weeds, and reduce the incidence of insect pests and plant disease (Hoeft et al. 2000, Christensen 2002, Fawcett and Towery 2002, Tacker et al. 2006, Givens et al. 2009, National Research Council 2010). Conventional tillage is the plowing or disking of soil after harvest or prior to planting. Conventional tillage typically leaves a crop residue of less than 15% between harvest and the next growing season.

In 2010, the National Research Council reported that the use of GECs is complementary to and increases the use of conservation tillage practices. Conservation tillage typically maintains crop residue on at least 30% of the soil surface until subsequent planting (Busari et al. 2015). No-till agriculture, a common conservation tillage practice, is a planting technique that drills crop seed directly through the previous crop's residue without soil tillage. Herbicides are typically used before and after planting to control weeds. The crop residue, in turn, aids in reducing erosion and providing habitat for wildlife, although it can also harbor agricultural pests overwinter. Because no-till agriculture leaves more crop residue after harvest, it is increasingly used and reported to provide the additional benefit of reducing the need to implement mechanical weed control measures, such as multiple plowing of crops to control noxious weeds (USDA-NRCS 2006, Towery and Werblow 2010b, USDA-APHIS 2013a,b). Conservation tillage agricultural practices are the most commonly preferred practices on NWRs in the southeast.

Invasive Plant and Pest Treatment

NWRs use pesticides and agriculture as part of an IPM approach. IPM is a "sustainable approach to managing pests by combining biological, cultural, physical/mechanical, and chemical tools in a way that minimizes economic, health, and environmental risks" (USFWS 2010a). IPM combines pest biology, environmental information, and available technology to prevent unacceptable levels of pest damage through the most economical means, while posing the least possible risk to people, property, resources, and the environment. The underlying philosophy of IPM is that pest control is most effective when a range of measures is deployed in a manner that diminishes the likelihood that the pest will become resistant to the measures.

Inputs typically associated with crop production include fertilizer (e.g., synthetic fertilizers, manures, and composts containing nitrogen, phosphorus, and potassium), pesticides (e.g., insecticides, herbicides, fungicides) (Olson and Sander 1988, Hoeft et al. 2000, McLeod and Studebaker 2006), and/or irrigation. Pesticide use for habitat management and invasive and nuisance species control is part of the approved CCP, HMP, and associated Environmental Assessments (EA) with a finding of no significant impact (FONSI) for each NWR. The southeast relies on four tiers of analysis to support NEPA compliance with respect to pesticide use on NWRs for wildlife management:

- Pesticide specific analysis by EPA;
- Pesticide specific analysis through the Service's Pesticide Use Proposal (PUP) process;
- Analysis of pesticides in general for a specific NWR or NWR complex through an EA/FONSI or EIS/Record of Decision (ROD) (e.g., EA/FONSI for a CCP or HMP); and,

- Analysis of pesticides in general through a periodic Environmental Action Statement (EAS) that documents the pesticide use/treatment planned for a particular NWR or NWR complex (note: The EAS will be updated as needed if use/treatment change).

The Service only uses EPA-registered pesticides that are reviewed and approved under the Federal Insecticide, Fungicide, and Rodenticide Act (7 USC §136) (FIFRA). EPA conducts risks assessments to ensure registered pesticides will not cause unreasonable adverse effects on the environment. EPA's risk assessment process is considered to be equivalent to fulfilling EPA's requirements of complying with NEPA. In addition to being EPA-registered, each pesticide proposed for use on a NWR must first be approved under the Service's PUP process (569 FW 1), through which each pesticide is analyzed for toxicological effects in relation to human/environmental aspects associated with the NWR. The Regional IPM Coordinator evaluates each chemical through the PUP process and approves or disapproves its use. The review process provides best management practices (BMPs) that assist the NWR with use of the pesticide to reduce potential impacts to non-target pest species. The manner in which the Service administers a pesticide is typically more restrictive than that required by the label, particularly as it pertains to buffers. The Service engages in an Intra-Service Section 7 consultation under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531–1543) (ESA) on each pesticide to evaluate whether threatened and/or endangered species near and/or adjacent to the treatment areas would be impacted. Pesticides are applied on NWRs in accordance with the Department of the Interior's Pesticide Use Policy (517 DM 1), the Service's Integrated Pest Management Policy (569 FW 1), and other applicable policies (e.g., 601 FW 3 Biological Integrity, Diversity, and Environmental Health; 620 FW 2 Cooperative Agriculture Use; 603 FW 1 Appropriate Use; and/or 603 FW 2 Compatibility).

Public Comment

The Service engaged the public through scoping early in the development of this PEA. Information on public engagement in this process is included in Appendix D.

The draft PEA is posted on the project website at https://sites.google.com/site/fwsregion4gmcpeis/home and on the Southeast's website at http://www.fws.gov/southeast/. Paper copies of the document will be mailed to those individuals who request through the web site, phone or mail.

The Service will accept comments on this draft PEA for 30 days from the date of the draft release.

Issues thoroughly treated by other agencies and scientific organizations

Other issues regarding specific GEC varieties were previously evaluated by APHIS under the Plant Protection Act, by APHIS's implementing regulations, and by EPA prior to general release of the GECs for use. Analysis of specific EPA registered chemicals is also beyond the scope of this PEA.

In the environmental assessments of these GECs, APHIS found that their use would not result in significant impacts to the human environment, particularly concerning:

- inadvertent crop to weed gene flow,

- impacts on human health and safety,
- impacts on non-target species,
- impacts on agricultural practices,
- potential impact on organic farmers,
- potential weediness of genetically engineered crops, or
- impacts on soil microorganisms.

These issues are addressed as appropriate in this PEA, but source documents for crop varieties with detailed information by the authorizing agency, United States Department of Agriculture, can be found at the following web addresses:

https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/permits-notifications-petitions/petitions/petition-status

More recently, the National Academies of Sciences, Engineering, and Medicine's Board of Agriculture and Natural Resources' Committee on Genetically Engineered Crops (NASEM) published a report that addresses many of the same issues that APHIS and other agencies have previously investigated (NASEM 2016). The NASEM (2016)found the available evidence at the time they published their report indicated that genetically engineered crops have had favorable economic outcomes, but these were variable depending on pest abundance, farming practices, and agriculture infrastructure. More relevant to this assessment, the NASEM (2016)found no conclusive evidence overall of cause-and-effect relationships between environmental and human health issues and the use of genetically engineered crops (additional discussion provided under alternative effects). Of particular interest to this PEA was a specific and detailed assessment provided by the Committee with respect to concerns over the status of monarch butterflies (*Danaus plexippus*) and possible associations with the use of genetically engineered crops (see Chapter 4). The entire report can be found at the following web address:

https://www.nap.edu/catalog/23395/genetically-engineered-crops-experiences-and-prospects

or direct to pdf:

https://agbiotech.ces.ncsu.edu/wp-content/uploads/2016/05/NAS-Genetically-Engineered-Crops-Full-Report.pdf?fwd=no

Chapter II: Affected Environment

Regional Setting

The Southeastern U. S. includes over 130 NWRs in 10 states, the Commonwealth of Puerto Rico, and the U.S. Virgin Islands. The Southeast stretches from the Appalachian Mountains south to the islands of the Caribbean, west to the Ozarks and east to the South Atlantic Coast, including the southern half of the Mississippi River Basin. Portions of the coastal areas of the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea also lie within the southeastern U. S. (See Figure 1). The combined area of refuges totals almost 4 million acres in the southeast. The Southeast's NWRs are steeped in rich and diverse natural resources, including numerous species of plants, fish, and wildlife. The southeast also supports up to a third of continental waterfowl populations during migration and winter and includes the southern portions of the Atlantic and Mississippi Flyways (Figure 2).

Physical Resources

Detailed descriptions of the specific climate, potential effects of geology and topography, climate change, soils, water resources, and air quality for each NWR (Appendix B) that would be analyzed under this PEA are available in the refuge's respective Comprehensive Conservation Plan which can be found at: https://www.fws.gov/southeast/national-wildlife-refuges/planning/, and is incorporated herein by reference.

Geology and Topography

The NWRS in the southeast is composed of a complex variety of landforms and topography resulting from millennia of geologic activity. The Atlantic Ocean provides the eastern border of the southeast along the North Carolina, South Carolina, Georgia, and Florida coasts. Louisiana, Mississippi, Alabama, and Florida are bounded to the south and west respectively by the Gulf of Mexico. Puerto Rico and the U.S. Virgin Islands lie within the Caribbean Sea. Areas adjacent to these major bodies of water exhibit expanses, some quite extensive, of coastal lowlands and salt and brackish marsh. In the southern, warmer climes of Florida and the Caribbean, mangrove islands and coral reefs occur along the coasts, and these coral reefs are responsible for the areas' primary limestone landforms. Coastal areas in the more northerly reaches of the southeast are characterized by sandy beaches with sand dunes and tidal marshes.

Moving inland, areas transition to coastal plain that is primarily flat in relief and segmented by the flow of rivers heading to open water. The coastal plain, which is low in elevation, once was submerged during past episodes of higher sea levels and now exhibits features such as swamps, bogs, Carolina Bays and escarpments that are a hint to these historic times. The interior areas in Florida are referred to as "Florida Uplands" that are low in relief, less than 300 feet in elevation, and characterized by pine and shrubby vegetation and interspersed with lakes resulting from the dissolution of limestone substrate.

Further inland and with increasing elevation is the Piedmont, which was a large forested region prior to European settlement. Now, the piedmont is characterized by low rolling hills with pine and hardwood forests and extends from the edge of the coastal plain at about 300 feet in elevation to the edge of the Appalachian mountain chain. The majority of agriculture in the southeast occurs in the coastal plain and Piedmont.

North and central to the southeast are the Appalachian Mountains, which were formed from geologic upheaval and, through time, shaped by rivers, natural elements and man. The mountain chain, whose foundation is granite, runs from Alabama in the south to Maine in the north. North Carolina, South Carolina, Georgia, Tennessee, Kentucky and Alabama each have some part of this feature within their respective borders. Many niche communities such as mountain bogs and alpine meadows occur within these mountains and are home to unique and, in some cases, threatened and endangered species of plants and animals.

Alluvial valleys are significant features that traverse the geologic features of the southeast. Due to river flow and flooding, the areas support ecologically rich wetlands that are important habitat for many species including waterfowl, a focal group for many NWRs in the southeast.

Figure 2. North American Waterfowl Migration Flyways*

* https://www.flickr.com/photos/usfwshq/29995934172

Climate Change

The majority of the Southeastern United States has a subtropical climate with hot, humid summers and mild winters. Cities such as New Orleans, Atlanta, and Charleston experience humid summers with average highs above 90°F (32 °C) in summer and winters that range from 50 to 60°F (10-16 °C). The frost-free period In the Southeastern Plains ecoregion can exceed 300 days with 1,358 mm of annual precipitation (Wiken et al. 2011).

Greenhouse gas emission is suspected as a primary cause of climate change (IPCC 2013), but emissions from agricultural practices represent a small portion in the United States (Causarano et al. 2006). Agriculture operations, including livestock, grasslands, crop production, and energy use, were responsible for approximately 6% of total emissions in the United States in 2008 (USDA-ARS 2011) compared to approximately 63% of emissions related to fuel combustion globally (Oliver et al. 2005). Of this total, less than 2% was attributable to cropland soils. Climate change may influence wildlife resources in the southeast through extreme weather events; changes in the timing, location, and intensity of wildfires; altered hydrology in rivers and wetlands; changes in rain and snowfall patterns; changes in access to water resources; and rising sea levels at coastal NWRs (Griffith et al. 2009). The Service's role is to formulate measures to adaptively manage these invaluable resources through various climatic changes. For example, a number of areas in the United States that are most vulnerable to rises in sea level are located in the Southeast, including the Mississippi River Delta, the Florida Keys, the Everglades, and the North Carolina coast.

Sea level rise is primarily caused by two factors related to global warming: the added water from melting land ice and the expansion of seawater as it warms. All signs indicate that sea level rise is accelerating (Kemp et al. 2011). A study from the University of Pennsylvania found the rate of sea level rise along the Atlantic coast of the United States to be greater now than it has been at any other point in the past two millennia (Kemp et al. 2011). Titus and Richman (2001) in an analysis of coastal North Carolina measured over one million acres of land below one meter of elevation and over 1.4 million acres below 1.5 meters -- the third largest low-lying region in the U.S. after Louisiana and Florida (IPCC 2007). Rising sea levels are expected to flood as much as 30% of NWRs in coastal areas and potentially displace protected wildlife (Liu and Delach 2012). Sixty-seven of the 131 NWRs in the southeast are situated along the coast from North Carolina to Louisiana. Loss of physical wetland area and degradation due to exotic species expansions resulting from climate changes will likely require increased management intensity, such as agricultural production, on the remaining refuges to meet the needs of wildlife at their current levels.

Climate change may have a positive influence on agriculture in general. According to the IPCC, climate change may increase crop yield by 5 - 20% during the current century (Field et al. 2007). The extent of positive effects on agriculture from climate change is speculative, however, and will vary. For example, the IPCC report indicates that certain regions of the United States will be impacted negatively by a significant decline in available water resources. Nevertheless, overall agricultural production in North America is expected to adapt to climate change impacts with improved cultivars and responsive farm management practices (Field et al. 2007).

The impacts of climate change, both favorable and adverse, are becoming apparent in some states. Greater precipitation during the growing seasons has been associated with increased yields; however, excessive precipitation early in the growing season has adversely affected crop productivity. Increased soil erosion rates due to heavy rain events have required many farmers to adopt additional conservation practices to improve soil and water quality (Rogovska and Cruse 2011).

Severe weather events, such as floods, droughts, and extreme heat all predicted to become more frequent and intense, can present substantial challenges to crop production and impact retail prices. For example, the 2012 drought impacted crop failure and yields in the central United States, particularly of field corn and soybeans, which led to increases in the prices of these commodities as well as of livestock (Kemper et al. 2012).

Soil resources

Soils on NWRs in the southeast where agriculture may primarily be used include alluvial deposited entisols, inceptisols, alfisols, and vertisols in the Mississippi Alluvial Valley (MAV) and non-alluvial ultisols in the Coastal Plain. Cropland soils on NWRs in the MAV are alluvial soils of the Mississippi River and, for the most part, are protected by levees; however, flooding of farmlands along the Mississippi River and associated tributaries still occurs. For detailed information on soils in the Southeastern U.S., see West et al. (2016).

Water Resources

The Southeastern United States, which is bounded to the south by the Gulf of Mexico and to the east by the Atlantic Ocean, encompasses portions of six water resource regions, including the South Atlantic-Gulf, Tennessee, Ohio, Lower Mississippi, Arkansas-White-Red, and the Texas-Gulf (Seaber et al. 1987). These watersheds are further divided into sub-units that follow major rivers. The South Atlantic is divided into the Chowan-Roanoke, Neuse-Pamlico, Cape Fear, Pee Dee, Edisto, Santee, Ogeechee-Savannah, Altamaha-St. Marys, and St. Johns subregions that drain from north to south into the Atlantic Ocean. The subregions of the South Atlantic-Gulf Region that drain into the Gulf of Mexico include the Peace-Tampa Bay, Suwanee-Ochlockonee, Apalachicola, Choctawhatchee-Escambia, Alabama-Mobile-Tombigbee, Pascagoula, Pearl, and Upper and Lower Tennessee.

Florida and Louisiana have the greatest wetland area (11.3 million and 8.6 million acres, respectively) and proportional coverage (30.2% and 27.9%, respectively) of all the Southeastern states. Conversely, Kentucky (0.2 million), Tennessee (0.8 million), and Arkansas (2.7 million) have substantially less wetland area (Hefner and Brown 1984). Widespread drainage and leveeing of floodplains for flood control and agriculture has resulted in tremendous declines in functional floodplain areas and associated wetland services (Havera 1999, Brinson and Malvarez 2002, Costanza et al. 2014).

The Ohio River Region encompasses portions of 14 states and accounts for 40% of the discharge of the Mississippi River while comprising only 16% of its drainage area. The watershed encompasses 529,000 km^2 and includes the Tennessee, Cumberland, Green, Wabash, and several other major rivers in the Southeast. The Lower Mississippi region encompasses 880,000 km^2 from the confluence of the Ohio River near Cairo, Illinois to the Gulf of Mexico. This region is bisected by a 1,536 km stretch of the Mississippi River that drains the upper Mississippi, Ouachita, White, Red, Arkansas, Big Black, Yazoo, and other major rivers. River floodplains in the region comprise one of the largest floodplain ecosystems in the world with 36,000 km^2 of wetland including 26 tributary streams and 242 lakes larger than 8 ha.

The Gulf Coast Region includes seven major rivers (i.e., Suwannee, Pearl, Black, Mobile, Escambia-Conecuh, Choctawhatchee, and Chattahoochee) that drain more than 265,000 km^2, range in size from 11,000 to 111,000 km^2, and lie completely or substantially in coastal plain soils.

The South Atlantic Region includes sixteen major rivers with the Roanoke, Cape Fear, Savannah, Ogeechee, and St. Johns Rivers representing the region's diverse natural communities with the river mouths occurring about every 100 km along the Atlantic coast. River lengths vary from 9,000 (Saltilla River) to 39,000 km (Santee River).

Air Quality

Air quality is influenced by a complex series of naturally occurring and anthropogenic factors. Pollutants affecting air quality associated with agricultural practices are highly variable in space and time. In the United States, ammonia, particulate matter, methane, and nitrous oxide are among the major potential air pollutants resulting from agricultural operations. Agriculture is the largest source of anthropogenically produced methane with most coming from livestock operations rather than row-crop operations (Aneja et al. 2009). Soil tillage practices that can increase airborne particulate matter have perhaps the largest potential impact on regional air quality. Using no-till and conservation tillage can limit particle suspension in the air (Stetler and Saxton 1996).

Biological Resources

Detailed descriptions of the specific habitat resources and wildlife of each NWR (Appendix B) analyzed under this PEA are available in the respective Comprehensive Conservation Plans and are incorporated by reference herein (https://www.fws.gov/southeast/national-wildlife-refuges/planning/, USFWS 2017).

Habitat Resources

Land Cover

Land cover on refuges in the southeast can be generally classified as open water; deciduous, evergreen and mixed forest; shrub/scrub; grassland/herbaceous; woody and herbaceous wetlands; and cultivated cropland (National Land Cover Database; http://www.mrlc.gov; Figure 3). While the proportional cover of each of these land cover types vary among NWRs, most areas are primarily composed of natural communities, such as forest, grasslands, and open water wetlands. Moreover, NWRs in coastal areas are comprised primarily of freshwater, brackish, and/or salt marshes with herbaceous vegetation. NWRs inland are comprised of a mix of mixed pine and hardwood upland forest, forested wetlands, and open water areas in lakes, reservoirs, and large rivers.

Many NWRs in the southeast have portions that are intensively managed to maintain specific natural communities (e.g., open pine savannah) or desired habitat conditions using infrastructure and artificial means (e.g., impounded moist-soil wetlands). Human impacts have greatly altered the natural processes and ecosystems in the southeast. In many cases, management is required to provide historical or desired natural communities that would be lost due to altered hydrology, fire suppression, invasive species, and other threats without active management.

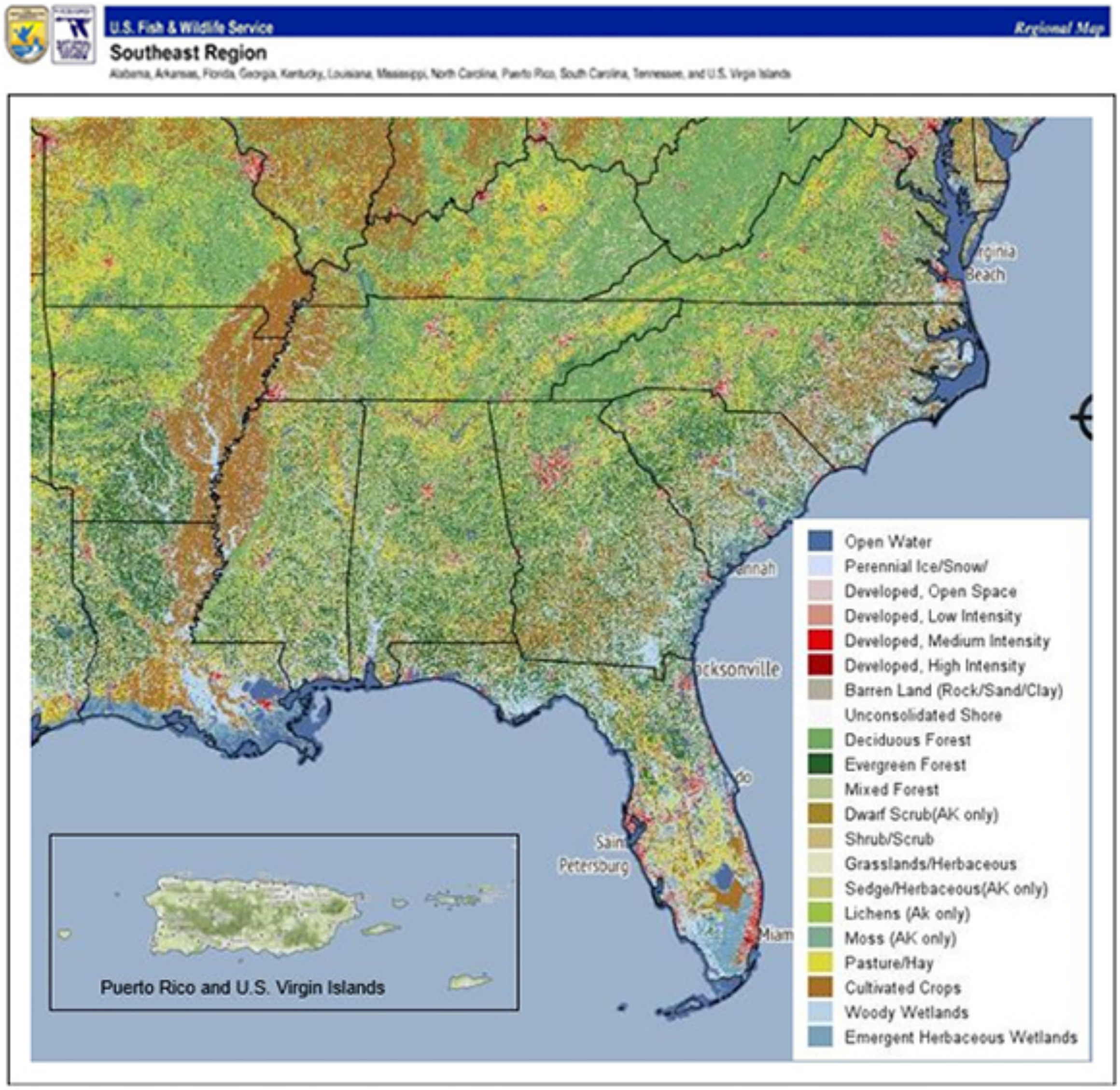
Wetlands are an important natural community covering 21% of the southeast and almost 50 million acres (Hefner et al. 1994). Nearly half of the freshwater wetlands and three-quarters of the estuarine wetlands in the continental United States were once located in the Southeast (Hefner et al. 1994). Hefner et al. (1994) reported that wetland loss in the United States from the mid-1970s to mid-1980s occurred mainly in the Southeast and accounted for 89% of the nation's losses. Similarly, forested, coastal and estuarine wetlands have been in decline across the Southeast for decades (MacDonald et al. 1979, Dahl 2011, Couvillian et al. 2011).

In 1992, Twedt and Loesch (1999) found that only 6.4 million acres of forested area (approximately 25% of the original forested area estimates) occurred in the MAV. Losses of forested wetlands as well as hydrological alterations to the river systems have significantly influenced the capability of the MAV to support wildlife populations, including wintering waterfowl (Reinecke et al. 1989, Fredrickson 2005, Wilson et al. 2005). The loss of 75% of the bottomland hardwoods in the MAV equates to a loss of at least 2 billion duck energy days (DEDs, i.e., one DED is the quantity of food necessary to feed one mallard-sized duck (*Anas platyrhynchos*) for one day); Reinecke and Kaminski 2006). Refuges in the Lower Mississippi Alluvial Valley (LMAV) alone provide more than 90 million DEDs . These DEDs satisfy twenty-eight percent (28%) of the energy objectives for the LMAV Joint Venture geography.[2]

Some refuges in the Southeast contain relatively significant elements of natural communities that occur as isolated patches surrounded by a matrix of highly degraded or altered land uses that compound management efforts to maintain natural ecosystems. Many refuges contain large areas that were in a significantly degraded state when acquired by the Service and could no longer function as natural ecosystems without implementation of management activities. Other areas have been so altered that restoration without active management is impractical. As a result, returning many refuges to "natural" conditions by eliminating active management practices may be impossible given surrounding land use, invasive species, and modified hydrologic regimes.

[2] Notwithstanding, the Lower Mississippi Valley Joint Venture (LMVJV) estimates that waterfowl face a 153 million DED shortage in the LMAV (USFWS LMVJV 2012, USFWS LMVJV 2015).

Figure 3: Land Cover in the Southeast



**USGS national Land Cover Database retrieved January 11, 2019 https://www.mrlc.gov/viewer/

Habitat Resource Use by Waterfowl

Historically, waterfowl used natural wetland communities in southern portions of the Mississippi and Atlantic Flyways, including flooded bottomland forest, non-riverine swamp forest, herbaceous wetlands, and open water areas of rivers, lakes, and ponds. Bottomland hardwood, non-riverine swamp forest, and herbaceous wetlands provide natural seeds (e.g., acorns in oak bottomlands; hard and soft mast in non-riverine swamp forests; grass seeds and tubers in moist-soil wetlands) and aquatic invertebrates that provide energy and other nutrients (Heitmeyer 1988, Fredrickson and Batema 1992, Kaminski et al. 2003, Heitmeyer 2006, Hagy and Kaminski 2012a,b). Breeding wood ducks and hooded mergansers nest in tree cavities in or near forested and emergent wetlands where they raise their broods (Dugger and Fredrickson 2001). Mallards, gadwall, and black ducks extensively use forested wetlands during migration and winter (Fredrickson and Heitmeyer 1988, Davis et al. 2009, Link et al. 2011, Newcomb 2014, Osborn et al. 2017). Natural wetlands with an interspersion of emergent cover and open water are also used for pair bonding, loafing, sanctuary, and thermal cover (Reinecke et al. 1989). Lakes, ponds, and other areas of deep, open water provide roosting and resting areas for a variety of waterfowl, especially species that can supplementally feed in uplands, such as tundra swan, Canada geese, and snow geese.

Freshwater marsh is extensively used by many species of ducks and geese, and it was a selected resource type of mallards in southwestern Louisiana (Link et al. 2011). Coastal Louisiana has supported as much as two-thirds of the wintering waterfowl population of the Mississippi Flyway (Bellrose 1980). Although waterfowl use brackish marsh extensively, the food value is substantially less than freshwater marsh, and primary foods are submerged aquatic vegetation, such as widgeongrass (*Ruppia maritima*; Hindman and Stotts 1989, USFWS 2005, Brasher et al. 2012). Many former areas of brackish marsh along the South Atlantic Coast were converted by farmers to freshwater impoundments and support a high percentage of waterfowl that use the Atlantic Flyway (Gordon et al. 1989, USFWS 2005).

Many NWRs in the southeast acquired lands with prior-converted wetlands and coastal marshes and have maintained seasonal flooding regimes to provide forage for waterfowl and other waterbirds. Levee systems allow management of water levels that encourage desirable plant communities, such as natural moist-soil and submerged aquatic vegetation. Food-rich agricultural crops, such as corn, milo, and millet, can also be produced inside impoundments to supply energy to wintering waterfowl. Water management in moist-soil units involves a drawdown in late spring or summer to encourage natural seed and/or tuber producing annual plants or allow planting of agricultural crops. Impoundments are re-flooded in late autumn and winter to make the food resources accessible to waterfowl.

Managing seasonally flooded impoundments for submersed and emergent aquatic vegetation, such as moist-soil plants, is a widely accepted waterfowl management practice dating back to at least the 1940s (Low and Bellrose 1944, Fredrickson and Taylor 1982, Fredrickson 1996). Although geese sometimes use moist-soil vegetation and feed on shoots of germinating plants, rhizomes, roots, or tubers (Austin et al., 1998), the primary emphasis of moist-soil management is to provide food for ducks. Common native plant taxa occurring in moist-soil wetlands include wild millet (*Echinochloa* spp.), sprangletop (*Leptochloa* spp.), flatsedge (*Cyperus* spp.), smartweed (*Polygonum* spp.) and panicgrass (*Panicum* spp.; Fredrickson and Taylor 1982, Schummer et al. 2012). Emergent wetlands, especially managed impoundments with moist-soil vegetation, are highly recommended as a means of supplying energy and other nutrients for waterfowl and as a way to meet the needs of a wide variety of waterfowl and other wetland-dependent wildlife (Fredrickson and Taylor 1982, Reinecke et al. 1989, Hine et al. 2017). Moist-soil and other natural wetlands provide a diversity of foods with essential amino acids and other nutrients not found in some cereal grains (Loesch and Kaminski 1989, Stafford et al. 2011).

Although natural wetlands provide foraging and resting habitat for many species of wetland-dependent wildlife, their energy content per unit area is much lower than standing agricultural crop areas. For example, unharvested corn provides approximately 14 times more energy than managed emergent marsh (Winslow 2003, McClain et al. 2019), 16 times more energy than managed moist-soil (Hagy and Kaminski 2012b), 34 times more energy than an oak-dominated bottomland forest (Straub et al. 2016), and 60 times more energy than harvested crop fields (Foster et al. 2010, Gray et al. 2013). Thus, agriculture provides an efficient mechanism to supply an abundance of energy to waterfowl in a relatively small area. When used as part of a complex with other natural wetlands, agriculture can be an efficient tool to help NWRs provide high-quality foraging habitat in support of NAWMP.

Due to the substantial decrease in quantity and quality of natural wetlands in the Southeast and changing farming practices on private lands, agricultural crops planted specifically to provide food for wildlife play an important role in waterfowl management by providing a source of high-energy food within a small area (Gates et al. 2001, Ely and Raveling 2011, Gray et al. 2013). Natural foods (e.g., acorns, moist-soil seeds) occurring within wetlands are now far less abundant, and commercial agricultural practices have become increasingly efficient leaving little waste grain for waterfowl (Manley et al. 2004, Foster et al. 2010, Pearse and Stafford 2014). Foster et al. (2010) found that biomass of corn, soybean, and grain sorghum seed in harvested fields decayed, was consumed by exotic and native species of wildlife other than waterfowl , or sprouted quickly following harvest. Most fields had no waste grain available by January in Tennessee. Manley et al. (2004) showed that waste grain in harvested rice fields declined 79-99% between harvest and early winter indicating little to no available food in harvested rice fields. In some areas of the Southeast, ratoon or other practices may increase food density for waterfowl in harvested rice fields (Marty 2017), but these practices are neither regionally widespread nor is there sufficient evidence to indicate that most harvested crop fields provide substantial amounts of food resources for most species of waterfowl during fall and the nonbreeding period.

Many waterfowl species commonly feed on agricultural grains when they are available (Baldassarre and Bolen 1984, Delnicki and Reinecke 1986, Combs and Fredrickson 1996, Heitmeyer 2006). Canada geese have adapted to agriculture provided food sources perhaps more than any other waterfowl species in North America (Bellrose 1980, Gates et al. 2001). Agricultural grains and green forage from natural vegetation, agricultural weeds, and agricultural crops have become the mainstay for Canada geese (Gates et al. 2001), snow and Ross' geese (Alisauskas et al. 1988, Massey 2017), and greater white-fronted geese (Kaminski 1986, Krapu et al. 1995, Ely and Raveling 2011) across large portions of their wintering and migration range. Agricultural grains, such as corn and rice, provide a high-energy diet and may be especially important during harsh winter weather (Gates et al. 2001, Ely and Raveling 2011). Cultivated grasses (e.g., winter wheat), natural vegetation (e.g., marsh hay cordgrass and seashore saltgrass rhizomes), and roots from cultivated crops (e.g., rice) likely contain higher protein and fiber levels than most grains (Sedinger 1984, Petrie et al. 1998, Ely and Raveling 2011).

Because of their high carbohydrate content, agricultural grains have a greater metabolizable energy than most natural foods, including moist-soil seeds, acorns, and aquatic vegetation (Petrie et al. 1998, Kaminski et al. 2003). Waterfowl consume energy-rich foods in wintering areas to rebuild lipid reserves used during southward migration and to meet energy needs during winter (Heitmeyer 1988, Massey 2017). They also need energy-rich foods to acquire sufficient resources for their northward migration to the breeding grounds and for reproductive success (Neely and Davison 1971, Williams et al. 1999). In addition to being high in energy, the yield per unit area of agricultural crops is much greater than that of natural wetland plants (Gray et al. 2013). For example, 100 acres of unharvested corn with a modest yield of 100 bu/ac would provide as much energy as 11,000 acres of bottomland hardwood forest with a high composition (e.g., 60%) of red oaks (Reinecke and Kaminski 2006). Additionally, flooded, unharvested corn provides approximately 16 times more energy than moist-soil wetlands (Reinecke and Kaminski 2006). The limited energy density of naturally wetland types on NWRs combined with limited wetland availability surrounding many NWRs necessitates a reliance on agricultural crops to provide a substantial portion of the species' nutritional needs during migration and winter.

Despite the overwhelming advantage of agricultural crops for providing waterfowl food density, NWRs typically use agricultural crops as a component of a larger wetland complex that most efficiently meets the needs of a wide variety of wintering and migrating waterfowl across the Southeast. Waterfowl typically use a variety of wetland communities throughout their daily and annual cycles (Jorde et al.1983). For example, Pearse et al. (2012) found that large wetland complexes (>5,000 ha) were more attractive to wintering ducks than single or structurally simple wetlands and that large groups of mallards and other dabbling ducks occurred in areas with approximately 50% cropland. Lancaster (2018) documented mean use of flooded croplands by female mallards in Mississippi ranged from 12% to 41% during winter, compared to 16–52% use of forested wetlands, 17–52% use of emergent wetlands, and 9–17% use of permanent wetlands. Gray (2010) noted that gadwall used intermediate brackish and fresh marsh more than agriculture or salt marshes in Louisiana, but that some individuals spent time in agricultural fields. Davis et al. (2009) noted that mallards' use of rice fields in Louisiana varied from 5% to 46% across years and time periods, compared to 46–81% for forested wetlands and 1–7% for moist-soil wetlands and idled crop fields, combined. Newcomb (2014) showed that black ducks in Tennessee used open water and emergent vegetation each about 1/3 of the time with forested and cultivated habitat comprising the other 1/3 of proportional use. Osborn et al. (2017) presented mean densities of dabbling ducks among important natural communities for dabbling ducks in Tennessee. They noted that mallards occurred in greatest densities in moist-soil, followed by wooded wetlands, and emergent marshes with submersed aquatic vegetation (SAV); gadwall occurred in greatest densities in moist-soil, followed by SAV, wooded wetlands, and mudflats; northern pintail occurred in greatest densities in moist-soil and little elsewhere; and, green-winged teal occurred in greatest densities in moist-soil followed by wooded wetlands. Thus, using agriculture as a component of a habitat complex for waterfowl is economically and logistically efficient and consistent with the preponderance of the scientific literature describing habitat resource use by wintering waterfowl.

Habitat Objectives for Wildlife

Currently, explicit habitat objectives for most species and guilds of wildlife are lacking due to a dearth of information describing population sizes and basic ecology. Refuges in the Southeast have explicit objectives for waterfowl that are stepped down from the NAWMP using the best available science (Hagy et al. 2019). A refuge's waterfowl objectives are typically expressed as total use days in the NWRs CCP and/or HMP and can be translated to habitat objectives using energy constants. Habitat objectives are typically expressed as energy days relative to a specific species or guild (e.g., DEDs, goose energy days). Traditionally, estimates of waterfowl population size (e.g., via a midwinter waterfowl survey count) at each NWR were multiplied by constants (i.e., 110 days for ducks, 90 days for geese) or extrapolated using a migration curve representing the entire wintering and migration periods to generate total use days for ducks, geese, and swans, as appropriate. Population objectives in use days can be converted to habitat objectives through a mathematical process involving the energy requirements of waterfowl and the energy content of typical habitat resources, such as moist soil or unharvested corn (Reinecke and Kaminski 2006, Gray et al. 2013). In the past, waterfowl habitat objectives also have been derived from larger-scale efforts coordinated by the Joint Ventures (e.g., Reinecke and Loesch 1996, Edwards et al. 2012, USFWS LMVJV 2015). Recently, a process was created to standardize waterfowl population objectives across NWRs in the southeast. Continental population objectives from NAWMP were stepped down to NWRs using waterfowl harvest and eBird data (Fleming et al. 2019, Hagy et al. 2019). Overall, refuges in the southeast should support approximately 400 million energy days, including dabbling ducks, diving ducks, geese, swans, and sandhill cranes. A substantial portion of that energy would need to be supplied using agriculture given the constraints on the current land base within the NWRS (H. Hagy, personal communication).

Wildlife Resources

Waterfowl Conservation in the Southeast

Waterfowl have seasonally dynamic needs that require a diversity of habitat resources throughout the annual cycle. Moreover, most waterfowl have an annual range encompassing thousands of miles and spanning many political jurisdictions. With a few notable exceptions, waterfowl primarily use the Southeast during migration and winter periods when food acquisition and survival are the two primary strategies. Wetlands provide the primary habitat resources for most species of waterfowl, but loss and degradation have significantly reduced the ability of natural wetlands to meet the needs of waterfowl at the population levels identified in the NAWMP. Consequently, proactive conservation and management of wetlands upon which waterfowl depend are critical to sustaining viable and harvestable populations of these species and meeting NAWMP objectives.

Many NWRs in the Southeast were established for the primary purpose of providing habitat for migratory birds with an emphasis on wetland-dependent wildlife, such as waterfowl. Thus, waterfowl management is a significant priority at most of the Southeast's refuges. The NAWMP established broad waterfowl management goals for North America, including continental population objectives, that can be stepped down through regional partnerships of federal, state, and non-governmental organizations called "joint ventures" (USDOI EC ECNRM 2012, 2014).

The original NAWMP identified the lower Mississippi River and Red River valleys, the Gulf Coast of Louisiana, Alabama, and Mississippi, Southwestern Florida; and Coastal North and South Carolina as waterfowl habitat areas of major concern within the Southeast (USDOI EC 1986). Accordingly, some of the first Migratory Bird joint ventures established following the 1986 NAWMP were the Gulf Coast, Lower Mississippi Valley, and Atlantic Coast Joint Ventures. Within the Southeast, 76 NWRs (58%) have waterfowl as a management priority and host significant numbers of waterfowl during the non-breeding period or are particularly important to one or more species of waterfowl (e.g., mottled duck [*Anas fulvigula*] and tundra swan [*Cygnus columbianus*]). Peak estimates of waterfowl exceed 100,000 birds on more than a dozen NWRs in the southeast. For example, four NWRs in the Central Arkansas Complex host more than 1 million waterfowl combined in most winters (H. Hagy, personal communication). Additionally, more than 40% of the American black duck (*Anas rubripes*) population in the Mississippi Flyway historically wintered in Tennessee, and most used Tennessee and Cross Creeks NWRs. Eastern North Carolina supports approximately 70% of the eastern population of tundra swans during winter (Roberts and Padding 2018).

NWRs operate under the biologically based strategy that providing food and sanctuary conditions in the Southeast will increase survival and body condition of waterfowl returning to the breeding grounds and help maintain abundant waterfowl populations. Sanctuary conditions provide waterfowl with opportunities for efficient food acquisition (i.e., reduced disturbance and energy expenditure) and resting areas to help maintain local wintering populations. Moreover, NWRs provide opportunities for waterfowl-related recreation (e.g., bird watching, hunting), which is assumed to provide economic and public support for conservation of continental waterfowl populations (USDOI EC ENRM 2012). The Southeastern United States hosts more than 10 million waterfowl annually and nearly one-third of active waterfowl hunters in the United States (Raftovich et al. 2018; H. Hagy, personal communication).

During winter, waterfowl spend much of their time conserving energy and avoiding mortality risk. In fact, some species lose mass during winter regardless of environmental conditions or food availability due to endogenous strategies to balance the risks of starvation and predation with physiologic requirements (Heitmeyer 1988, Loesch et al. 1992). However, most species exhibit hyperphagia (i.e., increased feeding) prior to spring migration and increase endogenous resources in order to prepare for the breeding season. Some species, such as mallards and American black ducks, select mates on the wintering grounds and stay paired throughout spring migration and the breeding season. Thus, management of habitat for migrating and wintering waterfowl must ensure not only sufficient food resources to allow waterfowl to survive the winter and return to their breeding grounds in good physical condition but also conditions suitable for pair bonding and other important life-history events (Baldassarre 2014).

In addition to species with continental scale distribution, the southeast supports a large portion of wood duck (*Aix sponsa*) populations and a substantial proportion of the continental mottled duck population. The primary distribution of mottled ducks is in Florida and the Western Gulf Coast of Texas and Louisiana although this species also occurs in South Carolina, Georgia, and Mexico. The Florida population of mottled duck is approximately 28,000 in spring whereas the Western Gulf Coast breeding population may exceed 600,000 individuals although this population appears to be declining (Bielefeld et al. 2010). Wood ducks are also more abundant in the Southeast than other areas of North America. Fall population size in the early 1980s likely exceeded 6 million individuals in the Atlantic and Mississippi Flyways with a large portion breeding and wintering in the Southeast (Bellrose and Holm 1994). Although estimating breeding population size of wood ducks is difficult due to their widespread distribution and use of forested wetlands, Bellrose and Holm (1994) estimated nearly 3 million breeding individuals in North America with 37% in the Atlantic Flyway and 58% in the Mississippi Flyway (Baldassarre 2014). Thus, the Southeast plays an important role in supporting continental waterfowl populations by providing migrating, breeding, and wintering habitat.

Other Birds

NWR management using agricultural practices can benefit a variety of bird species by providing open foraging or hunting areas, helping to maintain early-succession vegetation communities for nesting and brood rearing, and controlling invasive species. For example, long-legged wading birds, such as great blue herons *(Ardea Herodias*), great (*Ardea alba*) and snowy (*Egretta thula*) egrets, little blue herons (*Egretta caerulea*), ibis (*Eudocimus albus*), and shorebirds, such as sandpipers, lesser yellowlegs (*Tringa flavipes*), greater yellowlegs (*Tringa melanoleuca*), dowitchers (*Limnodromus* spp.), Wilson's snipe (*Gallinago delicate*), and American woodcock (*Scolopax minor*), regularly occur within agricultural areas on NWRs. Several species of secretive marsh birds, including king (*Rallus elegans*) and sora (*Porzana Carolina*) rails, use flooded crops, especially rice, during their migration and breeding periods. Additionally, numerous species of passerine birds, wild turkey (*Meleagris gallopavo*), and northern bobwhite (*Colinus virginianus*) forage for insects in crop fields (Mattson 1990, Krapu et al. 2004, MacGowan et al. 2006a,b, Palmer et al. 2011, Groepper et al. 2013). Moreover, agricultural fields, especially those with crop stubble and cover crops, can be used extensively during migration periods by passerines (Hagy et al. 2010, Wilcoxen et al. 2018). However, agricultural practices contribute substantially to supporting excessively large populations of nest predators and egg-laying parasites leading to declines in forest-breeding landbirds, particularly neotropical migrants, within extensively fragmented landscapes (e.g., Robinson et al. 1995). Many refuges have addressed this issue over the last thirty years through aggressive bottomland afforestation efforts to increase contiguous forest patch sizes and reduce local fragmentation as much as possible (see CCPs for specific NWRs, Appendix B).

Sandhill crane (*Grus canadensis*) wintering and migrating through Texas, Oklahoma, Kansas, and Nebraska have been reported to primarily consume agricultural grains, such as corn and wheat, when they are available (Guthery 1972, Lewis 1974, Reinecke and Krapu 1986, Hunt and Slack 1989, Ballard and Thompson 2000). Similarly, Sandhill crane populations breeding in the upper Midwest United States and southeastern Canada are expanding during migration and winter throughout the Southeastern United States to such an extent that several states, including Tennessee, Alabama, and Kentucky, offer hunting seasons in part to address crop losses as these populations also feed extensively on grain in agricultural fields. Some NWRs are becoming important sanctuaries for these cranes, especially Wheeler National Wildlife Refuge in Alabama, which now typically reports a wintering population of >25,000 cranes, which may exceed 25% of the eastern population (Bill Gates, pers. comm.).

Other Wildlife

More than half of the reptile and amphibian species in the United States can be found in the Southeast (Bailey et al. 2006). These species' ecological importance has become increasingly apparent as management objectives have begun to target non-game species, biodiversity conservation, landscape level ecology, and the role of all plants and animals in ecosystems. Croplands can support some of the amphibians and reptiles that occur under natural conditions. Amphibians and reptiles use agricultural lands as foraging habitat and travel corridors to migrate to other natural habitats. Bailey et al. (2006) noted a number of species in the Southeast that characteristically occur in and adjacent to agricultural fields, including Fowler's toad *(Anaxyrus fowleri*), upland chorus frog (*Pseudacris feriarum*), northern (*Acris crepitans*) and southern (*Acris gryllus*) cricket frog, tiger salamander (*Ambystoma tigrinum*), six lined racerunner *(Aspidoscelis sexlineata*), slender glass lizard (*Ophisaurus attenuates*), and eastern racer (*Coluber constrictor*).

Corn and soybean fields provide browse and/or grain for rabbits (*Sylvilagus spp.*), white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), squirrels (*Sciurus* spp.), raccoons (*Procyon lotor*), and a variety of rodents and small mammals. Black bears can benefit from vegetation management that promotes early-succession plant communities (Jones and Pelton 2003), such as forestry and agriculture, and agricultural grains are an important food item for black bears in North Carolina (Landers et al. 1979, Maddrey 1995). Black bears in Louisiana used agricultural areas and consumed substantial amounts of grain from crop fields (Benson and Chamberlain 2006), but selection tendencies were mixed among subpopulations perhaps because bears selected corn fields but avoided other types, such as cotton (Benson and Chamberlain 2007). Agricultural crops such as corn, soybeans, and wheat provide a substantial component of diet of white-tailed deer (Korschgen 1962) that extensively use agricultural fields (Nixon et al. 1991).

Insects are extremely important to ecosystem function and serve as pollinators, decomposers, predators, herbivores, and parasites (Calderone 2012; Obrycki et al. 2001). Invertebrate communities in crop fields represent a diverse assemblage of feeding strategies, including predators, crop-feeders, saprophages, parasites, and polyphages (Stevenson et al.,2002). Numerous insects and related arthropods perform valuable functions; they pollinate plants, contribute to the decay and processing of organic matter, reduce weed seed populations through predation, cycle soil nutrients, and attack other insects and mites that are considered pests. Although many arthropods in agricultural settings are considered pests, there are many beneficial arthropods that are natural enemies of both weeds and insect pests (Landis et al., 2005). Some of these beneficial species include the convergent lady beetle (*Hippodamia convergens*), carabid beetles (Carabidae), caterpillar parasitoids (e.g., *Meteorus communis* and *Glyptapanteles militaris*), and predatory mite (*Phytoseiulus persimilis*) (Shelton, 2011). Earthworms (Lumbricina), termites (Isoptera), ants (Formicidae), beetles, and millipedes (Diplopoda) contribute to the decay of organic matter and the cycling of soil nutrients (Ruiz et al., 2008). Some high-profile or representative invertebrate species, such as honey bees (Apis), earthworms, and butterflies (Lepidoptera), are generally studied more thoroughly than others. Insects (e.g., the lady beetle [Coccinellidae], big-eyed bug [Lygaeidae], ground beetle [Carabidae], lacewing [Chrysopidae], damsel bug [Nabidae], insidious flower bug/minute pirate bug [Anthocoridae], assassin bug [Triatominae], spined soldier bug [Pentatomidae], parasitoid wasps [e.g., Braconidae, Ichneumonidae], and a multitude of spiders [Order: Araneae]) may benefit from corn and/or soybean production by preying on plant pests (Stewart et al., 2007). Other soil dwelling fauna, such as earthworms and arthropods, play critical roles in the aeration of soil, processing of wastes and detritus, and nutrient cycling (Beetz 1999, Sullivan 2004). In addition, insects and other invertebrates can be beneficial to crop production, providing services such as nutrient cycling and preying on plant pests. Conversely, there are many insects and invertebrates that are detrimental to corn crops, such as the corn earworm (*Helicoverpa zea*), corn rootworm (*Diabrotica spp*.), and European corn borer (*Ostrina nubilalis*) (Willson & Eisley, 2001, Hellmich and Hellmich 2012), resulting in impacting yield, plant maturity, and seed quality.

The Southeast has the highest diversity of aquatic dependent species of any area in the United States (Smith et al. 2002, Jenkins et al. 2015). Over 60% of all native freshwater fish, north of Mexico, occur in the Southeastern United States. There are reported occurrences of similar and even higher percentages of native freshwater mussels, crayfish (Parastacidae), snails, dragonflies (Anisoptera) and allies. Many fish species (e.g., largemouth (*Micropterus salmoides*) and other species of bass, channel (*Ictalurus punctatus*) and other species of large catfish) are popular to anglers; however, there are several species, such as certain freshwater sunfish (Centrarchidae) and black (*Pomoxis nigromaculatus*) and white (Pomoxis annularis) crappie, that are of conservation concern. Declines in the occurrence of mussels and crayfish have been recognized and documented by The Nature Conservancy in its *Priority Areas for Freshwater Conservation Action: A biodiversity assessment of the Southeastern United States* (Smith et al. 2002). These declines are due to numerous sources, including dams and reservoirs, river and stream channelization, point and nonpoint pollution, competition with invasive species, and the overharvesting of some mussel and fish species.

Threatened and Endangered Species

There are approximately 1,661 Federally-listed threatened and endangered species in the United States and its territories and just under 1,000 are found on NWRs (USFWS 2019, USFWS 2020). NWRs in the Southeast are home to 87 of these listed species (USFWS 2019). These species include at least 12 birds, 7 clams, 1 crustacean, 9 fish, 14 mammals, 26 plants, 14 reptiles, 3 snails and 1 insect. Most of these species tend to be found in natural habitat resources within NWRs and not in cropped areas. To identify the species that occur on specific NWRs, the Threatened and Endangered Species Database can be searched for each NWR (USFWS 2019). Before issuance of our NEPA determination, we will comply with provisions of the ESA to ensure that the proposed action or any action that might be proposed under this PEA in the future is not likely to jeopardize the continued existence of any “endangered” or “threatened” species or modify or destroy a species’ critical habitat. We also will ensure that our proposed action is consistent with conservation programs for those species. The Intra-Service Section 7 ESA consultation may be found in Appendix E.

The Federally-listed threatened and endangered species that may be found on or in the vicinity of croplands in the Southeast include the Mississippi sandhill crane (*Grus canadensis pulla*), interior least tern (*Sterna antillarum athalassos*), piping plover (*Charadrius melodus*), whooping crane (the experimental non-essential “eastern” population,*Grus americana*), red wolf (the experimental non-essential population, *Canis rufus*), Indiana bat (*Myotis sodalist*), gray bat (*Myotis grisescens*), and subterranean species, such as the Alabama cavefish (*Orconectes alabamensis*).

Mississippi sandhill and whooping cranes have been observed using croplands on NWRs in the southeast. It is becoming increasingly important to provide agricultural foods for the eastern breeding population of the whooping crane at Wheeler National Wildlife Refuge, which is now supporting the largest wintering population of the species (up to two dozen individuals during the inter 2018-2019) in the southeast (W. Gates personal communication).

Black bears (*Ursus americanus*), including the recently delisted Louisiana Black bear (*Ursus americanus luteolus)* and other non-listed species, feed in cornfields throughout the southeast. Other threatened or endangered species occasionally observed in agricultural fields on NWRs include piping plovers and red wolves, but these species do not commonly feed on crops. Although uncommon on crop fields, piping plovers may forage for insects in harvested crop fields where there is standing water. Red wolves in eastern North Carolina use crop fields, especially where there are managed filter strips supporting higher numbers of their prey including, deer, rabbits, raccoons and other wildlife (K. Van Druten personal communication).

In cooperation with states and other federal agencies, the southeast began implementing a five-point strategy in 2017, to proactively conserve more than 400 at-risk and imperiled fish, wildlife and plant species over the next decade (USFWS 2017c). The southeast also is working with public and private partners on flexible, innovative, and cost-effective ways to help maintain ranches, farms, commercial forests, and other working landscapes in an effort to preclude the need to list species under the ESA. More detailed information on endangered and threatened species can be found at https://www.fws.gov/endangered/ and Appendix E.

Invasive Species

Invasive species are defined as "non-native species whose introduction does, or is likely to cause economic or environmental harm or harm to human health" (National Invasive Species Council, www.invasivespecies.gov/). Invasive species can be plants, animals, and microbes. For purposes of this analysis, we focus on invasive species affecting agricultural crops. Common invasive species on refuges that may be controlled through agricultural practices include species such as alligatorweed (*Alternanthera philoxeroides*), *Phragmites* spp., and several woody species (e.g., *Triadica sebifera, Ligustrum sinense*). Similarly, several native species, such as redvine (*Brunnichia ovata*), coffeeweed (*Sesbania herbacea*), cocklebur (*Xanthium strumarium*), creeping water primrose (*Ludwigia peploides*), that can become invasive can be controlled with agricultural practices

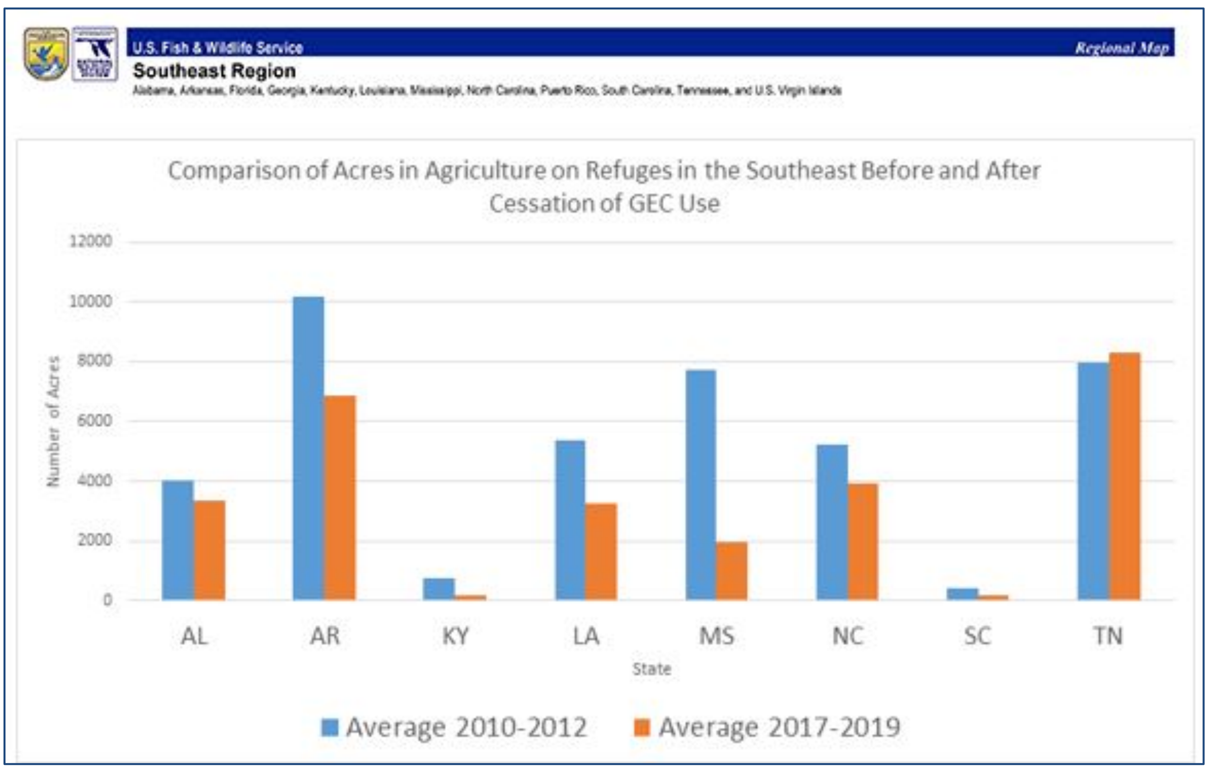
Invasive species alter wildlife habitat and pose challenges to those engaged in managing NWRs. While difficult to determine, estimates of the costs of damage from invasive species in the United States have been as high as $120 billion per year (Pimental et al. 2005). Pesticides, mechanical treatments, fire, physical removal, water management, and agricultural practices are among the measures used by the Service to battle invasive species. In traditional agriculture with non-GEC seeds outside of NWRs, pesticides with leaching properties, such as Atrazine, are used to control persistent weeds (e.g., sicklepod [*Senna obtusifolia*], pigweed [*Amaranthus* spp.], ragweed [*Ambrosia* spp.]) that typically occur in farm fields. However, Atrazine is persistent in the environment and the Service has suspended its use on NWRs.

Socioeconomic Profile of Agriculture in the Southeastern United States

Economic Significance of Agriculture

The United States has a land mass of about 2.3 billion acres. In 2012, approximately 390 million acres (17%) nationwide and 45 million acres within the Southeastern United States were used as cropland (USDA/ERS 2018b). During 2012, corn cultivation occurred on over 87 million acres, and soybeans were planted on 76 million acres (USDA/NASS 2013) in the United States. In 2019, 92,603 acres were used for agriculture on National Wildlife Refuges in the United States (USFWS 2019). Land used for agricultural practices to support natural resource management on NWRs in the southeast declined from an average of 41,676 acres between 2010 – 2012 to an average of 27,987 acres between 2017 – 2019, a 33% decline in farming acreage (Figure 4).

Figure 4. Three year average number of acres farmed on national wildlife refuges within the southeast when the Service allowed the use of genetically engineered crops (GEC) (2010-2012) compared to when GECs were not allowed for use (2017-2019).



In 2017, the human population in the Southeast was 76.8 million, which was up from 72.2 million in 2010 (USDC Census Bureau 2017). The southeast is home to two of the nation's 10 most populated metropolitan areas (Atlanta/Roswell and Miami/Fort Lauderdale). In 2016, >103 million Americans over the age of 16 engaged in fishing, hunting, or watching wildlife and photography and spent $156.9 million doing those activities (USFWS 2016). More than 15 million people visited NWRs in the Southeast in 2017 (USFWS RAPP 2017).

The agricultural industry is one of the biggest employers in the United States with approximately 2.6 million people directly employed on a farm in 2016. In addition, 21.4 million jobs in the country were related to the agriculture and food sectors, representing 11% of the total national employment. In 2015, agriculture and the food sector contributed $992 billion to the United States' gross domestic product constituting a 5.5% share (USDA/ERS 2018a). The commodity market values of corn and soybeans in the United States in 2012, were $67 billion and $38 billion, respectively.

Economic Significance of Wildlife-dependent Recreation

The Refuge Improvement Act identifies hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation as priority wildlife-dependent recreation activities that occur on NWR where such activities are compatible with wildlife conservation. NWRs in the Southeast are frequent destinations for hunters, wildlife observers, and wildlife photographers due to the presence of valuable wildlife habitat and abundant use by wildlife. In Fiscal Year 2006, the southeast's 9.4 million NWR visitors generated $427 million in economic activity and supported 7,381 private sector jobs (Carver and Caudill 2007).

Hunting in the United States is a big business generating more than $67 billion in economic output and more than one million jobs (Carver and Caudill 2013). In 2016, 11.5 million people 16 and older hunted a combined total of 184 million days, spending $26.2 billion in the process (USDOI/FWS and USDOC/Census Bureau 2016).

Wildlife watching (wildlife-oriented activities other than hunting) is identified in the same study as providing recreation for 86 million people and contributing $75.9 billion to our nation's economy. The diverse habitats found on NWRs, including agricultural fields, support the diversity of wildlife that attracts visitors who are interested in wildlife-oriented outdoor recreation. Recreation resulting from the NWRS added $2.4 billion to the economy, supported more than 35,000 jobs, and produced $792.7 million in job income for local communities in Fiscal Year 2011 (Carver and Caudill 2013).

In 2017, NWRs in the southeast hosted over 213,000 participants in environmental education programs (USFWS RAPP 2017). Though it is difficult to assign a monetary value to these programs, there is long lasting value to the outdoor related industries from an informed public that is connected to the natural environment.

Cultural Resources

Detailed descriptions of the specific cultural and historic resources of each NWR (Appendix B) that could be analyzed under this PEA are available in their respective CCPs and incorporated by reference herein (https://www.fws.gov/southeast/national-wildlife-refuges/planning/, USFWS 2017).

Cultural resources, also known as heritage assets, include archaeological sites (both prehistoric and historic and their associated documentation), buildings and structures, landscapes, objects, and historic documents.

The Service, like other federal agencies, is legally mandated to inventory, assess, and protect cultural resources located on lands owned, managed, or controlled by the agency. The Service's cultural resource policy is delineated in 614 FW 1-5 and 126 FW 1-3. In the southeast, the cultural resource review and compliance process is initiated by contacting the Regional Historic Preservation Officer/Regional Archaeologist (RHPO/RA).

The RHPO/RA determines whether a proposed undertaking has the potential to impact cultural resources, identifies the "area of potential effect," determines the appropriate level of scientific investigation necessary to ensure legal compliance, and initiates consultation with the pertinent State Historic Preservation Office (SHPO) and, when necessary, with Federally-recognized Tribes.

The area of potential effect for farming lands may be defined as the "modern plow zone," which is the depth at which a modern plow disturbs the soil during field preparation. This is generally about 12" below the ground surface; the great majority of the lands used for farming have been subject to plow zone disturbance at least since Euro-American settlement since the early colonial period on the east coast of North Carolina and the early 1800s for the Mississippi Valley.

Chapter III. Description of Alternatives

The two (2) alternatives analyzed in this PEA were developed within the parameters of NEPA and the authorities, policies, and regulations governing and affecting the NWRS. The Service also reviewed and considered the comments submitted during the public comment periods associated with the scoping processes in developing the alternatives. This chapter also describes the processes engaged by the Service in formulating, eliminating, selecting, and evaluating the alternatives.

The following were considered in developing the alternatives:

- The stated purposes and underlying authority for the establishment of each NWR, particularly regarding the use of agricultural practices for natural resource management;
- The goals and objectives for each NWR as stepped down from regional and/or national conservation plans (e.g., NAWMP) to respective CCP and HMP;
- The mission of the NWRS as set forth in the National Wildlife Refuge System's Administration Act and Improvement Act;
- The Department of the Interior's Pesticide Use Policy (517 DM 1, USDOI 2007), the Service's Integrated Pest Management Policy (569 FW 1, USFWS 2010a), and other applicable policies (e.g., 601 FW 3 Biological Integrity, Diversity, and Environmental Health, USFWS 2006a; 620 FW 2 Cooperative Agriculture Use, USFWS 2017a; 603 FW 1 Appropriate Use, USFWS 2006b; and/or 603 FW 2 Compatibility, USFWS 2000), and the Southeast's GEC Use Policy (USFWS 2007, 2010b);
- The availability, feasibility, effectiveness, and impacts of alternative wildlife management tools on wildlife, particularly migratory waterfowl.
- The Environmental Assessments prepared by the Service's Midwest and Mountain Prairie Regions, respectively, as comparative references on GEC use on NWRs;
- APHIS, EPA and FDA's respective scientific assessments and NEPA analyses of GECs and APHIS's deregulation of the use of certain GECs;
- The economic parameters of NWR operations and the effects of such operations on surrounding local and regional economies; and,
- The comments submitted during the Southeast's internal and external scoping processes on preparation of this PEA; and
- The best available science on the use and non-use of GECs in farming on private lands and as part of agricultural practices on NWRs in the Southeast as a wildlife management tool.

Alternatives Analyzed

This PEA analyzes the following alternatives for Southeastern NWRs' use of GECs in agricultural practices as a natural resource management tool to provide food and habitat for migratory waterfowl:

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

Description of Alternatives

The two alternatives selected for analysis represent different management approaches as described below.

Alternative 1: Use only non-GECs on NWRs (No Action Alternative)

Under this alternative, NWRs in the southeast would continue to use only non-GECs in their agricultural practices to cultivate supplemental foods for wildlife, manage invasive species, and attract wildlife for recreational purposes, such as wildlife observation. These non-GECs may include different seed varieties developed through years of selective and/or cross breeding to incorporate certain desired traits, such as enhanced yield, disease resistance, and maturity period, without introducing or removing specific genes from the plant as is done with GECs.

NWRs would continue to use cooperative partnerships with private farmers, contracts, and force account administrative models to administer their agricultural practices for natural resource management. Individual NWRs would make determinations regarding the crops that would be cultivated, the time of planting and harvesting, and the determination of the NWR and farmers' respective shares of crops. Refuges would continue to implement Best Management Practices, such as conventional or no-till farming, soil preparation, planting, nutrient management, pest management, harvesting, and other techniques.

Alternative 2: Allow the use of GECs on NWRs (Proposed Alternative)

Under this alternative, NWRs in the southeast could use GECs for natural resource management as is done on private lands and wildlife management areas run by state agencies. Only APHIS evaluated and deregulated GECs, as described in 7 CFR 340.6, would be used in NWR agricultural practices. A NWR would have the option of using GECs and non-GECs in rotation, as appropriate and guided by the overall NWRS purpose(s), CCP goals and objectives, and other policy, guidance, and decision documents. Under this alternative, refuges would continue to use cooperative partnerships with private farmers, contracts, and force account administrative models to administer their agricultural practices for natural resource management. Individual refuges would make determinations regarding the crops that would be cultivated, the time of planting and harvesting, and the determination of the refuge and farmers' respective shares of crops. Refuges would continue to implement Best Management Practices, such as conventional or no-till farming, soil preparation, planting, nutrient management, pest management, harvesting, and other techniques.

This Region would use a tiered analysis to determine whether a GEC could be used on NWRs based on the following:

1) APHIS's specific NEPA analysis and de-regulation of the GEC;
2) The Region's programmatic NEPA analysis of GEC use;
3) NEPA analysis of GEC use on a specific NWR or NWR complex tiered from the Region's programmatic NEPA analysis of GEC use as well as associated NWR planning documents (e.g., CCP, HMP, CD); and,

4) Analysis of whether such GEC use would satisfy the essentialness requirement of the BIDEH Policy;

Elements Common to each Alternative

Each of the alternatives evaluated in this PEA accords with the following:

Adherence to the National Wildlife Refuge System Administration Act, as Amended by the National Wildlife Refuge System Improvement Act of 1997 and Associated Policies

- Each NWR shall be managed to fulfill the mission of the NWRS and to accomplish the specific purpose(s) for which the NWR was established and approved objectives for habitat and wildlife;
- The Service shall not initiate or permit a new use of a NWR or expand, renew, or extend an existing use of a NWR unless it has determined that the use is a wildlife-dependent compatible use and consistent with public safety. (603 FW 1 and 603 FW 2);
- The Service will adhere to biological integrity, diversity and environmental health (601 FW 3 of the Service Manual, 2001; Amendment 1, 2006) of the NWRS; and,
- The Service will prepare a comprehensive conservation plan (602 FW 1; and 602 FW 3) for every NWR and wetland management district. The plans and their associated Environmental Analyses are incorporated herein by reference and can be accessed at http://www.fws.gov/southeast/planning/.

Adherence to Department of Interior, Departmental Manual, Integrated Pest Management Policy (517 DM 1) and U.S. Fish and Wildlife Service, Integrated Pest Management (569 FW 1)

The Departmental Manual (DM) and FWS Policies require the Service to manage pests and use Integrated Pest Management (IPM) principles in a manner that reduces risks from both the pests and associated pest management activities. IPM is a science-based, decision-making process. IPM incorporates management goals, consensus building, research, pest biology, environmental factors, pest detection, monitoring, and the selection of the best available technology to prevent unacceptable levels of pest damage. Bureaus will accomplish pest management through cost-effective means that pose the least risk to humans, natural and cultural resources, and the environment.

Adherence to the National Historic Preservation Act of 1966

The National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq. (NHPA), was enacted to preserve the nation's archaeological and historical sites. Section 106 of the NHPA establishes a review process for projects conducted or funded by federal dollars that may impact sites on or proposed for listing on the National Register of Historic Sites. The NHPA mandates consultation with Native American tribes, and State Historic Preservation Offices exercise statewide oversight of historic properties. In accordance with the NHPA, the Service conducts Section 106 reviews of projects, develops cultural resource management plans, conducts archaeological inventories of its lands, and conducts National Register eligibility testing. The Service also performs research-directed testing or excavation, site protection, and interpretation for sites covered by the NHPA. The State Historic Preservation Office, Native American Tribes (Tribes), interested parties, such as nearby universities, adjacent landowners, and State natural resource agencies are critical to the Service's efforts. When possible, the Service partners with interested Tribes to facilitate archaeological and ecological investigations, protection, and interpretation of sites deemed to have tribal cultural and religious significance. Incorporating concepts of site stewardship and ownership, where appropriate, into public use materials and interpretive panels would enhance protection of historic properties. Efforts would be further be enhanced by providing advanced archaeological resource protection training to NWR law enforcement personnel.

Alternatives Considered But Eliminated From Further Analysis in this pea

The following alternatives were considered but ultimately eliminated from further analysis.

Use only non-GEC Cereal (Small Grain) Crops

Cereal small grain crops, such as millet, provide less energy density for waterfowl than corn, rice, and milo. For example, millet provides 5,203 DED/ac compared to 28,591 DED/ac for corn, 23,833 DED/ac for rice, and 18,046 DED/ac for milo (Reinecke and Kaminski 2006). Given the limited amount of acreage suitable for agriculture on each NWR, the Service must implement practices that maximize crop yield while minimizing the crop footprint to further the mission of the NWRS and attain the nutrition and habitat goals and objectives of waterfowl management. Some NWRs do not possess the requisite amount of area needed to cultivate small grain cereal crops that would yield quantities sufficient to meet their waterfowl goals and objectives. Consequently, the Service eliminated this alternative from further analysis.

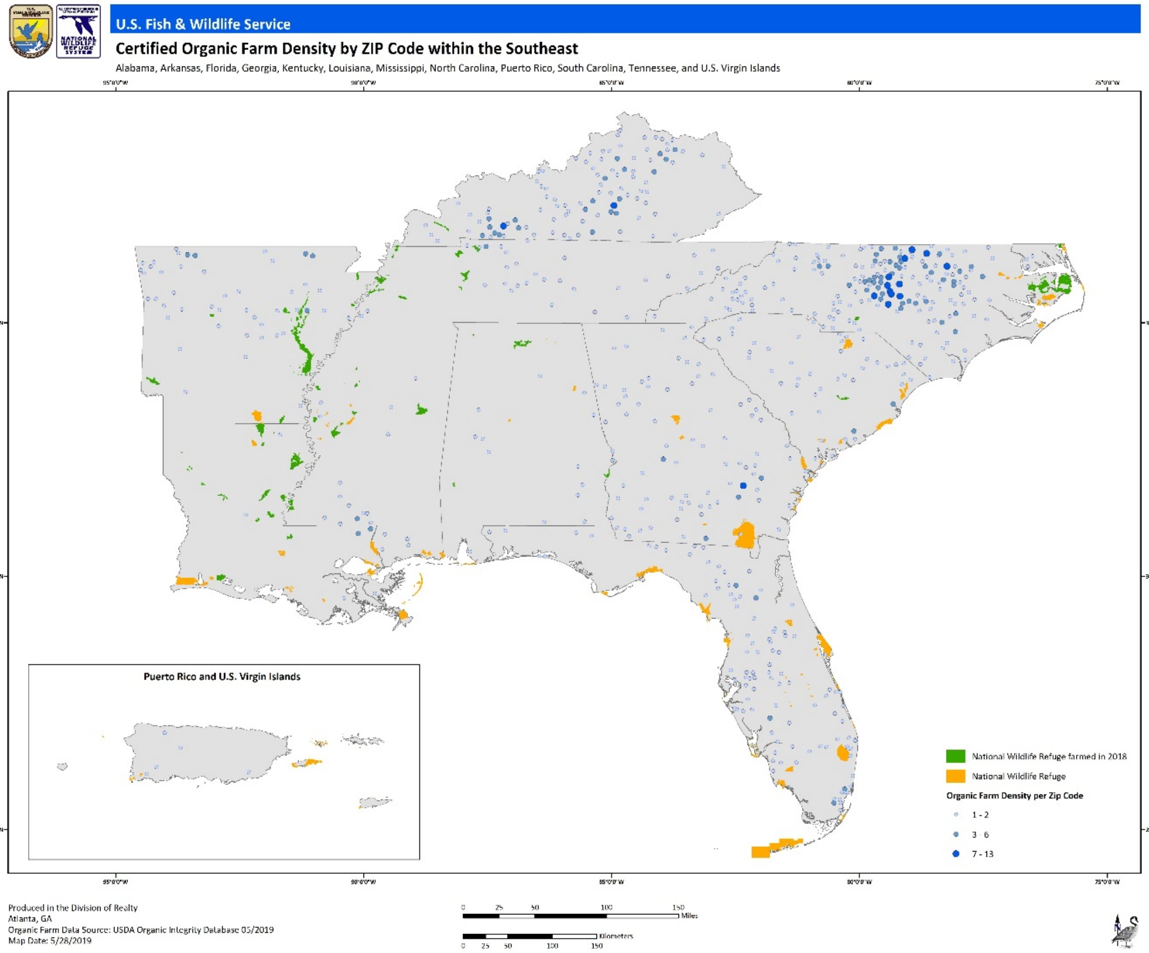
Use only Organic Agriculture with non-GECs

Organic agriculture is a crop production system that relies predominantly on natural soil and ecosystem processes without the use of synthetic chemicals. This type of agriculture often utilizes biological pest control, imported manure and other organic wastes, ocean-based fertilizers, mineral-bearing rock, and natural soil conditioners.

The Service eliminated this alternative from analysis due to the following:

- Increased labor and materials costs with reduced crop yield (USDA 1980). This Region lacks sufficient resources to utilize organic farming on the scale required to attain the wildlife goals and objectives established by the CCPs and associated HMPs for NWRs that use agriculture for natural resource management;
- An inadequate number of organic farmers operate in reasonable proximity to NWRs to make organic farming a reasonable alternative. A review of USDA 2019 data for this Region shows organic farms sparsely located in the states where agriculture is used as a wildlife management tool (i.e., North Carolina, Tennessee and Mississippi; Figure 5); and,
- Organic farming regulations make it unsuitable for natural resource management on NWRs. One of the regulations requires certification that the farmland has been chemical-free for a period of 3 years prior to crop production. To satisfy this requisite, NWRs would have to forego implementation of many management protocols necessary to attain their respective management goals and objectives for the millions of birds that annually inhabit their lands and, in so doing, fail to further the mission of the NWRS.

Figure 5. Location of Organic farms in the Southeastern United States.



Chapter IV. Environmental Consequences

This chapter analyzes the reasonably foreseeable environmental effects and consequences expected to result from each of the two alternatives described in Chapter III of this PEA. In accordance with NEPA, the Service is required to assess the direct effects, indirect effects and cumulative impacts of each alternative on the affected environment.

Direct Effects and Indirect Effects

Under NEPA, direct effects are caused by an action, occur at the same time and place as the action, and are typically well understood and predictable. Indirect effects are reasonably foreseeable and probable and caused by an action but manifested later in time or farther removed in distance.

Scope of the Analysis

Although the proposed alternative, which includes a step-by-step process for ensuring site-specific evaluation, would allow GEC use on any refuge in this Region, our analysis will focus primarily on refuges that have used agricultural practices as part of their natural resource management since 2007 (Appendix B).

Effects Common to EACH Alternative

Some of the effects will be the same for each alternative. We have analyzed three resource areas: environmental justice and human health, endangered and threatened species, and cultural resources.

Environmental Justice and Human Health

President William Clinton signed Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (59 FR 7629) on February 11, 1994, to focus federal attention on the environmental and human health effects of federal actions on minority and low-income populations with the goal of achieving environmental justice for all communities. The Order directed federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions, programs and policies on minority and low-income populations to the greatest extent practicable and permitted by law. Federal agencies also are directed to develop strategies for implementing environmental justice. The Order is intended to promote non-discrimination in federal programs that affect human health and the environment as well as provide minority and low-income communities access to public information and public participation.

APHIS considers the impacts of certain GECs on minorities and low-income populations prior to deregulation. In addition, the EPA and USDA Economic Research Service monitor the use of GEC products to determine impacts of agricultural practices on human health. The results of this monitoring will provide further safety and efficiency guidance over time as real-world data are collected on the effects of a particular GEC on minority and low-income populations and the environment.

In addition, the NASEM (2016) found that long-term data on livestock showed no adverse effects associated with genetically engineered crops and found no substantial evidence that foods from genetically engineered crops were less safe for human consumption than foods from non-genetically engineered crops (see Chapter 5). In addition, the NASEM reported that farm-worker health in the United States does not show any significant increases in cancer or other health problems that are due to the use of glyphosate, while evidence to date does not contradict the expectation that use of Bt insertions should result in fewer insecticide applications and therefore fewer incidences of harmful exposure of farm workers to insecticides (NASEM 2016).

Endangered and Threatened Species

Section 7(a)(2) of the ESA requires that Federal agencies, in consultation with the Service and/or the National Marine Fisheries Service, ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. The Region's Refuge Division and Ecological Services Division are engaged in section 7 consultation on the use of GECs in agricultural practices on refuges in the Region. The consultation request is provided in Appendix E. The consultation will be completed and considered in the Service decision on this proposed action.

As part of the environmental review process, APHIS thoroughly reviews all GEC product information and data to inform an agency's effects analysis of the ESA in its NEPA document as well as the Service's ESA biological assessment of actions proposed under NEPA. Specifically, relevant to this NEPA analysis, APHIS completed environmental assessments of the use of GECs on threatened and endangered species, species proposed for listing, designated critical habitat, and habitat proposed for designation and has not identified any stressor that could affect the reproduction, numbers, distribution, or critical habitat (USDA APHIS 2006, 2007, 2013a, 2013b, 2014a, 2014b, 2016).

Cultural Resources

Detailed descriptions of the specific cultural and historic resources of each refuge (Appendix B) that could be analyzed under this PEA are available in their respective CCPs and incorporated by reference herein (https://www.fws.gov/southeast/national-wildlife-refuges/planning/, USFWS 2017). Cultural resource review and compliance process are initiated by contacting the Regional Historic Preservation Officer/Regional Archaeologist (RHPO/RA), who determines whether a proposed undertaking has the potential to impact cultural resources, identifies the "area of potential effect," determines the appropriate level of scientific investigation necessary to ensure legal compliance, and initiates consultation with the pertinent State Historic Preservation Office (SHPO) and, when necessary, with Federally- recognized Tribes.

It is unlikely that the implementation of either alternative will have a significant effect on cultural resources on refuge lands, particularly on buried archeological sites. Agricultural activities have historically occurred on refuges in this Region. Any additional effects to cultural or historic resources would likely be minor or non-existent under either alternative. Tillage, which has already occurred on most of the refuges on which agricultural practices would occur, does not disturb soils beyond the plow zone, which is generally about 12" below the ground surface.

Moreover, the RHPO will review and determine whether an activity under this PEA constitutes more than the traditional agricultural practices that have already occurred.

Summary of Effects by Alternative

Physical Resources

To follow are our analyses of the effects that each alternative would have on the physical resources of climate change, soils, water quality, and air quality. We do not anticipate impacts to geology or topography from either of the alternatives.

Climate Change

Both the use and non-use of GECs indirectly affect emissions through: (1) the production of CO_2 from equipment use; and, (2) the production of nitrous oxide (N_2O) and particulate matter (PM) cropping from production practices, such as fertilizer application and tillage (USEPA 2012). Changes in climate are expected to continue to cause a general increase in the expansion of weeds and pests. Adaptive responses will be required to mitigate the potentially adverse impacts of these increases on crop yields and production costs (Backlund et al. 2008, IPCC 2014). Increased tillage may be required to control the range and diversity of herbicide-resistant weeds. Such increase could potentially release CO_2 sequestered in upper soil layers.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Non-GECs increase the need to use petroleum based pesticides, decrease conservation tillage (USDA 2013), increase the number and types of pesticide applications (USFWS PUPS Database), increase emissions through an increase in fossil fuel use, and decrease crop residue (Brooks and Barfoot 2006). The use of non-GECs and the attendant increases in conventional tillage and pesticide applications have necessitated increases in the number of trips over fields and increases in releases of N_2O and PM into the atmosphere. GECs, on the other hand, promote conservation tillage, fewer pesticides, and decreasing fossil fuel emissions and soil disturbances that can increase the release of sequestered CO_2 in the soil (Brookes and Barfoot 2013, Carpenter 2011, Cerdeira and Duck 2006, and Scheffe 2008).

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

GECs have been shown to increase the use of conservation tillage (USDA 2013) and reduce the number and types of pesticide applications (Brooks and Barfoot 2006). Increased consistent use of conservation tillage and decreased pesticide applications would likely reduce the number of trips over fields, fossil fuel emissions and soil disturbances that might reduce carbon emissions (Brookes and Barfoot 2013, Carpenter 2011, Cerdeira and Duck 2006, and Scheffe 2008). In comparison to the entire United States, the number of acres used for agricultural practices on refuges is miniscule such that the overall potential effects of climate change would be negligible. Similarly, an IPM approach that included use of GECs would lessen the negative effects on climate change more than would the use of non-GEC systems.

Soils

Current agronomic practices associated with non-GEC and GEC production, such as tillage, agricultural inputs (weed management and soil supplication), crop rotations, and cover crops, have the potential to impact soil quality. Tillage practices and agronomic inputs may affect soil fertility, increase erosion, and cause off-site transport of sediments into aquatic ecosystems consequently affecting soil quality. The various agricultural practices affect the biological, physical, and chemical properties of soil differently, including soil fertility and sustainable use.

Soil bacterial communities are influenced by plant species and cultivars as are other environmental factors, such as soil type and agricultural practices. Microorganisms that colonize the rhizosphere are affected by plant type and root exudates (Icoz et al. 2008).

Alternative 1: Use only non-GEC on NWRs. (No Action Alternative)

Non-GEC use often leads to the implementation of more conventional farming practices, such as increased conventional tillage, that have a greater impact on soil quality, structure and function (Benbrook, 2012). Conventional tillage practices cause soil erosion, soil compaction, reduction in soil bacteria, and reduction in crop residue (Towery and Werblow 2010). Crop residue is needed to minimize soil erosion, which can make land less productive and contaminate water. Despite the Service's incorporation of BMPs (e.g., cover crops, crop rotations) in its cooperative farming partnerships to reduce soil erosion and control pests, refuges have reported increased occurrences of pests and weeds, particularly since the Service's switch to only non-GEC in 2013 (T. Littrell, personal communication). Since the switch, NWRs have had to increase the amount and types of pesticides applied to control increases in pests and weeds (Figures 6 and 7). This increase in pesticide applications has necessitated more frequent trips over fields on heavy machinery, which has worsened soil compaction.

Crop rotations will continue to be implemented, as feasible, under this alternative; however, as farmers experience increased and continual crop losses due to pest issues, the potential for rotations become more limited than if GECs were used. Farmers on several refuges are finding it increasingly difficult to produce sufficient corn yields using non-GE corn and to justify planting corn as a harvested crop. These NWRs may be unable to keep crop rotations active throughout all of the farmland in production. Weed resistance to herbicides may increase if crop rotations decrease due to non-GE seed use and associated disease, pest incidence, weediness, and selection pressure (USDA 2013).

The planting of non-GECs should not have any substantial direct negative effects on microorganisms; however, use of non-GECs may increase implantation of traditional agricultural practices, such as conventional tillage at the end of the growing season and partial tillage during the growing season (in corn fields). These would increase soil disturbance and decrease the amount of crop residue, both of which have the potential to increase soil erosion that could impact microorganisms in ways that GECs would not.

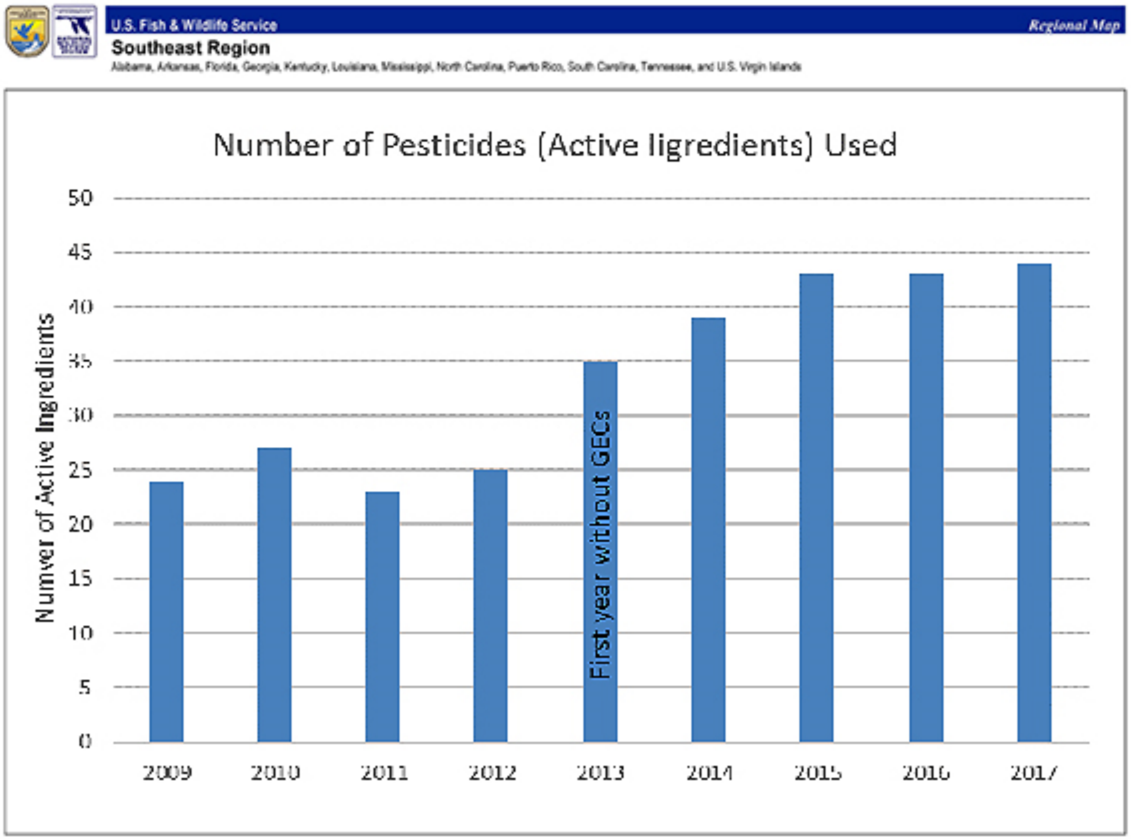
Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

The use of GECs increases conservation tillage methods that reduce erosion and runoff; preserve soil organic matter, beneficial biota, and nutrients; improve water-retention capacity; and, require less time and labor to prepare a field for planting relative to using non-GECs

(Roger-Estrade et al. 2010, He et al. 2011, Sharma and Abrol 2012, Van Eerd et al. 2014). Conservation tillage also may increase soil organic matter and plant residues. Herbicide application may provide soils with plant matter from dead weeds, and the new organic matter would be beneficial to omnivores in the soil, such as bacteria and nematodes, which would consume the organic matter as food (Zhao et al. 2013). Enhanced organic matter hinders pesticide movement and facilitates pesticide degradation (Locke and Zablotowicz 2004). The use of GECs as part of a holistic IPM system would allow the Service to increase conservation tillage, decrease the amounts and types of pesticides, decrease the compaction of soils, decrease soil disturbance and erosion, increase soil organic matter, increase crop residue, increase cover crop use and rotation, and decrease crop pests and weeds.

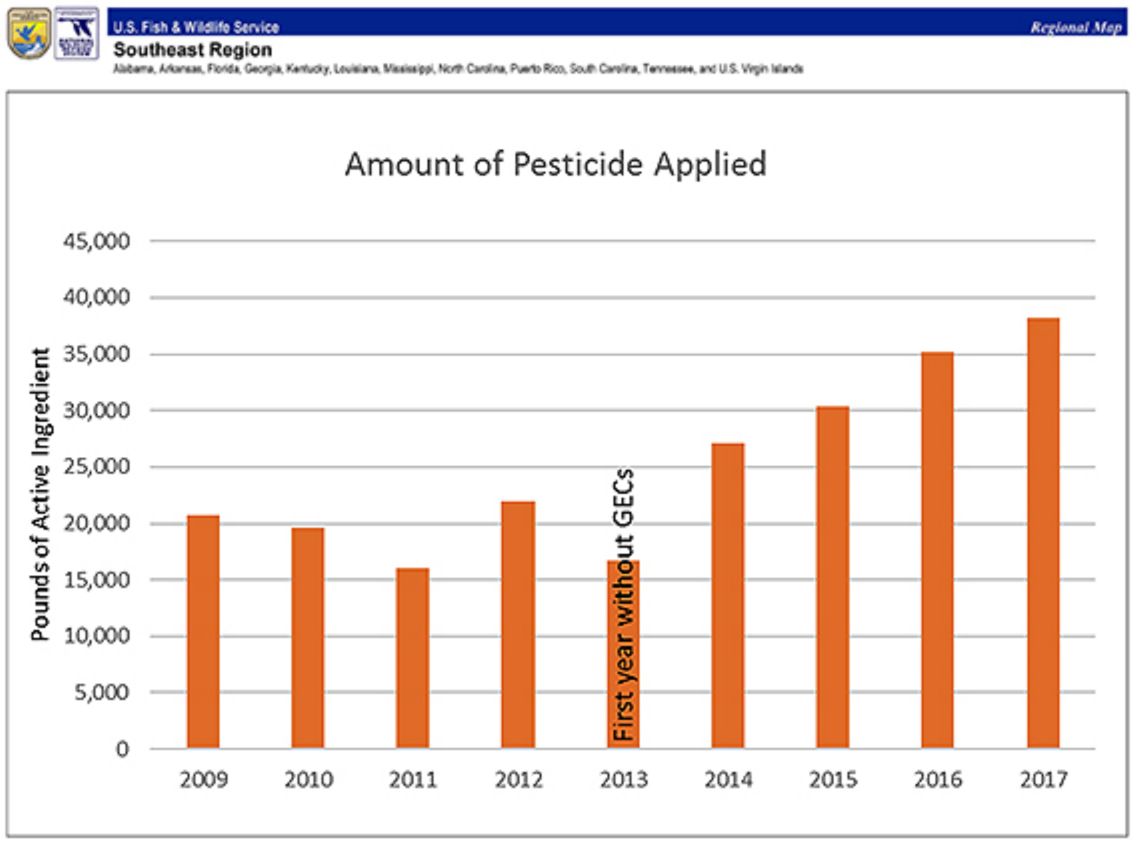
While the bacteria *B. thuringiensis* occurs naturally in soil, growing transgenic *Bt* corn increases the amount of Cry endotoxins (protein produced by *B. thuringiensis*) in agricultural areas (Blackwood and Buyer 2004). Most proteins, however, do not persist or accumulate in soils because they are inherently degradable in soils that have normal microbial populations (Icoz and Stotzky 2008). The numbers of microorganisms and the activity of some enzymes involved in the degradation of plant biomass exhibit substantial seasonal variation attributable to differences in the water content of soils, ambient temperatures, and plant stage growth at the time of sampling (Icoz and Stotzky 2008). Cry protein concentrations in the rhizosphere vary during the growth of the plant and can be affected by microbial activity, which depends in part on soil temperature and humidity (Baumgarte and Tebbe 2005). In general, cultivation of GE crops has not been demonstrated to present environmental risks to soil microbial populations (Vencill et al. 2012). The diversity of microbial populations may be affected by these crops, but effects reported to date have been transient and minor (Dunfield and Germida 2004, Vencill et al. 2012). These conditions would not change under this Alternative, however, because agronomic practices associated with currently available GECs would not alter the way soil microorganisms are affected in U.S. cropping systems.

Figure 6. Number of Agricultural pesticides (active ingredients) applied on West Tennessee, Wheeler, Tennessee and North Carolina Coastal Plains Complexes from 2009-2017.[333]



[333]USFWS Pesticide Use Proposal Database 2018

Figure 7. Pounds of Agricultural pesticides (active ingredients) applied on West Tennessee, Wheeler, Tennessee and North Carolina Coastal Plains Complexes from 2009-2017**.**



****USFWS Pesticide Use Proposal Database 2018

Water Quality

Current agronomic practices associated with GEC and non-GEC production that have potential to impact water quantity and quality are tillage, agricultural inputs, and irrigation. Over time, climate change impacts are expected to alter both water supplies and water demands across and within regions. Warming temperatures, changing precipitation patterns, and reduced snowpack are expected to significantly reduce late spring/summer stream flows (flows that historically were available for reservoir storage to meet peak irrigation water demands). In addition, higher temperatures are expected to increase crop-water demands in coming years via reduced crop evapotranspiration (ET) efficiency (Schaible and Aillery 2012).

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Using non-GECs on refuges has increased the application of conventional tillage in order to control weeds and prepare soil for planting (W Lewis personal communication). Conventional tillage has the potential to increase sediment input into streams, surface runoff, the use of irrigation water, and the amplitude of stream hydrographs (Towery and Werblow 2010) as well as perhaps to result in decreased water quality. The use of non-GECs only on refuges has also caused an increase in the amount, types and applications of pesticides of some less environmentally benign chemicals that could directly impact water resources. Pesticides typically used with conventional crops generally have more potential to move off site, leach into groundwater, and take much longer to break down to inert substances (Brookes and Barfoot 2010, Cerdeira and Duke 2006, COBFLES 2010, Ferry and Gatehouse 2008).

EPA-registered chemicals and associated label restrictions in combination with conservative Service BMPs help prevent the movement of chemicals into water bodies; however, increased buffers that protect water quality have decreased the availability of areas where certain pesticides can be used. This, in turn, has increased the number and types of weeds requiring control on refuges. The use of non-GECs does not allow the Service to best utilize an integrated pest management approach to maintain high water quality.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

Herbicide tolerant and insect resistant crops have facilitated a shift to the use of conservation tillage (Fernandez-Cornejo and Caswell 2006, Carpenter 2011). The benefits of conservation tillage on water quality are well known: conservation tillage reduces sediment input into streams; decreases surface runoff; reduces use of agricultural chemicals and fertilizer; decreases irrigation water use; and reduces the amplitude of stream hydrographs (Towery and Werblow 2010, Shipitalo and Owens 2011). Conservation tillage systems in which herbicide-tolerant crops are substituted for non-GEC varieties could help increase water quality.

As with soil effects, most of the work on water quality has focused on direct and indirect effects of herbicide-tolerant and insect-resistant crops and the resulting changes in pesticide use. There is evidence that suggests adoption of herbicide-tolerant crops can minimize environmental impacts through reduced herbicide use and increased use of conservation tillage practices. Significant reductions in insecticide use have occurred as a result of the introduction of insect-resistant corn and soybeans (Fernandez-Cornejo and Caswell 2006, National Research Council 2010), which results in less chemical inputs into water bodies. Herbicide resistant crops generally make weed control more effective, and may provide an incentive of lower cost of production to growers (National Research Council 2010, Fernandez-Cornejo et al. 2012).

The EPA determines the use requirements for these pesticides in order to protect water quality and human health. As part of assessing the risk of the exposure of aquatic organisms and the environment to a pesticide, the EPA estimates concentrations of pesticides in aquatic environments. Under the Food Quality Protection Act (FQPA), the EPA also estimates pesticide concentrations in drinking water as part of its establishing maximum pesticide residues on food (tolerance limits). For drinking water and aquatic exposure assessments and water quality assessments, EPA typically relies on label restrictions to avoid contamination. The Service often requires BMPs that are more restrictive than EPA's label restrictions in order to increase protections to water and associated wildlife. Research has shown that fewer restricted use chemicals and less volume of pesticides were applied on Service farmland prior to 2013, when GECs were used (Figures 5 and 6).

Air Quality

Agronomic practices such as tillage, pesticide applications (i.e., drift and diffusion), fossil fuel burning equipment and nitrous oxide emissions from nitrogen fertilizer, with or without the use of GECs on refuges, potentially impact air quality.

Alternative 1: Use only non-GEC on NWRs. (No Action Alternative)

The primary sources that affect air quality from crop production include soil particulates from tillage and wind erosion, exhaust from farming equipment, and spraying of pesticides (Madden et al. 2009). By generating a greater amount of suspended particulates (dust), conventional tillage also potentially contributes to higher rates of soil wind erosion, thus decreasing air quality (Towery and Werblow 2010). Although this impact is variable and affected by factors such as soil moisture and specific tillage regime employed, this observation demonstrates the role conservation tillage plays in reducing particulate matter.

Volatilization of fertilizers, herbicides, and pesticides from soil and plant surfaces also introduces these chemicals into the air. The USDA's Agricultural Research Service (ARS) conducted a long-term study to identify factors that affect pesticide levels in the Chesapeake Bay Region airshed (USDA-ARS 2011). This study determined that volatilization is highly dependent on exposure of disturbed unconsolidated soils and that variability in measured compound levels is correlated with temperature and wind conditions. Another ARS study of certain herbicides after application to fields found that moisture in dew and soils in higher temperature regimes significantly increases volatilization rates (USDA-ARS 2011).

Pesticide and herbicide spraying may impact air quality through both drift and diffusion. Pesticides are typically applied to crops by ground spray equipment or aircraft. Small, lightweight droplets are produced by equipment nozzles; many droplets are small enough to remain suspended in air for long periods allowing them to be moved by air currents until they adhere to a surface or drop to the ground. The amount of drift varies widely and is influenced by a range of factors, including weather conditions, topography, the crop or area being sprayed, application equipment and methods, and practices followed by the applicator. Non-GECs require increased spraying of insecticides to combat pest damage, and this practice potentially decreases air quality despite EPA label restrictions and the Service's implementation of more restrictive BMPs.

In some areas of the Southeast, multi-herbicide-resistant Palmer amaranth (*Amaranthus palmeri*) has forced growers to include or intensify tillage (Price et al. 2011). This can indirectly affect air quality as particulate matter can increase with more aggressive tillage practices. More aggressive tillage practices also require the use of more fossil fuels than do conservation tillage methods.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

Under this alternative, the use of GECs would increase the use of conservation tillage, which reduces the amount of dust and potentially contributes to lower rates of soil particulate into the air thus benefiting overall air quality (Towery and Werblow 2010, Fawcett and Towery 2002). Evidence suggests that the adoption of herbicide tolerant and insect resistant crops has facilitated the use of conservation tillage systems largely because GECs tend to make weed control more effective and less costly (Fernandez-Cornejo et al. 2012). Conservation and no-till practices contribute lower volumes of soil particulate matter into the atmosphere and reduce equipment emissions due to decreased usage of internal combustion engines, as compared to conventional tillage practices.

Use of pesticides and potential environmental impacts through drift and volatilization are expected to decrease on NWRs with the use of GECs. Prior to the ban of GEC use on refuges, the amount and types of pesticides use were much lower than those utilized in a non-GEC system (Figures 5 and 6). EPA label restrictions and the Service's BMPs decrease the occurrences of drift or volatilization for both GECs and non-GECs; however, in most cases, non-GECs require the use of chemicals that are more toxic in greater quantities (USFWS PUPS Database).

GEC use also would allow the Service to address pesticide resistant weeds more effectively by utilizing the entire suite of IPM options. IPM allows the use of a system to combat weeds and pests that decreases the use of harsh pesticides, increases conservation practices, and strives to decrease any effects to air quality.

Biological Resources

Habitat

Effects on Natural Habitat Resources on NWRs

Agricultural practices can potentially impact natural habitat resources and acreage on refuges and, thusly, affect the availability of food resources to wildlife species.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Under this alternative, the amount of managed moist-soil or other natural habitat resources on NWRs that commonly use agricultural practices would likely continue to increase. This increase would result in a substantial reduction in food for waterfowl and other wildlife and prevent many refuges from meeting their objectives. For example, moist-soil and other seasonal emergent wetlands have increased on refuges from 18,970 acres in 2012 to 19,812 in 2017, concurrent with the ban on GEC use. This increase is largely a result of a reduction in acres of agricultural practices due to the negative economic impacts of farming with non-GECs. Research indicates a potential 21% reduction in crop yield associated with non-GECs (Klumper and Qaim, 2014). Under this alternative, a decline in crop yields along with increased input costs will likely result in a continuing decline in cropland acres and an increase in natural habitat resources with lower food densities on refuges. Due to the difference in energy between agricultural and natural habitat resources, this alternative will likely result in substantially reduced energy supply for waterfowl and other wildlife. Although they should never completely replace natural foods, grain crops are essential if some NWRs within the Region are to meet the stepped-down waterfowl objectives of NAWMP and associated goals.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

There is no evidence that use of GECs negatively impact the health of other natural habitat resources on refuges. GEC use could result in higher yields and require less agricultural land to meet DED objectives potentially allowing the conversion of some croplands to natural habitat resources. When using GECs, the productivity of agriculture allows for fewer acres of cropland to produce food for wildlife. Economic factors associated with the use of non-GECs, such as additional input costs and declines in crop yields due to pest species, would not be issues under this alternative. GEC use has been associated with decreased pesticide use by 37%, increased crop yields by 21%, and increased farmer profits by 69% (Klumper and Qaim, 2014). These positive effects of using GECs could reduce the amount of land needed for agricultural crops to supplement wildlife food sources and allow the conversion of some agricultural fields to natural habitat resources.

The use of GECs (e.g., glyphosate/glufosinate tolerant corn and soybeans) has enabled farmers to control invasive weed species that were once targeted by Atrazine with less persistent chemicals. Some refuges (e.g., Wheeler and Tennessee NWRs) use agriculture as a management strategy to control invasive plants and set back plant succession in the management of moist-soil wetlands. For example, Wheeler NWR commonly employs agriculture to control alligatorweed, which is an aggressive and difficult to control exotic plant. One strategy to control alligatorweed is by permitting a farmer to plant a unit that has been invaded by plant so agricultural herbicides can be used (W. Gates, personal communication). Tennessee NWR utilizes agriculture in periodic rotation with moist-soil vegetation as a tool to set back plant succession and improve moist-soil seed production in subsequent years (R. Wheat, personal communication). In both of these instances where agriculture is used as a management tool, GECs would greatly increase the likelihood of success because soils of impoundments typically dry later in the year delaying agriculture planting. Insect and weed pressure is greater on late-planted crops (e.g., June-July), which can eliminate the viability of non-GEC varieties for use in cooperative farming partnerships. Moreover, European corn borers (*Ostrinia nubilalis*) are a threat for conventional seed varieties but can be readily controlled using GECs.

Effects on Adjacent Private Lands

Impacts to adjacent private lands are analyzed including the potential for refuges becoming pest reservoirs and increased crop depredation by wildlife due to reduced agricultural production resulting from agricultural practices including BMPs associated with farming on refuges.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Under this alternative, there would be no direct effects on adjacent farming operations from non-GEC use on refuges. The indirect effects of using non-GECs on NWRs could result, however, in refuges becoming reservoirs for agricultural pests and increasing occurrences of crop depredation by wildlife going beyond refuge boundaries to feed.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

Effects from GEC use on refuges to traditional, non-organic farming operations potentially include insect resistance and suppress regional insect pest populations (halo effect).

Given the widespread use of GE corn and soybeans immediately adjacent to most refuges, the likelihood that GEC use on refuges' affecting non-GECs on adjacent private lands is extremely low. Organic farming operations, as described by USDA's National Organic Program (NOP), are required to have distinct, defined boundaries and buffer zones to prevent unintended contact with excluded methods from adjoining lands that are not under organic management. Organic production operations must also develop and maintain approved organic production system plans to achieve and document compliance with the National Organic Standards (USDA NOP 2011). The likelihood of GEC agricultural practices on refuges impacting surrounding organic farmers is extremely low.

Weed Resistance

Resistance to herbicides is a concern in agricultural practices. Impacts to weed resistance under each alternative are analyzed, including impacts to trends in resistance and Best Management Practices.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Herbicide-resistant weeds can be an issue in any area where the same herbicide is repeatedly utilized. Herbicide resistant weeds in agriculture are a major problem involving 255 weed species and 163 different herbicides worldwide (http://weedscience.org/). Resistance to an herbicide develops as individual plants survive treatment to produce seed that results in generations of resistant plants. The continued and long-term use of the same or similar herbicides increases the possibility of resistance development. An example of this is the over reliance on glyphosate as the sole means to control certain weeds that has led to the emergence of several glyphosate-resistant weeds (Benbrook 2012).

One specific weed, Palmer amaranth, which has been found to have resistance to multiple herbicides of different chemistries and modes of action, has quickly become one of the most troublesome weeds in row crops in Tennessee (http://www.utcrops.com/weeds/pigweed.htm) as well as in other states in the Region. Farmers on the Tennessee NWR Complex are struggling with multiple herbicide-resistant Palmer amaranth with populations occurring on Cross Creeks NWR and the Big Sandy Unit of Tennessee NWR. Increasingly, in order to control weed species such as Palmer amaranth that have become or are more resistant to herbicides, it is necessary to utilize various herbicides with multiple modes of action.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

In the mid-1990s, the thought that there would be an evolution of herbicide-resistant weeds was, at best, considered remotely possible. Herbicide resistant plants began to be reported, however, in the late 1990s in Australia (Powles et al. 1998). The first report of herbicide resistance in the United States was in 2001, in Delaware (VanGessel 2001).

The risk of further evolution of herbicide resistant weeds can be managed by rotating crops, implementing weed management strategies (USDA-APHIS 2000, Jones 2011), and incorporating herbicide tolerant crops as part of an overall integrated weed management strategy (Mortensen et al. 2012). The Region's GEC Guidance requires that a non-GE crop or different GE crop be planted in rotation with Roundup-Ready varieties no less frequently than every 4 years (Appendix C). Crop rotation results in the use of different pest control strategies that slow the evolution of resistance consistent with the Service's Integrated Pest Management policy (569 FW 1). Accordingly, this alternative would be beneficial in addressing weed resistance issues.

Wildlife

Most wildlife that occur in areas where agricultural practices are used do not typically nest or reside in crop fields during the growing season due to agricultural activities or temporal patterns of abundance (e.g., migration of waterfowl and other birds). Spray drift might have minimal impact on non-target plant species immediately adjacent to crop fields or insects transiting crop fields at the time of application. Run-off from crop fields carrying pesticides, excess soil nutrients, and sediments could adversely impact aquatic wildlife/ecosystems, but the effects can be ameliorated using Service BMPs and the practices associated with GECs and non-GECs. These impacts are discussed by type of wildlife.

Migratory and Resident Waterfowl

Effects on Waterfowl and NWR Waterfowl Habitat Objectives

Many units of the NWRS were established to support migratory birds. Providing food for large numbers of waterfowl is often accomplished by managing natural wetlands, impoundments, and cultivated areas to produce crops (Reinecke et al. 1989, Gray et al. 2013).

Reduced food availability due to loss of agricultural practices from the loss of GECs could result in a decrease in waterfowl use of refuges thus affecting waterfowl distribution on the landscape. The lack of food also could affect the physical condition of waterfowl, especially during winter, reduce recruitment during the subsequent breeding season. Lastly, given refuges' support of waterfowl harvest opportunities on and beyond their boundaries, reductions in waterfowl usage due to agricultural practices and related reductions in food availability could create inequities in harvest opportunities on the landscape (Salyer 1945).

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Agricultural practices, including crop production, provide an efficient and practical way to meet waterfowl objectives on a limited land base, control invasive species, and set-back succession to benefit waterfowl and other wildlife (Gray et al. 2013). Refuges in this Region collectively have waterfowl objectives of providing approximately 400 million energy days (Heath Hagy, personal communication), and these objectives, which were stepped down from the NAWMP, cannot be met using the current land base without viable agricultural practices. From 2010 to 2012 when GECs were used on refuges, the average area farmed on NWRs was 41,676 acres compared to 27,987 acres during 2017-2019 when GECs were not available (Figure 4). Using 25% as the typical refuge share, the loss of 2,129 acres of unharvested corn would result in a decline of more than 66 million duck energy days. Moreover, conversion of these acres to managed moist-soil wetlands with natural vegetation would yield only 17 million duck energy days (Gray et al. 2013). Continuing declines in the viability of agricultural practices on refuges due to the discontinuance of GEC use could result in a loss of hundreds of millions of energy days for wildlife.

The economic factors associated with the reduction in acres where agricultural practices were used for natural resource management include additional input costs associated with pest control for non-GECs, decline in crop yields associated with increased weed and insect pest problems, and limited availability of non-GECs in a market focusing on GEC technology. These factors have directly affected the Region's ability to maintain cooperative farming partnerships and to meet refuge objectives.

More specifically, using conventional crop varieties rather than GECs requires a substantially greater amount of refuge staff time for pest scouting, pesticide applications, between-row tillage and other alternative pest-control practices, pesticide use tracking, and overseeing cooperative farmers. The Region saw a substantial increase in staff time following the switch from GEC to non-GEC varieties in 2012. The prohibition on GEC use on refuges has also made it increasingly difficult to create and maintain cooperative farming partnerships (T. Littrell, personal communication). These partnerships produce agricultural foods for waterfowl and other wildlife on NWRs. Allowing professional farmers to conduct agricultural production on refuges is efficient and practical; however, deviations from farming practices used on private lands reduce the likelihood of attracting and maintaining farmers in cooperative farming partnerships with refuges.

Use of conventional crops can have indirect health implications to waterfowl. With the use of non-GECs, there is an increase in the need for topically applied pesticides to control corn earworms, corn borers, and corn rootworms (USFWS Pesticide Use Proposal Database 2018). In turn, increased incidence of boring insects can decrease yields and increase the occurrence of fungal diseases, which produce mycotoxins and can cause health problems in waterfowl (Pellegrino et al. 2018).

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

It is probable that a portion or all of the 2,129 acres of lost farmed acreage (see Alternative 1) could be restored with the use of non-GECs to better enable refuges to meet their respective objectives. As presented in Alternative 1, refuges in this Region have a collective waterfowl objective of providing approximately 400 million energy days. GEC use on refuges would restore viable cooperative farming partnerships and facilitate refuges meeting their respective waterfowl objectives. The restoration of 11,080 acres of unharvested corn crops would result in a potential 319 million duck energy days (assuming the corn was planted on all of those acres). Such a crop combined with energy from natural wetland communities on refuges would likely enable the Region to satisfy its NAWMP stepped-down objective of 400 million energy days (Reinecke and Kaminski 2006). GEC use with managed natural habitat resources (e.g., bottomland forest, moist-soil) provide the best option for the Region to meet its waterfowl habitat objectives.

The number and quantity of insecticides used for production of non-GEC varieties is greater than that needed for GECs (Klumper and Qaim 2014; Figures 5 and 6). GECs can also produce yields of up to 25% more than non-GEC varieties, especially in areas with pest problems or other production challenges. For example, GECs use could result in disproportionately greater benefits to refuges where conditions often include later planting dates in bottomland settings, reduced pesticide use, poor soil quality, and high soil moisture. Because NWRs often occur in low-lying areas with diverse ecological functions, including floodwater retention and provision of habitat to spring-and summer-breeding species, conditions for agricultural practices are often less optimal than on nearby private lands. Thus, GEC use on refuges is disproportionately important for successful agricultural production and providing increased high energy food production for waterfowl.

Effects on Waterfowl from Ingesting GECs

This section analyzes the impacts to waterfowl, including nutrition availability and toxicity, from feeding on non-GE crops and GE crops.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Occurrences of boring insects are problematic to non-GE crops and increase the likelihood of fungal diseases (Pellegrino et al. 2018). Mycotoxins produced by fungi (fumonisins in particular) in grain (Clements et al. 2003) can kill waterfowl and other birds.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

There are no published studies comparing waterfowl use of GECs to non-GECs notwithstanding that waterfowl readily feed on both crops (H. Hagy, personal communication). Studies of nutritional content and toxicological profiles indicate that GECs are equivalent to non-GECs on domestic livestock, including poultry (Aumaitre et al. 2002, Flachowsky et al. 2007). Published data on acute toxicity or other direct effects of consumption of GECs or associated *Bt* residue on birds and other wildlife indicated “no hazard.” (Mendelsohn et al. 2003, USEPA 2001).

Insect-resistant corn has been found to decrease exposure to the toxic chemical aflatoxin (Wiatrak et al. 2005, Williams et al. 2005) and some other mycotoxins produced by fungi (fumonisins in particular) in grain (Clements et al. 2003). The ability to utilize insect-resistant GECs may benefit waterfowl by reducing the occurrence of mycotoxins.

Other Birds

This section analyzes impacts to other bird species located on and feeding on refuges where agricultural practices included non-GEC and GEC agricultural practices. Issues covered include ingestion of crops, effects of commercial pesticides, soil disturbance, erosion, removal of residual cover and food availability.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

As is the case for waterfowl, there have been no documented negative effects on other birds due to the consumption of non-GE crops or their residue. However, extensive data are available on the adverse effects of commercial insecticides on migratory birds (Parsons et al.

2010, Mineau and Palmer 2013), which have increased due to a larger variety of insecticide use on non-GECs on NWRs.

Increased use of conventional tillage associated with non-GE crops on refuges will result in more soil disturbance, erosion, and removal of residual cover. This, in turn, decreases the amount of cover and food availability to insectivorous birds. Several refuges in this Region manage forests and grasslands for migratory landbirds. The reduced yield potential of non-GECs could negatively affect the amount of natural habitat, such as bottomland hardwoods and grasslands, occurring on these refuges. When yields per unit area decrease (Brookes and Barfoot 2013), the amount of farmland needed for refuges to meet waterfowl objectives may increase. Reduction in the refuges' shares to mitigate the reduced profitability of non-GEC farming could require refuges to increase the amount of farmland needed to meet waterfowl objectives.

As with waterfowl, cranes take advantage of corn because it provides an energy-dense food source. For example, Sandhill cranes and whooping cranes extensively use areas on Wheeler NWR where farmers leave unharvested corn for geese and ducks. The crane population has recently (2017-2018) exceeded 28,000 on the refuge. In the past few years, the refuge has wintered 20% of the eastern management population of whooping cranes. Without GECs, it would become increasingly difficult for Wheeler NWR to sustain agriculture economically through cooperative farming partnerships. The loss of agriculture would substantially reduce habitat resources for cranes.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

There are no data to indicate any negative effects of GECs use on wildlife (USEPA 2001, Mendelsohn et al. 2003). However, extensive data are available on the effects of commercial insecticides on migratory birds. An increase in insecticide use associated with non-GECs could have negative effects on birds or their prey base (Parsons and Renfrew 2010, Mineau and Palmer 2013). It is well documented that *Bt*-transformed crops have resulted in dramatic declines in insecticide application (56 million kg over 16 years for corn and cotton alone) nationally as well as on NWRs (Benbrook 2012).

Some evidence suggests that conservation tillage, which is promoted for GEC use, could provide better habitat resource for birds than conventional tillage (Holland 2004), and crop residue provides nesting and foraging substrate (Field et al. 2007). Conservation tillage systems would promote earthworm populations (House and Parmelee 1985) and enhance nocturnal wintering habitat for American woodcock (Berdeen and Krementz 1998). As noted in Alternative 1, the increased economic viability of cooperative farming partnerships with GEC use could benefit whooping cranes and sandhill cranes.

Mammals

Most mammals that occur in crop fields feed on the crops after maturity and may use fields during the growing season for forage or cover. The individual effects to mammals using GEC and non-GEC agricultural fields includes an evaluation of the direct effects of ingestion and the indirect effects of increased conventional tillage and increased use and variety of agricultural chemicals on non-GECs.

Alternative 1: Use only non-GEC on NWRs. (No Action Alternative)

As is the case for waterfowl, there has been no documentation of negative direct effects on mammals due to the consumption of non-GE crops or their residue (Aumaitre et al. 2002, Flachowsky et al. 2007). Conventional tillage, which is most associated with non-GECs, will decrease residual cover and potential habitat and cover for small mammals and the insects upon which they prey upon. The use of non-GECs rather than GECs poses more overall risk to wildlife on refuges in this Region due to the increase in the variety, amount and toxicity of the pesticides (Klumper and Qaim 2014; Figures 5 and 6). This increased risk exists despite refuges' following EPA label restrictions, Regional and NWRs BMPs, Service policies, and agricultural practices guidance in an effort to avoid negative effects to wildlife.

Some NWRs provide habitat for large mammal species, such as black bear and deer, to reduce crop depredation on private property. The reduction in agricultural practices on refuges could cause mammals to relocate to private properties and increased conflicts with humans. For example, if cooperative farming were to end at Alligator River and Pocosin NWRs because of the prohibition on the use of GECs (a trend the Service is observing), the refuges' staffs would be unable to do force account farming on the same scale and the amount of area farmed would be reduced. As a consequence, black bears and other mammals would relocate to adjacent farmland and/or communities to find resources. Depredation pressure and nuisance bears would increase in the surrounding community and lands.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

The use of GECs has direct and indirect conservation advantages for mammals. There have been no documented negative direct effects on mammals from consumption of GE crops or their residue. The high energy crops left for wildlife on refuges provide an important food source for species such as black bear, deer, and other mammal species. The use of GECs also allows refuges to provide consistent sources of food for these species. Extensive research into potential effects of herbicide tolerant crops on livestock has failed to uncover any adverse effects or differences between transformed and conventional feeds (Aumaitre et al. 2002, Flachowsky et al. 2007). At least one study suggests that agronomic systems using GE soybeans are preferable to conventional crop systems from the standpoint of mammalian toxicity because some of the herbicides used in conjunction with GECs are less toxic than those used with non-GECs (Nelson and Bullock 2003). The Service was able to apply less amounts of and more benign pesticides to manage GE crop systems (Figures 5 and 6) prior to the 2012 planting season. The increased crop residue from conservation tillage can provide habitat for insects and other arthropods, which increases prey for mammalian insect predators (USDA-APHIS 2013a).

The safety of GE insect resistant crops has been thoroughly reviewed by EPA, FDA and APHIS. Studies have shown that "mammalian toxicology information gathered to date does not show a hazard to wild or domesticated mammals" (USEPA 2001). The insect-specific toxins produced by GECs have been shown to be non-toxic to mammals at exposures many times higher than would be possible from consuming *Bt* crops (Betz 2000). EPA has discounted the possibility that the toxins could bioaccumulate because toxins are proteins subject to metabolic decomposition (USEPA 2001).

Amphibians and Reptiles

Potential impacts to amphibian and reptile species occurring on refuges from tillage, agricultural chemicals, habitat availability, and habitat makeup are analyzed.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

The individual effects to amphibians and reptiles from non-GECs include increases in conventional tillage, use and variety of agricultural chemicals. Conventional tillage decreases residual cover which serves as potential habitat and cover for amphibians, reptiles, and insect prey. Under this alternative, indirect adverse effects to amphibians and reptiles can be expected with the increased use of tillage to suppress weeds and increased soil erosion. Similarly, if chemical inputs change with non-GECs use, there could be other impacts on wildlife. The particular mix of weed management tactics selected by a farmer would be dependent upon many important factors, including landscape context, the problem weed type, and agronomic and socioeconomic factors (Beckie 2006). Since the switch to non-GEC use on refuges in 2013, an increased need to use more restricted use pesticides has been observed and quantified (USFWS Pesticide Use Proposal Database 2018; Figures 5 and 6). As discussed above, more intensive tillage can reduce wildlife habitat and contribute to increased sedimentation and pollutants in runoff to nearby surface waters affecting water quality and negatively impacting amphibians and reptiles.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

The use of GECs will not have a direct effect on reptiles and amphibians. Prior to 2013 when non-GEC use were the only option available, the Service used more benign and lesser amounts of chemicals on refuges with less likely impacts on reptiles and amphibians (Figures 5 and 6). Conservation tillage will increase residual cover, which will increase potential habitat for amphibians, reptiles, and insect prey. Fewer agricultural inputs in the form of pesticide applications and less frequent mechanical disturbance also could decrease possible negative effects on these populations. EPA has discounted the possibility that *Bt* toxins could bioaccumulate because toxins are proteins that are subject to metabolic decomposition (USEPA 2001).

Insects

Potential impacts to insect species found on NWRs using agricultural practices are analyzed including use of chemicals associated with agricultural practices directly related to GEC use and related food sources. Potential for insects to have impacts on crops is a primary focus of research, both to determine the efficacy of all insecticides on target species of insect pests and the potential for effects on non-target insects from both genetically engineered, herbicide-tolerant and insect resistant varieties.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Under this alternative, there could be an increase in the use of synthetic insecticides that could have negative effects on non-target insect species given the toxicity and required amounts of the chemicals. The widespread use of broad-spectrum insecticides can affect target and non-target insects. Beneficial insect species are more likely to be impacted by the use of broad-spectrum insecticides where non-*Bt* inserted crops are planted.

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

NASEM (2016) found overall no conclusive evidence between genetically engineered crops and any environmental issue that has been identified, but also recognized that some of these issues are complex, especially those issues that have involved long-term changes such as with several species of high profile insects. From a more general perspective specific to insects, their habitat, and overall biodiversity within crop fields, NASEM (2016) determined that:

> *FINDING: Planting of Bt varieties of crops tends to result in higher insect biodiversity than planting of similar varieties without the Bt trait that are treated with synthetic insecticides.*

> *FINDING: In the United States, farmers' fields with glyphosate-resistant GE crops sprayed with glyphosate have similar or more weed biodiversity than fields with non-GE crop varieties.*

These statements are made in light of information available up unto the 2016 report publication date and included more detailed assessments on specific non-target insect species with purported declining trends. Use of GECs should overall reduce likelihood of negative effects on insects with the exception of targeted pest species for which Bt crops are specifically used to control these insects. The toxins they produce are lethal to insects in the orders Lepidoptera and/or Coleoptera; therefore, extensive research has focused on the possibility that non-target insects could be harmed by Bt crops under field conditions. Because the Bt toxin occurs in the pollen of Bt-transformed corn, researchers have examined the possibility that non-target insects will be harmed by consuming the pollen either through direct foraging or by consuming other plants where pollen has been deposited.

Attention has focused particularly on monarch butterflies (Danaus plexippus) because of their status as a species of conservation concern and the fact that they overlap important corn-growing areas during the corn flowering period (Oberhauser et al. 2001). However, most research found no or negligible effects on monarch larvae from Bt corn under field conditions, with the exception of one type of Bt corn (i.e., Event 176; Oberhauser and Rivers 2003; Sears et al. 2001), that contains much higher levels of the Cry1ab toxin in the pollen as a result of the location of the gene insertion in the plant's genome (the "event") (Agricultural Biotechnology Stewardship Technical Committee--Non-target Organism Subcommittee and Novigen Sciences, Inc. 2001). Event 176 was shown to have harmful effects on monarchs and on black swallowtail butterflies (*Papilio polyxenes*; Zangerl et al. 2001). NASEM reported on the same events and results as described here. Corn varieties derived from insertion of Event 176 have been withdrawn from the market (NASEM 2016) and will not be used on NWRs.

Early research on other non-target insects including honey bees, green lacewings (*Chrysoperla carnea*), springtails (*Collembola*), parasitic wasps, and ladybird beetles, has also generally shown few or no effects. The EPA has concluded that these insects are not at risk from exposure to pollen from currently available varieties of Bt corn (Betz et al. 2000, ATTRA-NOS 2001). USDA-APHIS has concluded on the strength of field studies conducted by Pioneer Hi-Bred International, Inc., that Bt corn has no negative effects on non-target insects including honey bees, green lacewings, ladybird beetles (*Hippodamia convergens* and *Coleomegilla maculata*), the monarch butterfly (*Danaus plexippus*), and parasitic wasps (*Nasonia vitripennis*) (USDA-APHIS 2013a).

Recent laboratory investigations (Schmidt et al. 2009) suggest that the lepidopteran-active Bt protein Cry1Ab may cause elevated mortality of larvae of ladybird beetles, but the effects of the coleopteran-active Cry3Bb were much less pronounced. The authors were surprised that the lepidopteran-active toxin had a greater effect on ladybird beetles than did the coleopteran-active toxin, and were not able to explain the effect. Effects on green lacewings have been the subject of some controversy as well, and testing protocols used for evaluating non-target effects on predatory insects have been called into question (Hillbeck, Meier & Trtikova 2012). In a follow-up study that used more rigorous methodology including verification of dose administration to the ladybird beetles, no adverse effects were detected from either Cry1Ab or Cry3Bb1 toxins, even at directly fed doses 10 times those administered through predation on spider mites reared on Bt corn (Álvarez-Alfageme et al. 2011).

Overall insecticide use has declined dramatically as a result of the introduction of insect-resistant (Bt) corn and soybeans (Fernandez-Cornejo and Caswell 2006, National Research Council 2010) nationally and on NWRs prior to 2013. The possibility that the toxins could bioaccumulate has been discounted by the U.S. EPA because the toxins are proteins which are subject to metabolic decomposition (USEPA 2001). Non-target effects of these compounds can be expected to decrease as well.

The remainder of the issues treated here involve herbicide-resistant GECs and those evaluated and deregulated by APHIS have not been shown to have direct negative impacts on populations of any insect species. Herbicide-tolerant crops that incorporate the transformed CP4 EPSPS protein (for example conferring tolerance to glyphosate) are not expected to have any adverse effects on non-target insects because the expressed enzyme is nearly identical to that produced in non-transformed crop plants and has never been shown to be toxic or allergenic. Therefore, APHIS has concluded that there is negligible risk for non-target organisms, including insects (USDA-APHIS 2007).

There is, however, continuing concern that increased use of herbicides reduces larval food plants for some butterflies, such as for milkweed supporting monarch caterpillars. The NASEM Committee concluded that studies and analyses at the time of their 2016 publication had not demonstrated the reduction of milkweed by glyphosate is the cause of monarch decline and went further to state that the cause-effect relationship between lower abundance of milkweed and the decline of overwintering monarchs remains uncertain. Regardless, the NASEM Committee recognized there is a continuing lack of scientific consensus on whether there is no association between monarch declines and increased use of glyphosate. The NASEM Committee further determined that "Although there is no analysis of whether adoption of GE crops played some part in fueling the conversion of natural lands to maize and other crops, the conversion appears mostly to be a response to both increased demand for liquid fuels and rapidly increasing crop prices rather than adoption of genetic-engineering technology, which was already widespread before the largest conversions of unmanaged lands."

Regardless of the debate regarding the role of glyphosate in supporting milkweed and other larval food plants for butterflies, NWRs in the Southeast support 50-foot spray buffers and other vegetated filter borders in and around crop fields to mitigate whatever undiscovered problems there may be with glyphosate use.

Resistance to at least certain toxins used in GECs in the United States has evolved in at least three species of insect pests *Hilicoverpa zea*, *Spodoptera frugiperda*, and *Diabrotica virgifera virgifera*. *Helicoverpa zea*, known variously as the cotton bollworm, corn earworm, and tomato fruitworm, has evolved resistance to the *Bt* toxins Cry1Ac and Cry2Ab in some cotton-growing regions of the United States. (Randall and Jackson 2012). The fall armyworm, *Spodoptera frugiperda,* a generalist pest known to damage more than 80 host plants, is most problematic in the Southeastern United States (Capinera 2005). The western corn rootworm, *Diabrotica virgifera virgifera*, has evolved resistance to the *Bt* toxin Cry3Bb1 in Iowa (Gassmann et al. 2011, 2012).

A number of mitigating factors have contributed to the slow emergence of resistance. First, EPA requires farmers to plant "refuge" areas or use a certain percentage of non-transformed (susceptible) crop seed, a practice known as the "high dose-refuge" strategy (Sanchis and Bourguet 2008, Tabashnik et al. 2009). This requirement ensures that sizeable populations of pests susceptible to the *Bt* toxin are maintained. Compliance with this requirement is critical to maintaining the effectiveness of *Bt* products against such pests as corn borer and corn rootworm. EPA has established a compliance assurance program and growers of *Bt* crops are contractually obligated to follow the requirements of this program. Failure to comply may result in the farmer's loss of the use of *Bt* products (http://www.thelandonline.com/l_seed/x155261924/Corn-growers-reminded-to-follow-refuge-requirements-as-spring-planting-nears).

A second reason that resistance has been slow to appear is that transformed crop plants that can produce two or more toxins are now available. The presence of more than one toxin in the crop plant greatly decreases the probability that a single mutation in the pest organism will confer greater fitness (i.e., be resistant to both toxins). This strategy is known as the "pyramid" strategy (Carrière et al. 2010) and has been suggested as one resistance management strategy, which would be effective at controlling *Bt*-resistant western corn rootworm (Cullen 2013).

The occurrence of resistant populations has been correlated with the failure of farmers to use integrated pest management strategies. For example, the number of successive years (up to 7) that the same transformed variety of corn has been planted in the same field can result in a resistant population (Gassmann et al. 2012). Considering the comparative small amount of "refuge" cropland acreage associated with GECs and the Service's requirements for refuge staff and cooperators to adhere to EPA and Service IPM policies, potential effects to adjacent private lands associated with this alternative should be extremely low.

Widespread adoption of insect-resistant crops can depress pest populations regionally, providing a benefit to producers, including organic producers, who plant conventional crops. This effect, termed "Halo Effect", results in the decline of pest populations in areas where large acreages are planted with insect-resistant crops and crop damage even on susceptible conventional crop plants, is reduced (Tabashnik 2010). This benefit has been documented and its economic returns quantified in the upper Midwest for the pest *Ostrinia nubilalis*, the European corn borer (Hutchison et al. 2010). This effect has also been documented for *Ostrinia nubilalis* and *Helicoverpa zea* in Maryland where insect resistant corn was the dominant crop (Storer 2008, Carpenter 2011), in the Mississippi Delta for *Heliothis virescens* and *H. zea* where *Bt* cotton is the dominant crop, and in Arizona, California, and northern China for various target pests (Carpenter 2011).

Aquatic Species

Aquatic ecosystems potentially impacted by agricultural activities include water bodies adjacent to or downstream from agriculture fields, including ponds, lakes, and streams or rivers. Near coastal areas, aquatic areas affected by agricultural production may also include marine ecosystems and estuaries. Aquatic species that may be exposed to sediment from soil erosion and nutrients and pesticides from runoff and atmospheric deposition include freshwater, estuarine, and marine fish and invertebrates and freshwater amphibians. Although research has shown that agricultural practices can be detrimental to stream health (Genito et al. 2002), some research suggests that agricultural lands may support diverse and compositionally different aquatic invertebrate communities when compared to nearby urbanized areas (Lenat and Crawford 1994, Wang et al. 2000, Stepenuck et al. 2002).

The greatest impacts to aquatic species would occur from runoff of pesticides into nearby surface and subsurface waters. To reduce potential impacts to amphibians, reptiles and other aquatic animals, the Region has implemented a mandatory 50-foot spray buffer to surface water for all terrestrial use chemicals. The Region's buffer requirement goes above and beyond the requirements on EPA labels for each chemical application and has been adopted as a best management practice.EPA label instructions allow many chemicals to be sprayed to the water's edge.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Under this alternative, the planting of non-GECs should not have any negative direct effects on aquatic species; however, agricultural practices associated with non-GECs could have greater negative effects than practices associated with GECs. The use of non-GECs may result in an increase in conventional tillage at the end of the growing season and partial tillage during the growing season (in cornfields). These could increase the disturbance of the soil and decrease the amount of crop residue. Both of these practices have the potential to increase soil erosion, which may affect aquatic species. This alternative includes applying a variety of pre-emergent and post-emergent pesticides that could have potentially greater impacts on wildlife, fish, and other aquatic organisms than those used with GECs. The pre-emergent and post-emergent pesticides could move in surface waters more readily and take longer to break down to inert substances than pesticides used on GECs (Cerdeira and Duke 2006, COBFLES 2010).

As for other taxa of non-target animals, APHIS has reviewed the available literature and concluded that non-GECs and their residue are safe for aquatic systems and the aquatic species that live in those systems (USDA-APHIS 2007).

Alternative 2: Allow the use of GECs on NWRs. (Proposed Alternative)

Under this alternative, the planting of GECs should not have any direct negative effects on aquatic species, and potential indirect impacts should be less than associated with non-GECs. The use of GECs may increase the use of conservation and no-tillage practices eliminating extra plowing at the end of the growing season and partial tillage during the growing season.

These activities would decrease the disturbance of the soil and increase the amount of crop residue. Both have the potential to decrease soil erosion and benefit aquatic species.

After reviewing the available evidence, EPA concluded that there was no risk of harm to aquatic animals from *Bt* crops under field conditions because of the low inherent toxicity of the *Bt* Cry toxins to fish and aquatic invertebrates and exposure rates (worst-case is from wind-deposited transformed corn pollen + agricultural runoff) that would not exceed 144 ng/l (=ppb) of Cry1Ab and 1.4 ng/l of Cry1F. The lowest observed effective concentration of Cry1Ab for the invertebrate *Daphnia magna* was 150 mg/l, or 1,000 times the worst-case contamination scenario under field conditions (USEPA 2001). EPA concluded there was no hazard to these animals and found no evidence of any risk to fish from *Bt* crops through either pollen deposition or runoff (USEPA 2001).

Socioeconomic Resource Effects

The impacts to economic factors related to GEC use including to the agriculture sector and the wildlife related outdoor recreation industry are considered in this section.

Economic Role of non-GECs

Economic impacts to agriculture related industries are assessed, including impacts of costs related to pesticide use, fuel, labor and resulting productivity of use of non-GEC and GEC use associated with NWR agricultural practices. Impacts to cooperative farming agreements on refuges are also assessed.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

Although actual costs will vary across refuges and from farmer-to-farmer, additional costs of pesticides, fuel, and labor associated with non-GECs could increase the costs per acre and or cost per bushel for these crops compared to those from GEC use. The University of Tennessee Agricultural Extension found that GEC seed was 25-43% higher in cost; however, non-GEC pesticide costs were up to 90% greater depending on the pest issues. Machinery costs were up to 36% greater and labor costs were up to 71% greater when using non-GECs rather than GECs. Yield for non-GE corn is up to 16% less than that of GE corn across the Southeast thus reducing overall profits when production costs are included (Aaron Smith, personal communication).

Comparing non-GE soybean to GE soybean crop budgets, the University of Tennessee Agricultural Extension found that seed costs were 23-48% less for non-GECs but that chemical/weed control costs were up to 258% greater for non-GECs, depending on pest issues. Total costs for non-GE soybeans ranged from 9% lower to 7% higher than GE soybeans. However, yields were up to 30% less with non-GE soybeans again reducing the profit margin of non-GECs compared to GEC varieties (Aaron Smith, personal communication). Variations in input costs primarily result from differences in pest severity, which determines the amount of pesticide needed as well as machinery and labor costs.

Enhanced genetic traits (associated with *Bt* GECs), which protect against pests like Southwestern and European corn borer, help to reduce the amount of insecticide applied on fields by controlling the pests before they become a problem. By increasing the need for insecticide use associated with non-GECs, the need for additional application by large specialized equipment will increase fuel and labor expenses. Aerial application is sometimes necessary to prevent loss of non-GECs, generating public concern relative to adjoining crops. Under this alternative, more complex, selective, and expensive pesticides are needed to control pests. Prior to the use of non-GECs, refuges in the West Tennessee, Tennessee, and Wheeler complex and the Alligator River NWR complex used approximately 24 different pesticides (active ingredients). With non-GE crops, 44 different pesticides (active ingredients) were used in 2017 (Figure 5). In addition, the amount of pesticide applied went from 20,000 pounds (with the use of GECs) to 37,000 pounds (with non-GECs) on these four NWR complexes in 2017 (Figure 6).

Use of agriculture on NWRs across the southeastern United States has been accompanied with an increase cost in pesticide application since 2013, due to using non-GEC varieties. For example, the pesticide expenses for non-GE corn is estimated to be $100 more per acre due to the greater number of chemicals required compared to use of GE corn at Tennessee NWR (R. Wheat, personal communication). The pesticide expenses at Tennessee NWR for cooperative farmers using non-GE soybeans is estimated to be $120 more per acre compared to GE soybean use (R. Wheat, personal communication).

Rising fuel prices and more frequent cultivation practices and application of pesticides would also increase the cost to cooperative farmers and refuges. Recent communications with Project Leaders who use agriculture for natural resource management on their refuges indicate that since 2012, there has been a loss of at least 16 cooperative farming partnerships with private farmers (a 25% decrease) in the Region due to the economic impacts of GEC crop restrictions. Specific economic impacts that have occurred on NWRs include: 1) a substantial increase in the amount of pesticide needed to control weeds, insects and diseases; 2) increased refuge personnel time to address the pest problems; 3) increased fuel costs associated with pesticide spray equipment; and, 4) lower crop yields due to pest issues and the limited selections of available seed varieties.

The decrease in cooperative farming on refuges associated with the switch to non-GECs has resulted in some NWRs not meeting the specific objectives of their respective CCPs and/or HMPs. Lowered and more variable yields from non-GECs has forced refuge managers to choose between farming more acres to meet waterfowl objectives or failing to meet their HMP and CCP objectives. An additional consequence of decreases in cooperative farming partnerships due to negative economic factors associated with non-GECs is significant losses to local economies near refuges. Across the Region, cooperative farming partnerships provide millions of dollars to local economies while helping local refuges meet their objectives and accomplish the purposes for which they were established.

Alternative 2*:* Allow the use of GECs on NWRs. (Proposed Alternative)

The use of GECs allows NWRs to sustain partnerships with local cooperative farmers, which in turn bolsters local economies, provides an economically efficient means of natural resource management, and enables refuges to accomplish a broad assortment of wildlife management objectives. GEC use also gives cooperative farmers greater latitude in addressing pest issues in accordance with the Service's Integrated Pest Management Policy through reductions in chemical applications, labor and machinery costs, and carbon footprints. (Trevor Smith, personal communication). GECs also optimize crop yields which increase and sustain the economic feasibility of cooperative farming. Economic impacts are a particularly sensitive issue in that cooperative farming must be profitable to the cooperator. Restrictions on farming tools, such as the use of GECs, discourage local farmers from entering cooperative agreements with refuges. Klumper and Qaim (2014) consolidated the evidence of the economic impacts of GEC use through a meta-analysis of 147 studies and found a reduction of pesticide cost by 39%, an increase in crop yields by 21%, and an increase in farmers' overall profits by 69% compared to non-GECs.

Fernandez-Cornejo et al. (2014a) concluded that pesticides were a contributing factor to the substantial increase in the average corn yield of 20 bushels/acre in 1930 to more than 150 bushels/acre around 2014, demonstrating that, if left uncontrolled, crop pests result in lower yields. For example, in 2016, the Tennessee NWR experienced a significant reduction in corn yield because of excessive pest problems. The 2016 average corn yield declined by 58% from the previous year. The effects of increasing weed pressure since 2013, along with weather conditions that were favorable to insect and disease outbreaks, resulted in a devastated corn crop such that the refuge failed to meet its waterfowl foraging objectives. In a specific case, an entire cornfield was lost because of damage to developing ears of corn by fall armyworms (*Sopdoptera frugiperda*). This damage provided entry of a fungal disease, corn smut (*Ustilago maydis*), that resulted in a yield of 11 bushels/acre compared to 190 bushels/acre of corn in 2014 (R. Wheat, personal communication). Many GE *Bt* corn varieties are resistant to fall armyworms and, if used, would have prevented this loss. GE crops may not always increase yields, but they do have a greater potential of preventing yield losses from pests than do non-GECs (Fernandez-Cornejo et al. 2014b). Since 2012, other refuges have experienced similar economic impacts from the non-use of GE crops. Following the prohibition of GEC use on refuges, farmed acreage declined from 42,339 acres to 29,903 (29% decline) from 2013 to 2017, with many refuges not meeting their respective CCP waterfowl foraging objectives.

GECs must be strategically incorporated into IPM systems to counter the evolution of insect and weed resistance and maintain farm productivity (Ronald 2011). The Service requires that IPM principles be used for natural resource management. One example of an IPM principle implemented in the Region is that approved post emergent pesticides will not be used until crop scouting indicates pest density is at or beyond economic threshold levels. Farmers also have adopted an IPM program that incorporates practices, such as crop rotation, tillage, herbicide rotation, herbicide mixtures using multiple modes of action and stacked trait GE varieties, to control herbicide resistant weeds. The use of double or triple stacked GECs would provide weed management options to control a broader spectrum of weed species, including herbicide resistant weeds. These GECs could increase costs of production; however, these costs could be offset by higher yields, relative to IPM, with little negative impact on net returns.

The National Research Council (2010; NRC) reports the following indirect cost benefits from the use of GE crops: 1) increased use of conservation tillage practices that reduce the use of machinery and fuel by around 50% and labor costs by 40%; 2) decreased use of more costly and, in many cases, more toxic herbicides; and, 3) reduced use of highly toxic insecticides due to use of insect resistant GE crops. NRC cited one study (Rice 2004) that estimated a reduction of 5.5 million pounds of insecticide active ingredient per 10 million acres of *Bt* corn. These indirect cost benefits offset increased seed costs and make the use of most GE products profitable (National Research Council 2010).

Economic Impact on Wildlife-dependent recreation

Occurrence of concentrated populations of waterfowl and other wildlife species on NWRs make them popular destinations for wildlife dependent recreation enthusiasts. Bird watching, photography, kayaking, canoeing and wildlife observation are a few activities common on refuges. Many refuges are also a popular destination for hunters and fishermen. The growing recreational industry also generates income for local economies near refuges.

Alternative 1: Use only non-GECs on NWRs. (No Action Alternative)

As stated in Chapter II, refuges use agricultural practices and other habitat management activities to meet specific wildlife objectives. NWRs in this Region sustain waterfowl for months. With the loss of millions of acres of wetlands, agricultural practices have become essential to provide much needed food resources for millions of waterfowl. Non-GEC use has great potential to reduce refuges' abilities to sustain wintering waterfowl populations that support migratory bird-related recreation.

Where agriculture practices are reduced in scale or eliminated due to challenges associated with using only non-GECs, the affected refuge may host fewer waterfowl and diminish migratory bird-related recreational opportunities both within and outside of the refuge. These opportunities may also decrease on nearby public and privately owned lands as locally wintering waterfowl numbers decline. Decreasing wintering waterfowl numbers and migratory bird-related recreation opportunities may substantially impact local economies and the Region as refuge visitation and visitation-related spending decline.

Alternative 2: Allow the use of GECs on refuges. (Proposed Alternative)

GEC use enhances the ability of NWRs to sustain wintering waterfowl populations and support migratory bird-related recreation. These refuges will remain destinations for hunters, wildlife observers, and wildlife photographers due to their large concentrations of waterfowl. Spending associated with these recreational visits will benefit local economies and the Region. In 2015, refuges hosted approximately 47 million visitors who participated in a wide variety of recreational activities including hunting, fishing, wildlife observation, photography, interpretation and environmental education. According to the 2013 "Banking on Nature" report, these visitors generate $2.4 billion in annual sales and economic output, creating 35,000 jobs (Carver and Caudill 2013). On average, NWRs return $4.87 to local economies for every $1 Congress provides in federal funding (USFWS 2015).

Waterfowl are vital to the communities, hunters, and economy in both the Atlantic and Mississippi Flyways. Several refuges in the Region offer birding festivals or birding events for visitors to view and learn about waterfowl. Wheeler NWR annually hosts the two-day Festival of the Crane during the second week of January, which usually attracts over 4,000 visitors with over half of these being from out of town. A free one-day annual waterfowl event on Tennessee NWR has drawn over 600 visitors to the Duck River Unit to view tens of thousands of ducks and numerous eagles. Wings Over Water (WOW) is a wildlife festival, with an emphasis on birds, that occurs over a week in October and three days in December, on six refuges in Eastern North Carolina. WOW consistently has 300 registrants that pay for multiple events during the festival. These festivals, which are dependent on the presence and abundance of waterfowl, attract visitors from outside the local area who spend money on food, lodging, gas and other items during their visits.

Cumulative Impacts

A cumulative impact is defined as an impact on the natural or human environment, which results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (federal or non-federal) or person undertakes such other actions (40 Code of Federal Regulations, 1508.7). Impacts can also “accumulate” spatially, when different actions affect different areas of the same resource. Occasionally, different actions counterbalance one another, partially canceling out each other’s effect on a resource. Sometimes the overall effect is greater than merely the sum of the individual effects, such as when one more reduction in a wildlife population crosses a threshold of reproductive sustainability, and threatens to extinguish the population.

The GECs proposed for use on refuges have been analyzed and deregulated through APHIS and are currently used extensively on private lands and by state agencies on wildlife management areas. In conducting NEPA, APHIS conducts a detailed nationwide analysis of the potential cumulative effects of deregulation of a specific GEC. The analysis includes such relevant factors as the long term and cumulative effects on physical, biological and socioeconomic resources among other factors analyzed. The most significant factor in evaluating the cumulative effects of future use of GECs on NWRs in the Region is the widespread use of GECs in the nation, as a whole, including the southeastern United States. Based on USDA survey data, 94% of domestic soybean, 91% of cotton, and 90% of corn acres were GE (HT) varieties in 2014 (USDA Economic Research Service 2018). Similarly, domestic *Bt* corn acreage was 82% in 2018, with 80% cultivated in stacked seeds with both HT and *Bt* traits (USDA Economic Research Service 2018)

This Region’s GEC Guidance limits the scope and effects of GEC use on refuges and surrounding lands and communities (Appendix C). The use of GECs would increase the efficiency of natural resources management and help staff meet NWRS purposes and objectives. Moreover, the specific use of GECs on any NWR or NWR complex must be recommended by the refuge manager and approved by the NWR Regional Chief in accordance with Service policies. In particular, the Regional GEC Guidance provides for crop types, crop rotation, and pesticide spray buffers that will avoid or minimize the potential negative effects of using GECs at both the local and Regional (cumulative) levels (Appendix C). The Service policies and GEC use would not affect or interact with local planning, communities, and landscapes.

Cumulative Impacts: Physical Resources

The farming practices on refuges that could potentially impact soil, water quality, air quality, and climate change are tillage, agricultural inputs (fertilizers and pesticides), and irrigation. As part of an IPM approach, GECs would reduce the quantity and types of pesticides needed and increase the use of conservation tillage. Furthermore, the use of associated best management practices with GECs could protect water resources. As such, a determination authorizing the use of GECs in refuge farming programs in this Region is not anticipated to result in any significant cumulative impacts on water quality or use, soil, air quality, or on climate change relative to the No Action Alternative.

Cumulative Impacts: Biological Resources

The scale of GEC use on NWRs would be insignificant when considered as part of this Region as a whole. Of the almost 4 million acres of refuge land in the Region, agricultural practices are conducted on less than 30,000 acres (<1%) annually. In fact, GEC use on refuges in this Region would constitute only 0.01% percent of the total cropland within the United States.

Positive impacts of GEC use as a means to help control weeds and invasive species include stabilizing conservation tillage practices, which would enhance biodiversity due to decreases in runoff and erosion (Carpenter 2011). It is noted that EPA will have new regulatory mechanisms in place to oversee HT crops and deter resistant weed development. In addition, the NWRS would incorporate and implement best management practices in association with GEC use to protect biodiversity and deter resistance.

From a "Wildlife First" perspective as well as in conjunction with a truly IPM system, GEC use would allow NWRs in the Region to maximize yields to meet the objectives of the NAWMP and other planning documents, minimize chemical use on refuge lands and exposure to species utilizing these lands, and minimize the use of refuge staff in overseeing agricultural practices. Plant and wildlife diversity would remain a top priority in establishing best management practices for refuges. The current BIDEH Policy (USFWS 2006) would continue to apply to refuges as regards to the possible expansion of agricultural practices and associated use of GECs. This means that the Service would continue to evaluate the use of a GEC on a refuge on an individual, case-by-case basis in accordance with the individual needs and founding purpose of a refuge.

Cumulative Impacts: Socioeconomic Resources

The scoping effort by the Service as well as the analysis done in this document indicate that the use of GECs is the most economically feasible tool to incentivize their continued participation in cooperative farming partnerships with refuges. A decrease in the use of GECs on private lands near refuges in this Region is highly unlikely. It is much more likely that local farmers will continue to use current GECs and combinations of GEC traits as well as new technologies as they become available (e.g., double and triple stacked varieties). The Service's proposed alternative, i.e., use of GECs on refuges in this Region, would allow the use of only APHIS-deregulated GE crops.

The Service is unaware of any past, present, or future planned actions that, when added to the Region's proposed alternative, would result in a significant cumulative impact to the environment.

Short-term Uses of GECs versus Long-term Productivity

Based on the analysis above, incorporating GECs in this Region's natural resource management programs, including agriculture, would be more economical in both the short-term and the foreseeable long-term. Efficiencies realized due to a decrease in the amount and severity of pesticides and in refuge staff's time and effort in administering or implementing agricultural practices for natural resource management purposes would benefit individual refuges in particular and the NWRS in general. With the current technology available, the use of GECs on refuges in this Region for natural resource management purposes is the most effective way to achieve the NWR regional and national waterfowl and wildlife management goals and objectives.

Summary of Analysis

The purpose of this PEA is to provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI). Table 1 provides a summary of environmental effects by alternative.

Alternative 1 – No Action Alternative

A summary of this alternative is provided in the table below. While this alternative could perhaps meet the purpose and needs of the Service in achieving waterfowl foraging objectives, the purposes for which a NWRs was established, and the mission of the NWRS, further loss of cooperative farming, decreased residual cover, increased pesticide use, increased personnel time to address farming and the associated practices, lower yields due to pest issues and the limited selections of available seed varieties would make it more difficult for refuges to achieve their respective waterfowl foraging objectives.

Alternative 2 – Proposed Action Alternative

A summary of this alternative is provided in the table below. This alternative meets the purpose and needs of the Service as described above because it would facilitate refuges' efficiently and effectively achieving their respective waterfowl foraging objectives, contribute to the respective purposes for which refuges were established and accomplish the mission of the NWRS.

Table 1. Summary of environmental effects by alternative, National Wildlife Refuges in the Southeastern United States, USFWS.

Issues	Alternative 1 (No Action Alternative)	Alternative 2
Soil	Increased soil erosion from increased conventional tillage cropping system	Decreased soil erosion from increased use of conservation tillage
Water Quality	Decreased to unchanged water quality effects from increased use of conventional tillage and increased use and variety of agricultural chemicals.	Increased water quality from use of conservation tillage and use of more benign chemicals.
Effects on Adjacent Fields (GE Crops)	No effects.	No effects.
Organic and Conventional (non-GECs) Crop Issues	None to minimal effects for conventional farming and no effects to organic farmers due to the requirements to maintaining buffers and to EPA label spray drift requirements.	None to minimal effects for conventional farming and no effects to organic farmers due to the requirements to maintaining buffers and to EPA label spray drift requirements.
Weed Resistance	The potential for weed resistance exists and addressed through the BMPs and IPM techniques.	The potential for weed resistance is minimal to no effect.
Habitat	Use of non-GECs would either require NWRs to increase cropland and potentially decrease natural habitat resources to meet waterfowl objectives or result in NWRs failing to meet waterfowl objectives.	Use of GECs allows NWRs to meet waterfowl objectives.
Migratory and Resident Waterfowl	Negative effects to waterfowl due to not achieving objectives.	No known effects to waterfowl.

Other Birds	Conventional tillage systems decrease residual cover and increased insecticide use, potentially affecting prey items that other birds would otherwise utilize in crop fields.	Conservation tillage associated with GEC use allows residual vegetation which can increase prey items available.
Amphibians and Reptiles	Given the use of EPA labeling restrictions and the Service's PUP and IPM, effects would be minimal.	Given the use of EPA labeling restrictions and the Service's PUP and IPM, effects would be minimal.
Mammals	No known effects.	No known effects.
Non-target Insects	Potential effects to non-target insects due to increased exposure to broad-spectrum insecticides.	No to minimal effects to non-target insects.
Aquatic Species	No known effects due to use of Southeast Regional NWR increased buffer policy.	No known effects due to use of Southeast Regional NWR increased buffer policy.
Threatened and Endangered Species	No known effects determined by Intraservice Section 7 Consultation.	No known effects determined by Intraservice Section 7 Consultation.
At-risk Species and Species of Concern	No known confirmed effects.	No known confirmed effects.
Socioeconomic Environment	Economic losses associated with conventional farming practices has resulted in loss of cooperative farming partnerships, loss of revenue to local farming communities. Loss of recreational activities due to reduced waterfowl populations could impact local economies.	Maintain cooperative farming partnerships on NWRs, decreased costs associated with conservation tillage, and maintains recreational activities and local economy.

Appendix A. References and Literature Citations

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Appendix B. List of National Wildlife Refuges in the Southeastern United States that have Recently Used Agricultural Practices for Natural Resource Management

National Wildlife Refuge	State
Choctaw NWR	Alabama
Eufaula NWR	Alabama
Key Cave NWR	Alabama
Wheeler NWR	Alabama
Central AR NWR Complex	Arkansas
Bald Knob NWR	Arkansas
Cache River NWR	Arkansas
Big Lake NWR	Arkansas
Wapanocca NWR	Arkansas
White River NWR	Arkansas
Overflow NWR	Arkansas
Pond Creek NWR	Arkansas
Holla Bend NWR	Arkansas
Clarks River NWR	Kentucky
North LA NWR Complex	Louisiana
Red River NWR	Louisiana
Upper Ouachita NWR	Louisiana
Black Bayou Lake NWR	Louisiana
Handy Brake NWR	Louisiana
Lacassine NWR	Louisiana
Central LA NWR Complex	Louisiana
Lake Ophelia NWR	Louisiana
Grand Cote NWR	Louisiana
Catahoula NWR	Louisiana
Bayou Cocodrie NWR	Louisiana
Tensas River NWR	Louisiana
Cat Island NWR	Louisiana
Coldwater River NWR	Mississippi
Panther Swamp NWR	Mississippi
St. Catherine Creek NWR	Mississippi
Yazoo NWR	Mississippi
Sam Hamilton Noxubee NWR	Mississippi
Morgan Brake NWR	Mississippi
Tallahatchie NWR	Mississippi
Dahomey NWR	Mississippi
Mattamuskeet NWR	North Carolina
North Carolina Coastal Refuge Complex	North Carolina
Alligator River NWR	North Carolina
Mackay Island NWR	North Carolina
Pocosin Lakes NWR	North Carolina
Pee Dee NWR	North Carolina
Santee NWR	South Carolina

Cross Creeks NWR	Tennessee
Tennessee NWR	Tennessee
West Tennessee NWR Complex	Tennessee
Lake Isom NWR	Tennessee
Reelfoot NWR	Tennessee
Lower Hatchie NWR	Tennessee
Hatchie NWR	Tennessee

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1875 Century Boulevard
Atlanta, Georgia 30345

In Reply Refer To:
FWS/R4/RF/RM-PL

APR 2 2007

Memorandum

To: Refuge Managers Requesting the Use of Genetically Modified Crops on Service Lands in the Southeast Region (See list below)

From: Regional Chief, NWRS, Southeast Region

Subject: Delegation of Authority and Process for Approving the Use of Genetically Modified Crops (GMCs) on National Wildlife Refuges in the Southeast Region.

The authority for approval of GMCs on refuge lands has been delegated from the Director through the Regional Director to the Regional Chief of the National Wildlife Refuge System in the Southeast Region. The Regional Chief now must approve and/or disapprove the use of genetically modified crops on refuges. During October of 2006, a required GMC usage process that included a questionnaire was provided by the Regional Office to all Refuge Managers in the Southeast Region that are conducting farming programs. Managers were instructed to fill out the questionnaire and, justify the use of GMC's on refuge lands that they manage. The questionnaires have been completed by the Refuge Managers, returned, and evaluated. No problems were identified with the use of GMC's on refuges in the Southeast Region.

This memorandum will serve as approval for those refuges listed below that justified the use of GMCs and will remain effective until otherwise notified. The use of GMCs in the Refuge System must comply with the Biological Integrity, Diversity, and Environmental Health policy (601 FW 3), and, other Service policies pertaining to pest management and herbicide use.

The following is the list of refuges that provided justification for using GMC's:

1. Santee NWR – Bernie Good
2. North Louisiana Refuges Complex – Brett Hunter
3. Theodore Roosevelt Complex – Joe Fontaine
4. Tennessee NWR – Andy Hoffman
5. Cache River NWR – Jonathan Windley
6. Wapanocca NWR – Jonathan Windley
7. West Tennessee Complex – Randy Cook
8. Bald Knob – Bill Alexander
9. Central Louisiana Complex – Mindy Gautreaux
10. Mattamuskeet NWR – Jerry Fringeli
11. Wheeler NWR – Bill Gates
12. Key Cave NWR – Steve Seibert

13. Clarks River NWR – Michael Johnson
14. North Mississippi Complex – Robert Barkley
15. Holla Bend NWR – Ben Mense
16. Noxubee NWR – Brett Wehrle
17. Pocosin Lakes NWR – Wendy Stanton
18. Eufaula NWR – Milton Hubbard
19. Felsenthal NWR – Lake Lewis
20. St. Catherine Creek NWR – Randy Breland
21. White River NWR – Steve Reagan

If you have any questions about use of GMCs or any other farming policies please contact Whit Lewis at 731-772-0501 extension 225.

GUIDANCE

The following is the usage process that includes such items as the required GMC rotations, etc.

Background

GMCs are agricultural plants with inserted DNA extracted from sexually incompatible organisms in vitro which allows these plants to be resistant to certain herbicides that are typically more environmentally friendly. GMCs have become a prominent feature of American agriculture. However, when comparing the Refuge System farming practices to the American agricultural community the Refuge System constitutes less than 1 percent GMC usage in the continental United States. However, the use of GMCs on Service lands in the Southeast Region is currently at an all time high (approx. 95% of the acres farmed on refuges are planted to RoundUp Ready [RR] GMCs). The use of GMCs is so dominant in today's market to purchase non-GMC seed requires special ordering thus adds a higher cost to the refuge farmer.

Main examples of GMCs include RoundUp Ready (RR) corn, RR soybeans, RR milo and Liberty-Link corn. RR corn, RR soybeans and RR milo contain gene insertions conferring resistance to the herbicide glyphosate. Liberty-Link corn contains a gene insertion that confers resistance to glufonsinate-ammonium herbicide.

Other GMCs are currently being developed by the agricultural industry. The guidance provided herein will also suffice for evaluating the use of newly developed GMCs in the future.

Benefits of GMCs

GMCs may be incorporated into an integrated pest management approach. The use of GMCs will result in the use of reduced amounts and fewer types of herbicides than are used in conventional (non GMC) crop production (i.e., crop production without the use of GMCs). Reducing the use of herbicides benefits many species by reducing the contamination of soil, air, and water.

GMCs can be used with herbicides that may pose less risk to the environment than herbicides used with conventional crops. The Southeast Region went to RR crops when Atrazine was eliminated for use on refuges several years ago. To date, the use of RR crops still offers the only alternative to effective corn herbicides such as Atrazine.

Risks of GMCs

Pest species could develop resistance to glyphosate in conventional cropping systems if not rotated. The increased risk may be countered by rotating RR GMCs after three consecutive years of growth to non RR GMCs on the fourth year (see RR GMC Rotation below).

While the use of GMCs will reduce the use of some non GMC herbicides, it may increase the use of other herbicides such as glyphosate associated with RR corn, RR soybeans, and RR milo.

Gene flow refers to the movement of genetic material from the GMCs to cultivated and/or wild relatives via cross pollination, potentially resulting in genetic contamination. However, wild relatives of corn, soybeans and milo are not present in the United States thus no risks are associated with the use of GMCs in the Southeast Region.

Process for Approving the Use of GMCs on Refuges in the Southeast Region

The use of GMCs is limited to circumstances where farming with GMCs is essential for accomplishing refuge purposes and objectives set forth for the refuge. With the GMC Eligibility Questionnaire (Exhibit A), Refuge System field personnel will justify and demonstrate the eligibility of GMCs as a management tool and explain the necessity of using GMCs to achieve the refuge mission. The Regional Chief will review and provide written approval/disapproval on the use of GMCs in the Southeast Region.

In addition, to completing the GMC Eligibility Questionnaire, other compliance documents may be required for the use of GMCs on a particular refuge and/or refuge complex. For example, a likely to adversely affect (AA) on a Section 7 consultation would stimulate further review through the development of NEPA documents, compatibility determinations, special use permits, etc.

Precautions such as crop rotations must be taken to avoid, minimize, or mitigate potential adverse effects. Since RoundUp Ready (RR) is by far the most dominant used GMC in the United States, as well as, on refuges in the Southeast Region and since essential non GMC corn herbicides (Atrazine, Simazine) are not available for use in the Southeast Region, it's not a realistic approach to rotate RR GMCs on a bi-annual basis. Accordingly, the following RR GMC rotation will be implemented on refuges within the Southeast Region.

RR GMC Rotation: The Regional Chief may permit up to three consecutive years planting of RR GMCs without a rotation to a non GMC conventional crop until the fourth year. The fourth year will require the use of any or all combinations of the following farming methods such as, the special ordering and planting of non GMC conventional cropping seeds, special ordering and planting of non-RR GMC crop seeds/herbicides (example - Liberty and/or Lightning Link crop seeds/herbicides). Moist soil rotations with no agricultural crops planted, fallow land rotations with no agricultural crops planted, etc. After the fourth year, the RR GMC rotation will repeat itself.

NOTE: Non GMC Soybeans offers a better rotation on the fourth year due to the fact that the current Station Managers Chemical List provides a variety of conventional chemicals that have effective control of pest species in Soybeans. This rotation is noted in Exhibit B below. The first rotation (RR Corn to RR Soybeans to RR Corn to Non RR GMCs) is the preferred rotation. This rotation will allow for a three year to one year rotation which can be accomplished with minimal impact to the resource and the cooperative farmer.

Exhibit A: GMC Eligibility Questionnaire

Refuge System field personnel shall use this questionnaire to determine if GMCs are eligible for use. If GMCs are determined eligible for use by field personnel, the completed questionnaire shall be submitted to Whit Lewis, Regional IPM/Farming Coordinator for the Southeast Region by the deadline of December 1, 2006. Whit will compile the questionnaires and forward onto the Regional Chief for review. Send your completed questionnaire to Whit at Hatchie National Wildlife Refuge, 6772 Hwy 76S, Stanton, Tennessee 38069 by the deadline stated above.

(1). Is it practicable to achieve refuge purposes and objectives by managing native plant communities and without growing domesticated crops such as; corn, soybeans, milo, etc.?

- If yes, stop here. GMCs are not permitted and farming will not be practiced.
- If no, briefly describe why and go onto Question 2.

(2). Is it practicable to grow conventional (non- GMC) crops in a quantity sufficient to achieve refuge purposes and objectives without using pesticides?

- If yes, stop here. GMCs are not permitted.
- If no, briefly describe why and go onto Question 3.

(3). Is growing GMCs on Service lands necessary for achieving refuge purposes and objectives?

- If yes, briefly describe why and go onto Question 4.
- If no, stop here. GMCs are not permitted.

(4). Which GMCs do you seek approval for using?

- List each and go onto Question 5.

(5). Is there any Federal or State law that prohibits the planting or production of GMCs on the refuge or in the area in which the refuge is located? Contact the local County Extension Service in your area for updated information pertaining to this question.

- If yes, stop here. GMCs are not permitted.

- If no, go onto Question 6.

(6). Do federally listed threatened or endangered species (or species proposed for listing) inhabit areas of the refuge in which GMCs will be grown?

- If yes, identify the species here and go onto Question A.
- If no, the use of GMCs may be approved.

A. Will the use of GMCs have a no effect (NE) or a not likely to adversely affect (NA) listed species (or species proposed for listing)? (Only the Refuge Manager can determine a No-Effect [NE].)

- If yes, there is a potential to affect, contact your local Ecological Services Office regarding Section 7 consultation. Go onto Question B.
- If no, there is no potential to effect, the use of GMCs may be approved.

B. Does the consultation indicate that using GMCs will have a no effect (NE), not likely to adversely affect (NA), or likely to Adversely Affect (AA) listed species?

- If a likely to adversely affect (AA) is determined, GMCs will not be permitted at that time. Compliance documents will be required and additional review will be conducted!
- If a no effect (NE) or a not likely to adversely affect (NA) is determined, the use of GMCs may be approved.

Exhibit B: This Exhibit lists some Examples of Stewardship Practices When Using Glyphosate-Resistant GMCs

General Practices*

- Rotate between RoundUp ready and conventional crops or crops with other types of herbicide resistance.
- Rotate glyphosate with herbicides that function with non-glyphosate modes of action (such as conventional type herbicide chemicals). Rotate conventional chemicals over time as well.
- Apply glyphosate at labeled rates at the correct stage of growth.
- Scout fields regularly and identify weeds.
- Respond quickly to changes in weed population.
- When using RR GMCs maintain a 50 feet buffer from all permanently standing and/or running water.

<u>Some</u> examples of RR GMC Crop Rotation Scenarios*

Year	RR Corn/RR Soybean Rotation This is the Preferred Rotation!! Read GMC Rotation Methods in the above text.	RR Soybean/ RR Corn Rotation	Continuous RR Corn Rotation	Continuous RR Soybean Rotation
1	RR Corn with both pre and post – emergence of glyphosate	RR Soybeans with both pre and post emergence of glyphosate	RR Corn with both pre and post emergence of glyphosate	RR Soybeans with both pre and post emergence of glyphosate
2	RR Soybeans with both pre-post emergence of glyphosate	RR Corn with both pre and post emergence of glyphosate	RR Corn with both pre and post emergence of glyphosate	RR Soybeans with both pre and post emergence of glyphosate
3	RR Corn with both pre and post emergence of glyphosate	RR Soybeans with both pre and post emergence of glyphosate	RR Corn with both pre and post emergence of glyphosate	RR Soybeans with both pre and post emergence of glyphosate
4	**Rotate to Non RR GMCs and use the <u>GMC rotation method</u> stated in the text above. <u>Non RR Soybeans would rotate well the 4th year!!</u>**	Rotate to Non RR GMCs and use the <u>rotation method</u> stated in the text above. **Remember we have no totally effective non GMC corn herbicides at this point. I would suggest using the first rotation method.**	Rotate to Non GMCs and use the <u>rotation methods</u> stated in the text above. **Note: This type rotation would need to rotate to non GMC Soybeans on the 4th year.**	Rotate to Non GMCs and use the <u>rotation methods</u> stated in the text above. **Note: This rotation would need to rotate to non GMC on the 4th year.**
5th year	**Repeat rotation**	Repeat rotation	Repeat rotation	Repeat rotation

* Modified from: University of Wisconsin Extension. 2003. Wisconsin Farmers and Agri-Business Call for Glyphosate (Roundup) Stewardship. Full document available at http://www.weeds.iastate.edu/mgmt/2004/glyphosate%20white%20paper.pdf.

Appendix D. Public Involvement

In accordance with NEPA implementing regulations and the Departmental and Service's NEPA policies, the Service encouraged and solicited public involvement in the development of this PEA via a multi-level scoping process. This document incorporates information provided by interested citizens, conservation organizations, and local and state agencies.

The Service utilized a number of strategies to reach the widest possible audience during the scoping process. One of the strategies developed by the Service to facilitate public accessibility to information pertaining to the development of this PEA was a website at https://sites.google.com/site/fwsregion4gmcpeis/home.

The scoping process was officially initiated on April 30, 2013, with publication in the *Federal Register* of a Notice of Intent (NOI) to prepare a PEA (78 F.R. 25297). The planning process was halted in 2014 due to a decision by the NWRS Chief to discontinue the use of GECs to feed wildlife on NWRs. A reversal of agency policy in 2018 resulted in resumption of the development of PEA.

During initial scoping, the Service hosted five scoping and informational meetings to inform the public of the context and policies associated with the Service's previous use of GECs and to accept comments in an 'open house' format. The following meetings were held (Table 1):

Table 1. Location, and Dates, and Number of Attendees of Public Scoping Meetings.

Location	Date	Number of Attendees
Columbia, North Carolina	June 6, 2013	54
Decatur, Alabama	June 10, 2013	20
Dyersburg, Tennessee	June 11, 2013	24
Natchez, Mississippi	June 12, 2013	17
Alexandria, Louisiana	June 13, 2013	4

The Service contracted with Environmental Management Planning Services, Inc. (EMPSi) to facilitate the scoping meetings and prepare written reports of each meeting. A summary of comments provided at those 2013 meetings is located on the Region's GEC web page at https://sites.google.com/site/fwsregion4gmcpeis/.

Issues Raised During Public Scoping

Comments received during scoping were identified and organized into four issue categories:

- Resource issues – These comments focused on issues that relate to natural resources or project-specific resources. These comments were further developed into the following resource issues:
  1. What are the potential impacts on humans, wildlife, and insects that are exposed to GECs?
  2. How would pesticide and herbicide type, amount, and frequency of use change between GECs and non-GECs?
  3. How would the economic viability of agricultural operations be affected by restrictions on GECs?
  4. How would potential changes in agricultural practices resulting from restrictions on GEC use on NWRs impact the Service's ability to provide food for migratory birds?
  5. What are the risks of cross-contamination between GECs and non-GECs?
  6. How would GEC use impact soil conditions and ecology? How would GEC use impact biodiversity within the surrounding ecosystem?
  7. How would GEC use impact water resources?
  8. How would GEC use impact non-agricultural vegetation?
  9. What impact would GEC use have on greenhouse gas emissions and climate change?
- General comments related to GECs – These comments were primarily concerned with whether enough testing of GECs had occurred to justify their use, with commenters coming down on both sides of this issue.
- General project comments – These comments focused on more general aspects of the project, including the ability of the Service to fulfill the purposes of NWRs with or without allowing GEC use, the overall impact of this decision on the environment compared to its impact on farmers, existing analyses that could be adopted by the Service, and what form the environmental analysis should take.
- Project considerations – These comments proposed different ways for the Service to manage GECs on NWRs, including site-specific analysis, non-GEC buffers, use of non-GECs, requesting donations of non-GEC seeds, and using NWRs for field studies to further analyze the impacts of GECs on the environment.

Appendix E. Intra-Service Section 7 Biological Evaluation

Originating Person: Tina Chouinard
Telephone Number: 731-432-0981
E-Mail: tina_chouinard@fws.gov
Date: July 15, 2019

PROJECT NAME: USFWS Draft Programmatic Environmental Assessment for Use of Genetically Engineered Crops on National Wildlife Refuges in the Southeastern United States

I. Service Program:

___ Ecological Services

___ Federal Aid

___ Clean Vessel Act

___ Coastal Wetlands

___ Endangered Species Section 6

___ Partners for Fish and Wildlife

___ Sport Fish Restoration

___ Wildlife Restoration

___ Fisheries

_X_ Refuges/Wildlife

II. Station Name: National Wildlife Refuges in the southeastern United States with agricultural practices for wildlife management

III. Description of Proposed Action: The U.S. Fish and Wildlife Service (Service) would reinstate the use of genetically engineered crops (GEC) when agriculture is required to meet National Wildlife Refuge purposes and objectives in the southeastern region (North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Tennessee, Kentucky), as analyzed in the Service's Draft Programmatic Environmental Assessment for Use of Genetically Engineered Crops on National Wildlife Refuges in the southeastern United States.

NWRs would have the option of using APHIS-approved and deregulated GECs consistent with approved APHIS practices used on private lands and wildlife management areas run by state agencies. GECs are evaluated and deregulated by APHIS, as described in 7 CFR 340.6. The Service would have the option of using these approved and deregulated crop types, along with other non-GECs in rotation as appropriate, guided by the overall NWR purpose(s), CCP goals and objectives, and other policy, guidance, and decision documents.

The Service would use a tiered analysis for considering the use of GECs on NWRs:

1) GEC specific NEPA analysis and de-regulation by the USDA APHIS;
2) Regionional GEC analysis through the Service's Programmatic Environmental Assessment and Finding of No Significant Impact (FONSI) or Environmental Impact Statement (EIS)/Record of Decision (ROD);
3) Analysis of Essentialness to comply with BIDEH Policy;
4) Analysis of GEC use in general for a specific NWR or NWR complex through an Categorical Exclusion/Environmental Action Statement, tiered from of PEA and other Environmental Assessment (EA) / Finding of No Significant Impact (FONSI) or Environmental Impact Statement (EIS) / Record of Decision (ROD) related to an associated NWR planning document (CCP, HMP, CD); and
5) Determination of Essentialness.

NWRs would adhere to all requirements for determining appropriateness and compatibility of agriculture as a NWR management tool. NWRs would continue to use cooperative partnerships with private farmers, farming contracts, or force account farming for implementation. NWR managers would oversee specific agriculture agreements and programs with attention to crop selection, time of planting, time of harvesting and determination of shares. Best Management Practices (BMPs) would be followed and conventional or no-till farming, soil preparation, planting, nutrient management, pest management and harvesting would remain components of a agricultural management program.

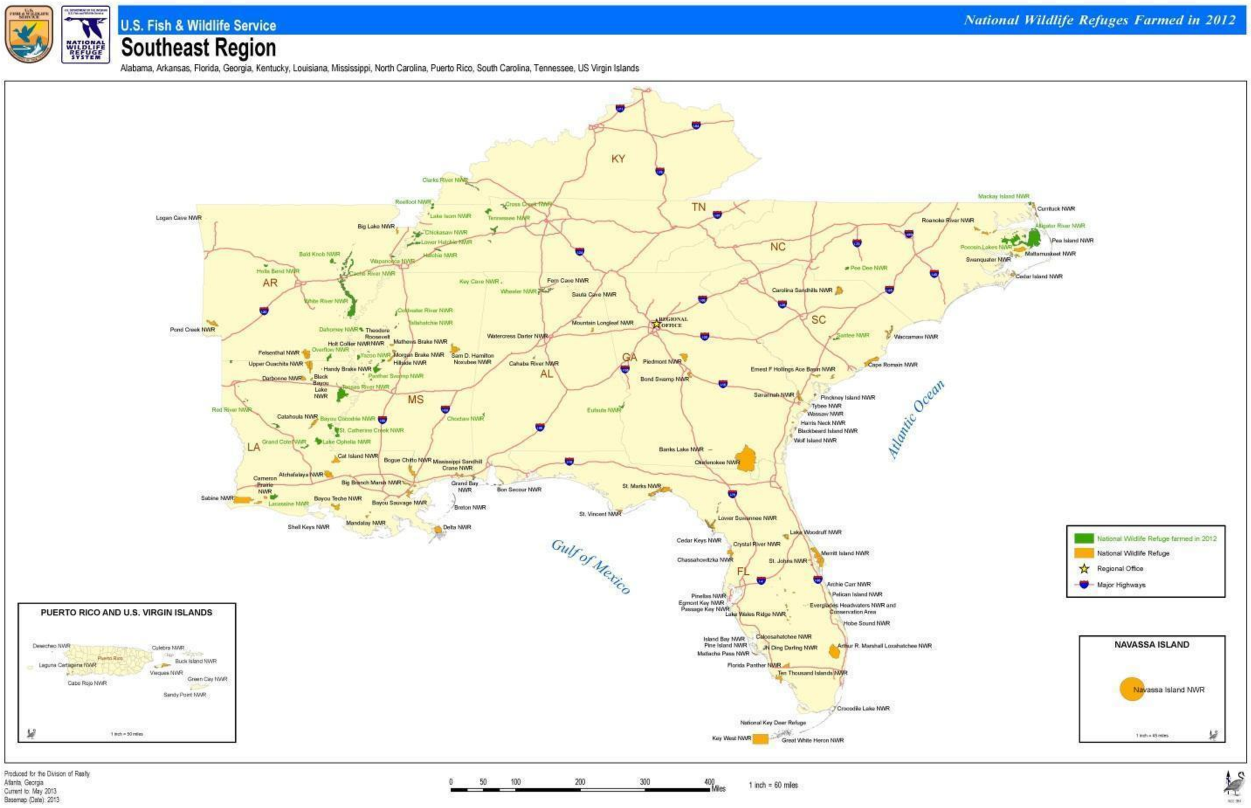
IV. Pertinent Species and Habitat:

SPECIES/CRITICAL HABITAT	STATUS1
Louisiana black bear (*Ursus americana*)	E
Red wolf (*Canus rufus*)	E
Mississippi sandhill crane *(Grus canadensis pulld)*	E
Interior Least Tern (*Sterna antillarum*)	E
Piping Plover (*Charadrius melodus*)	E
Red-cockaded woodpecker *(Picoides borealis)*	E
Yellow-shouldered blackbird *(Agelaius xanthomus)*	E
Whooping Crane *(Grus americana)*	E
Kirtland's Warbler *(Dendroica kirtlandii)*	E
Ivory-billed Woodpecker (*Campephilus principalis*)	E
Pallid sturgeon (*Scaphirhynchus albus*)	E
Indiana bat (*Myotis sodalist*)	E
Northern Long-eared Bat (*Myotis septentrionalis*)	T
Gray myotis (*Myotis grisescens*)	E
West Indian manatee (*Trichechus manatus*)	E
American burying beetle (*Nicrophorus americanus*)	E
Anthony's riversnail (*Athearnia anthonyi*)	E
American alligator (*Alligator mississippiensis*)	T (S/A)
Gopher tortoise (*Gopherus polyphemus*)	T
Undescribed cave shrimp sp.	__
Alabama cavefish (*Speoplatyrhinus poulsoni*)	E
Armored snail (*Pyrgulopis pachyta*)	E
White warty-back pearlymussel (*Plethobasus cicatricosus*)	E
Spectaclecase (*Cumberlandia monodonta*)	E
Slabside pearlymussel (*Pleuronaia dolabelloides*)	T, CH
Slender campeloma (*Campeloma decampi*)	E

Sheepnose (*Plethobasus cyphyus*)	E
Rough pigtoe (*Pleurobema plenum*)	E
Pink Mucket Mussel (*Lamsilis abrupt*)	E
Fat Pocketbook Mussel (*Potamilus capax*)	E
Rabbitsfoot Mussel (*Quadrula cylindrica*)	T, CH
Pondberry (*Lindera melissifolia*)	E
Wood stork (*Mycteria americana*)	E
Schaus Swallowtail butterfly	E
Spring pygmy sunfish (*Elassoma alabamae*)	T, PCH
Snuffbox mussel (*Epioblasma triquetra*)	E

1STATUS: E=endangered, T=threatened, PE=proposed endangered, PT=proposed threatened, CH=critical habitat, PCH=proposed critical habitat, C=candidate species, S/A=Similar Appearance

V. Location: The majority of agricultural use occurs in eastern North Carolina, the Tennessee Valley, and the Mississippi Alluvial Valley of the southeastern United States, USFWS.



Species/Habitat Occurrence

Species	Occurrence
Louisiana black bear (*Ursus americana*)	Is known to occur in Louisiana and Mississippi on Atchafalaya National Wildlife Refuge, Bayou Cocodrie National Wildlife Refuge, Caddo Lake National Wildlife Refuge, Cat Island National Wildlife Refuge, Central Louisiana Refuges Complex Coldwater River National Wildlife Refuge, Grand Cote National Wildlife Refuge, Panther Swamp National Wildlife Refuge, St. Catherine Creek National Wildlife Refuge, Tensas River National Wildlife Refuge, and Theodore Roosevelt National Wildlife Refuge Complex. May occasionally occur on other NWRs in the southeast.
Red wolf (*Canus rufus*)	Is known to occur in Florida, South Carolina and North Carolina on Alligator River National Wildlife Refuge, Cape Romain National Wildlife Refuge, Mattamuskeet National Wildlife Refuge, Pocosin Lakes National Wildlife Refuge, St. Vincent

	National Wildlife Refuge, and Swanquarter National Wildlife Refuge. May occur on other NWRs in the southeast.
Mississippi sandhill crane *(Grus canadensis pulld)*	Is known to occur in Mississippi on Mississippi Sandhill Crane NWR.
Interior Least Tern (*Sterna antillarum*)	Is known to occur in Mississippi, Tennessee, Arkansas, Kentucky, and Louisiana on Bald Knob National Wildlife Refuge, Chickasaw National Wildlife Refuge, Cross Creeks National Wildlife Refuge, Cypress Creek National Wildlife Refuge, Lake Isom National Wildlife Refuge, Lower Hatchie National Wildlife Refuge, Overflow National Wildlife Refuge, St. Catherine Creek National Wildlife Refuge, and Yazoo National Wildlife Refuge. May occasionally occur on other NWRs in the southeast.
Piping Plover (*Charadrius melodus*)	Is known to occur in Mississippi, Arkansas, and Tennessee and on many NWRs within the southeast.
Red-cockaded woodpecker *(Picoides borealis)*	Is known to occur in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina and South Carolina on Ace Basin National Wildlife Refuge, Alligator River National Wildlife Refuge, Big Branch Marsh National Wildlife Refuge, Carolina Sandhills National Wildlife Refuge, D'arbonne National Wildlife Refuge Felsenthal National Wildlife Refuge, Florida Panther National Wildlife Refuge, Mississippi Sandhill Crane National Wildlife Refuge, Noxubee National Wildlife Refuge, Okefenokee National Wildlife Refuge, Pee Dee National Wildlife Refuge, Piedmont National Wildlife Refuge, Pocosin Lakes National Wildlife Refuge, Santee National Wildlife Refuge, St. Marks National Wildlife Refuge, and Upper Ouachita National Wildlife Refuge. May occasionally occur on other NWRs in the southeast.
Whooping Crane *(Grus americana)*	Experimental, non-essential population segment may occur in Kentucky, Tennessee, Arkansas, Mississippi, Louisiana, South Carolina, North Carolina, Florida, and Alabama.

Kirtland's Warbler *(Dendroica kirtlandii)*	May occur on NWRs in Florida and South Carolina.
Ivory-billed Woodpecker (*Campephilus principalis*)	May occur on Cache River and White River NWRs in Arkansas.
Pallid sturgeon (*Scaphirhynchus albus*)	Known to occur in Arkansas, Mississippi, Kentucky, Tennessee, and Louisiana on Atchafalaya National Wildlife Refuge and other NWRs in the Southeast Region.
Indiana bat (*Myotis sodalist*)	Known to occur in Alabama, Arkansas, Florida, Mississippi, North Carolina, Kentucky, Tennessee, and on Clarks River National Wildlife Refuge, Cross Creeks National Wildlife Refuge, Logan Cave National Wildlife Refuge, and other NWRs in the Southeast.
Gray myotis (*Myotis grisescens*)	Known to occur in Alabama, Arkansas, Florida, Georgia, Mississippi, North Carolina, Kentucky, Tennessee, and on Cross Creeks National Wildlife Refuge, Logan Cave National Wildlife Refuge, and other NWRs in the Southeast.
West Indian manatee (*Trichechus manatus*)	May occur on or near NWRs in North Carolina, South Carolina, Alabama, Florida, Georgia, Louisiana, and Mississippi on Alligator River NWR, Archie Carr NWR, and Loxahatchee NWR and other NWRs in the Southeast.
American burying beetle (*Nicrophorus americanus*)	Known or may occur in NWRs in Arkansas and Kentucky.
Anthony's riversnail (*Athearnia anthonyi*)	Known to occur in Alabama and Tennessee and may occur on or near NWRs in the Southeast.
American alligator (*Alligator mississippiensis*)	Known to occur on NWRs in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North and South Carolinas
Gopher tortoise (*Gopherus polyphemus*)	Known to occur in Alabama, Mississippi, Louisiana on Bogue Chitto NWR, MS Sandhill Crane NWR, and other NWRs in the Southeast.
Undescribed cave shrimp sp.	Alabama
Alabama cavefish (*Speoplatyrhinus poulsoni*)	Known to occur on Key Cave NWR in Alabama
Armored snail (*Pyrgulopis pachyta*)	Believed to occur in Alabama.

White warty-back pearlymussel (*Plethobasus cicatricosus*)	Known or believed to occur in Alabama, Kentucky and Tennessee and may occur on or near NWRs in the Southeast.
Spectaclecase (*Cumberlandia monodonta*)	Known or believed to occur in Alabama, Arkansas, Kentucky, Tennessee and may occur on or near NWRs in the Southeast.
Slabside pearlymussel (*Pleuronaia dolabelloides*)	Known or believed to occur in Alabama, Kentucky, Tennessee and may occur on or near NWRs in the Southeast.
Slender campeloma (*Campeloma decampi*)	Known or believed to occur in Alabama, and may occur on or near NWRs in the Southeast.
Sheepnose (*Plethobasus cyphyus*)	Known or believed to occur in Alabama, Mississippi, Tennessee and may occur on or near NWRs in the Southeast.
Rough pigtoe (*Pleurobema plenum*)	Known or believed to occur in Alabama, Kentucky, Tennessee and may occur on or near NWRs in the Southeast.
Pink Mucket Mussel (*Lamsilis abrupt*)	Known or believed to occur in Alabama, Arkansas, Kentucky, Tennessee and may occur on or near NWRs in the Southeast.
Fat Pocketbook Mussel (*Potamilus capax*)	Known or believed to occur in Arkansas, Kentucky, Louisiana, Mississippi and may occur on or near NWRs in the Southeast.
Rabbitsfoot Mussel (*Quadrula cylindrica*)	Known or believed to occur in Alabama, Arkansas, Kentucky, Louisiana, Mississippi, and Tennessee and may occur on or near NWRs in the Southeast.
Pondberry (*Lindera melissifolia*)	Known to occur on some NWRs in Arkansas, Alabama, Georgia, Mississippi, North Carolina and South Carolina.
Wood stork (*Mycteria americana*)	Known or believed to occur on some NWRs in Alabama, Georgia, Florida, Mississippi, North Carolina and South Carolina.
Schaus Swallowtail butterfly	Known to occur only in peninsular Florida.
Spring pygmy sunfish (*Elassoma alabamae*)	Known to occur in Alabama
Snuffbox mussel (*Epioblasma triquetra*)	Known to or is believed to occur: Alabama , Arkansas, Kentucky, Mississippi, Tennessee

Northern long-eared bat (*Myotis septentrionalis*)	Known or believed to occur: Alabama, Arkansas, Georgia, Kentucky , Louisiana, Mississippi, North Carolina, South Carolina and Tennessee

VI. Determination of Effects:

Specifically relevant to this analysis, APHIS completed environmental assessments of the use of GEC crops (USDA-APHIS 2013, USDA-APHIS 2007, USDA-APHIS 2006) and concluded:

> There are no significant differences between the chemical compositions of GEC. Contact with, or ingestion of, GEC are very unlikely to have any effect on any plant or animal.
>
> Feeding experiments with chickens failed to detect any differences between GEC and non-GEC regarding mortality rates, weight gain, and reproductive rates (USDA-APHIS 2013, USDA-APHIS 2007).
>
> There are no known species of plants in the United States that are reproductively compatible with crops in this analysis, so there is no likelihood that there can be an unintended transfer of genes to a threatened or endangered species.
>
> GEC are very unlikely to escape into natural habitats because they can only persist with intensive human management, so there is no chance they will invade native habitats occupied by threatened or endangered species.
>
> Use of GEC will not significantly alter cultivation practices.

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
Louisiana black bear (*Ursus americana*)	This species occasionally feeds in or travels through crop fields and filter strips (buffers of vegetation along canals) on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs include regular consultation with the local Ecological Services office as well as, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Red wolf (*Canus rufus*)	This species feeds in crop fields and filter strips (buffers of vegetation along canals) on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Mississippi Sandhill crane *(Grus canadensis pulld)*	This species occasionally feeds in or travels through crop fields on NWR lands. This species is limited to the Mississippi Sandhill Crane NWR. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including regular consultation with the local Ecological Services office, no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Interior Least Tern (*Sterna antillarum*)	This species occasionally utilizes mudflat habitat near crop fields on NWR lands. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Piping Plover (*Charadrius melodus*)	This species occasionally feeds in or utilizes crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.

Red-cockaded woodpecker *(Picoides borealis)*	This species occasionally flies over crop fields on NWR lands. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Whooping Crane *(Grus americana)*	This species feeds in or utilizes crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Kirtland's Warbler *(Dendroica kirtlandii)*	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Ivory-billed Woodpecker (*Campephilus principalis*)	If this species flew over or occupied habitat adjacent to crop fields on NWR lands, it would not likely be impacted by the proposed action.
Pallid sturgeon (*Scaphirhynchus albus*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Indiana bat (*Myotis sodalist*)	This species occasionally flies over crop fields on NWR lands. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). Pesticide applications will occur in low winds to prevent drift into forested areas. Only treat insects that are creating a direct impact on crops or facilities. No treatment from dusk to sunrise. This species would not likely be impacted by the proposed action.
Northern Long-eared Bat (*Myotis septentrionalis*)	This species occasionally flies over crop fields on NWR lands. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). Pesticide applications will occur in low winds to prevent drift into forested areas. Only treat insects

	that are creating a direct impact on crops or facilities. No treatment from dusk to sunrise. This species would not likely be impacted by the proposed action.
Gray myotis (*Myotis grisescens*)	This species occasionally flies over crop fields on NWR lands. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). Pesticide applications will occur in low winds to prevent drift into forested areas. Only treat insects that are creating a direct impact on crops or facilities. No treatment from dusk to sunrise. This species would not likely be impacted by the proposed action.
West Indian manatee (*Trichechus manatus*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
American burying beetle (*Nicrophorus americanus*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Anthony's riversnail (*Athearnia anthonyi*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
American alligator (*Alligator mississippiensis*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.

Gopher tortoise (*Gopherus polyphemus*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Undescribed cave shrimp sp.	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Alabama cavefish (*Speoplatyrhinus poulsoni*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Armored snail (*Pyrgulopis pachyta*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
White warty-back pearlymussel (*Plethobasus cicatricosus*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Spectaclecase (*Cumberlandia monodonta*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.

Slabside pearlymussel (*Pleuronaia dolabelloides*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Slender campeloma (*Campeloma decampi*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Sheepnose (*Plethobasus cyphyus*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Rough pigtoe (*Pleurobema plenum*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Pink Mucket Mussel (*Lamsilis abrupt*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Fat Pocketbook Mussel (*Potamilus capax*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.

Rabbitsfoot Mussel (*Quadrula cylindrica*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Pondberry (*Lindera melissifolia*)	This species occupies habitat that may be adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Wood stork (*Mycteria americana*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Schaus Swallowtail butterfly (*Papilio aristodemus*)	This species only occurs within a limited range of south Florida and will not be impacted by the proposed action
Spring pygmy sunfish (*Elassoma alabamae*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.
Snuffbox mussel (*Epioblasma triquetra*)	This species occasionally occupies habitat adjacent to crop fields on NWR lands. There is no evidence that ingestion of GEC versus non-GEC seeds is different or harmful. BMPs including no-tillage, crop rotations, pesticide spraying rotations, and establishing pesticide no spray buffer distances to surface water are utilized in all farming practices (above and beyond EPA required buffer distances). This species would not likely be impacted by the proposed action.

VII. Explanation of actions to be implemented to reduce adverse effects:

SPECIES/ CRITICAL HABITAT	ACTIONS TO MITIGATE/MINIMIZE IMPACTS
Louisiana black bear (*Ursus americana*)	Following Best Management Practices described above will minimize any impacts.
Red wolf (*Canus rufus*)	Following Best Management Practices described above will minimize any impacts.
Mississippi sandhill crane *(Grus canadensis pulld)*	Following Best Management Practices described above will minimize any impacts.
Interior Least Tern (*Sterna antillarum*)	Following Best Management Practices described above will minimize any impacts.
Piping Plover (*Charadrius melodus*)	Following Best Management Practices described above will minimize any impacts.
Red-cockaded woodpecker *(Picoides borealis)*	Following Best Management Practices described above will minimize any impacts.
Whooping Crane *(Grus americana)*	Following Best Management Practices described above will minimize any impacts.
Kirtland's Warbler *(Dendroica kirtlandii)*	Following Best Management Practices described above will minimize any impacts.
Ivory-billed Woodpecker (*Campephilus principalis*)	Following Best Management Practices described above will minimize any impacts.
Whooping crane (*Grus americana*)	Following Best Management Practices described above will minimize any impacts.
Pallid sturgeon (*Scaphirhynchus albus*)	Following Best Management Practices described above will minimize any impacts.
Indiana bat (*Myotis sodalist*)	Following Best Management Practices described above will minimize any impacts.
Gray myotis (*Myotis grisescens*)	Following Best Management Practices described above will minimize any impacts.
West Indian manatee (*Trichechus manatus*)	Following Best Management Practices described above will minimize any impacts.

American burying beetle (*Nicrophorus americanus*)	Following Best Management Practices described above will minimize any impacts.
Anthony's riversnail (*Athearnia anthonyi*)	Following Best Management Practices described above will minimize any impacts.
American alligator (*Alligator mississippiensis*)	Following Best Management Practices described above will minimize any impacts.
Gopher tortoise (*Gopherus polyphemus*)	Following Best Management Practices described above will minimize any impacts.
Undescribed cave shrimp sp.	Following Best Management Practices described above will minimize any impacts.
Alabama cavefish (*Speoplatyrhinus poulsoni*)	Following Best Management Practices described above will minimize any impacts.
Armored snail (*Pyrgulopis pachyta*)	Following Best Management Practices described above will minimize any impacts.
White warty-back pearlymussel (*Plethobasus cicatricosus*)	Following Best Management Practices described above will minimize any impacts.
Spectaclecase (*Cumberlandia monodonta*)	Following Best Management Practices described above will minimize any impacts.
Slabside pearlymussel (*Pleuronaia dolabelloides*)	Following Best Management Practices described above will minimize any impacts.
Slender campeloma (*Campeloma decampi*)	Following Best Management Practices described above will minimize any impacts.
Sheepnose (*Plethobasus cyphyus*)	Following Best Management Practices described above will minimize any impacts.
Rough pigtoe (*Pleurobema plenum*)	Following Best Management Practices described above will minimize any impacts.
Pink Mucket Mussel (*Lamsilis abrupt*)	Following Best Management Practices described above will minimize any impacts.
Fat Pocketbook Mussel (*Potamilus capax*)	Following Best Management Practices described above will minimize any impacts.
Rabbitsfoot Mussel (*Quadrula cylindrica*)	Following Best Management Practices described above will minimize any impacts.

Pondberry (*Lindera melissifolia*)	Following Best Management Practices described above will minimize any impacts.
Wood stork (*Mycteria americana*)	Following Best Management Practices described above will minimize any impacts.
Schaus Swallowtail butterfly (*Papilio aristodemus*)	Following Best Management Practices described above will minimize any impacts.
Spring pygmy sunfish (*Elassoma alabamae*)	Following Best Management Practices described above will minimize any impacts.
Snuffbox mussel (*Epioblasma triquetra*)	Following Best Management Practices described above will minimize any impacts.
Northern long-eared bat (*Myotis septentrionalis*)	Following Best Management Practices described above will minimize any impacts.

VIII. Effect Determination and Response Requested:

SPECIES/CRITICAL HABITAT	DETERMINATION1			REQUESTED
	NE	NA	AA	
Louisiana black bear		X		Concurrence
Red wolf		X		Concurrence
Mississippi sandhill crane		X		Concurrence
Interior Least Tern		X		Concurrence
Piping Plover		X		Concurrence
Red-cockaded woodpecker		X		Concurrence
Yellow-shouldered blackbird		X		Concurrence
Whooping Crane		X		Concurrence
Kirtland’s Warbler		X		Concurrence
Ivory-billed Woodpecker		X		Concurrence
Whooping crane		X		Concurrence
Pallid sturgeon		X		Concurrence
Indiana bat		X		Concurrence

Gray myotis		X		Concurrence
West Indian manatee		X		Concurrence
American burying beetle		X		Concurrence
Anthony’s riversnail		X		Concurrence
American alligator		X		Concurrence
Gopher tortoise		X		Concurrence
Undescribed cave shrimp sp.		X		Concurrence
Alabama cavefish		X		Concurrence
Armored snail		X		Concurrence
White warty-back pearlymussel		X		Concurrence
Spectaclecase		X		Concurrence
Slabside pearlymussel		X		Concurrence
Slender campeloma		X		Concurrence
Sheepnose		X		Concurrence
Rough pigtoe		X		Concurrence
Pink Mucket Mussel		X		Concurrence
Fat Pocketbook Mussel		X		Concurrence
Rabbitsfoot Mussel		X		Concurrence
Pondberry		X		Concurrence
Wood stork		X		Concurrence
Schaus Swallowtail butterfly	X			Concurrence
Spring pygmy sunfish		X		Concurrence
Snuffbox mussel		X		Concurrence
Northern long-eared bat		X		Concurrence

DETERMINATION/ RESPONSE REQUESTED:

NE = no effect. This determination is appropriate when the proposed action will not directly, indirectly, or cumulatively impact, either positively or negatively, any listed, proposed, candidate species or designated/proposed critical habitat. Response Requested is optional but a "Concurrence" is recommended for a complete Administrative Record.

NA = not likely to adversely affect. This determination is appropriate when the proposed action is not likely to adversely impact any listed, proposed, candidate species or designated/proposed critical habitat or there may be beneficial effects to these resources. Response Requested is a" Concurrence".

AA = likely to adversely affect. This determination is appropriate when the proposed action is likely to adversely impact any listed, proposed, candidate species or designated/proposed critical habitat. Response Requested for listed species is "Formal Consultation". Response requested for proposed and candidate species is "Conference".

______________________________ ______________________________

Signature (originating station) Date

VIV. Reviewing Ecological Services Office Evaluation:

A. Concurrence ______ Nonconcurrence _______

B. Formal consultation required _______

C. Conference required _______

D. Informal conference required ________

E. Remarks (attach additional pages as needed):

______________________________ ______________________________
Signature Date

______________________________ ______________________________
Title Office