

**U.S. FISH AND WILDLIFE SERVICE 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

Fish and Wildlife Service
Southeastern United States
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TABLE OF CONTENTS

Chapter I. Introduction, Purpose and Need, and History of Agricultural Practices in the Southeastern United States	1
Introduction.....	1
Purpose and Need for Action.....	2
Decision Framework.....	3
Authority, Legal Compliance, Compatibility, and Policy	4
Agricultural Practices Used for Natural Resource Management.....	6
Administrative Models to Facilitate Agricultural Practices.....	6
Crop Varieties.....	6
Use of GECs and non-GECs on NWRs.....	7
Crop Rotation.....	7
Tillage Practices	7
Invasive Plant and Pest Treatment	8
Public Comment	9
Issues treated by other agencies and scientific organizations.....	10
Chapter II: Affected Environment	12
Regional Setting	12
Physical Resources	12
Geology and Topography.....	12
Climate Change	15
Soil resources.....	16
Water Resources	16
Air Quality	17
Biological Resources	17
Habitat Resources	17
Land Cover	17
Habitat Resource Use by Waterfowl.....	20
Wildlife Resources.....	23
Waterfowl Conservation in the Southeast.....	23
Other Birds.....	25
Other Wildlife	25
Threatened and Endangered Species.....	27
Invasive Species.....	28

Socioeconomic Profile of Agriculture in the Southeastern United States.....	29
Economic Significance of Agriculture	29
Economic Significance of Wildlife-dependent Recreation	30
Cultural Resources	30
Chapter III. Description of Alternatives	33
Alternatives Analyzed	33
Description of Alternatives.....	34
Elements Common to each Alternative.....	35
Alternatives Considered But Eliminated From Further Analysis in this pea	36
Chapter IV. Environmental Consequences.....	41
Direct Effects and Indirect Effects.....	41
Scope of the Analysis	41
Effects Common to Both Alternative	41
Environmental Justice and Human Health	41
Endangered and Threatened Species.....	42
Pesticide Use	42
Cultural Resources	45
Summary of Effects by Alternative	45
Physical Resources.....	45
Biological Resources	50
Habitat.....	50
Wildlife.....	53
Socioeconomic Resource Effects	63
Cumulative Impacts	67
Cumulative Impacts: Physical Resources.....	68
Cumulative Impacts: Biological Resources	68
Cumulative Impacts: Socioeconomic Resources	69
Short-term GEC Uses versus Long-term Productivity.....	69
Mitigation Measures	69
Summary of Analysis.....	70
Appendix A. References and Literature Citations	74
Appendix B. List of National Wildlife Refuges in the Southeastern United States that have Recently Used Agricultural Practices for Natural Resource Management	94
Appendix C. Regional Genetically Modified Crop (GEC) Guidance	95
Appendix D. Public Involvement.....	103

Scoping	103
Issues Raised During Public Scoping.....	103
Public Review and Comment.....	104
Coordination	105
Comment Period	105
Appendix E. Intra-Service Section 7 Biological Evaluation	107
Appendix F. Response to Substantive Public Comments.....	127
Appendix G. Finding of No Significant Impact	162
Introduction.....	162
Alternatives.....	162
Selection Rationale.....	163
Environmental Effects.....	163
Mitigation Measures.....	165
Coordination	166
Findings.....	167
Supporting References.....	167
Document Availability	168
Decision	168

List of Figures

Figure 1. US Fish and Wildlife Service, Southeastern United States.4
Figure 2. North American Waterfowl Migration Flyways 14
Figure 3: Land Cover in the Southeast..... 19
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).....29
Figure 5. Location of Organic Farms in the Southeastern United States.39
Figure 6. Number of Agricultural pesticides (active ingredients) applied on West Tennessee, Wheeler, Tennessee and North Carolina Coastal Plains Complexes from 2009-2019.44
Figure 7. Pounds of Agricultural pesticides (active ingredients) applied on West Tennessee, Wheeler, Tennessee and North Carolina Coastal Plains Complexes from 2009-2019*44

List of Tables

Table 1. Summary of environmental effects by alternative, National Wildlife Refuges in the Southeastern United States, USFWS.....71

Programmatic Environmental Assessment

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

INTRODUCTION

National wildlife refuges (NWRs or refuges) of the U.S. Fish and Wildlife Service (Service) in the southeastern United States (U.S.) have historically 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, to control invasive species, and maintain 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 within major migratory waterfowl flyways (Appendix B) in the Lower Mississippi Alluvial Valley, eastern North Carolina, and the Tennessee River Valley. This analysis focuses on the ten states that comprised the majority of the National Wildlife Refuge System in the southeast once referred to as the U.S. Fish and Wildlife Service Region 4 and now referred to as Interior Regions 2 and 4. The states included within Interior Region 2 and the southern half of Region 4 (Region) and focused on herein are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina and Tennessee.

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 and other wildlife (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 availability and quality for wildlife in the southeast. In the current, human-modified landscape, remaining habitat must be actively managed to sustain desired wildlife population levels based on numeric objectives in science-based, partner-drive plans. 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 land uses. 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 grasslands, managing moist-soil wetlands, and invasive species control.

PURPOSE AND NEED FOR ACTION

The Service, a bureau of the U.S. Department of the Interior, is 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, including Farm Service Agency/Farmers Home Administrations transfers that are part of the NWRS but not designated as part of any specific refuge. 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 Comprehensive Conservation Plan (CCP) 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 (GEC) on NWRs in the southeast in order to meet wildlife management objectives and achieve the specific goals of a NWR's CCP, Habitat Management Plan (HMP), and other national and international conservation initiatives, including the North American Waterfowl Management Plan (NAWMP; USDO I EC ENRM 2012). In addition, the purpose of this PEA is 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 Policy), the Department of the Interior's Pesticide Use Policy (517 DM 1), and the Service's Integrated Pest Management Policy (569 FW 1), and other applicable policies (e.g., 620 FW 2 Cooperative Agriculture Use).

The need for the Service to evaluate the use of GECs in agricultural practices on NWRs in the southeast is to:

- Ensure that NWRs can consistently meet goals and objectives while adhering to applicable laws and policies;
- Reduce the number and amount of pesticides used in agriculture practices;
- Minimize the agricultural footprint required to meet goals and objectives;
- Minimize economic risks of implementing agricultural practices; and,

- Minimize physical, biological, socioeconomic, and cultural impacts while achieving goals and objectives.

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.

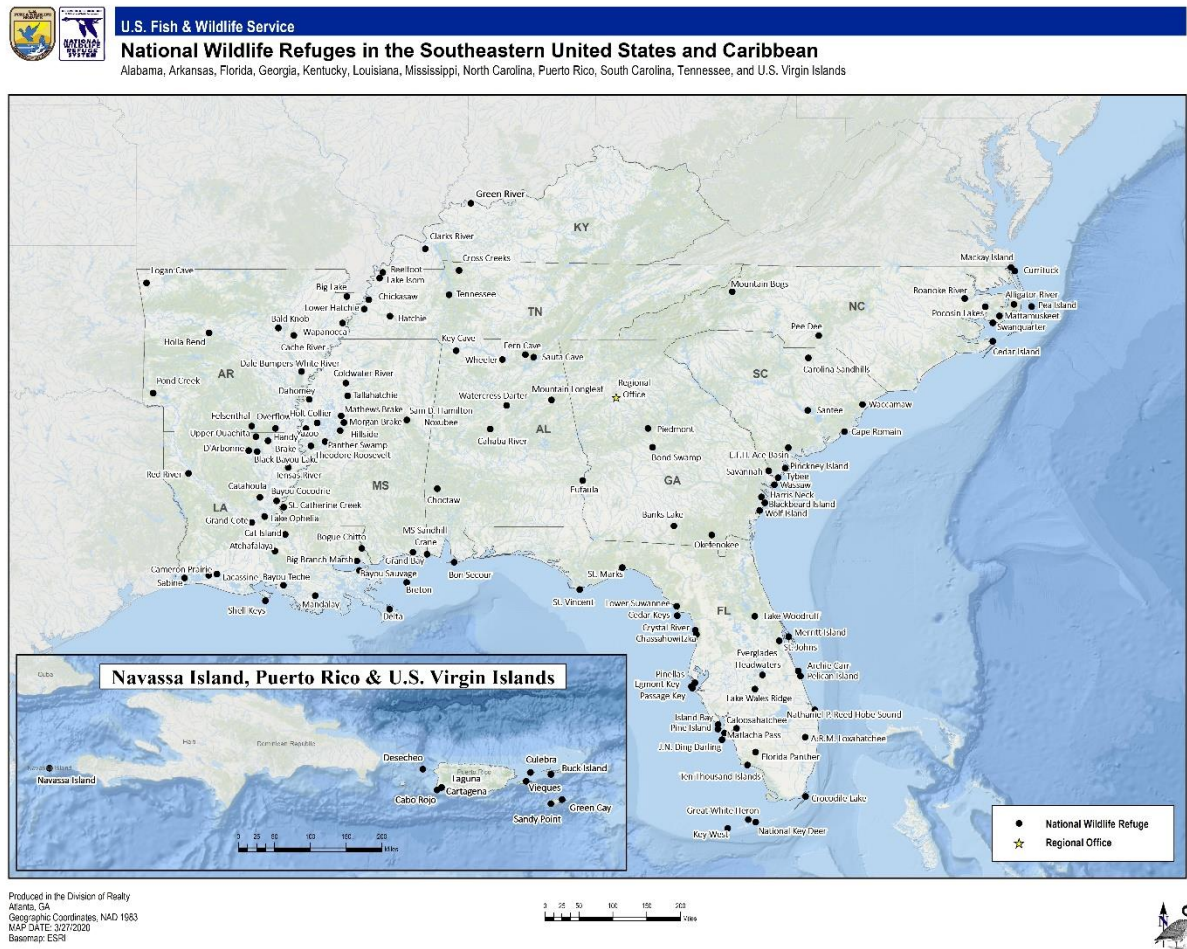
DECISION FRAMEWORK

Based on this PEA, the Regional Director for the Interior Regions 2 and 4 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 Environmental Impact Statement in accordance with the National Environmental Policy Act (NEPA), [42 U.S.C. § 4321 et seq.](#)

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. US 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;
- 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 on the NWR.

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 Policy and Budget website](#)

Some of the management policies governing uses on refuges are the Service's Biological Integrity, Diversity, and Environmental Health Policy (USFWS 2006a) (BIDEH Policy) and Integrated Pest Management Policy (USFWS 2010a) (IPM Policy) as well as the Region's current Genetically Engineered Crop Use Guidance (Regional GEC Guidance, Appendix C, USFWS 2006a, 2010b). The BIDEH Policy 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. The BIDEH Policy also provides refuge managers with an evaluation process to analyze their refuges 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 is the requirement that strategies under the IPM 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 to the BIDEH Policy provides 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 Region's Chief of NWRS developed the current Regional GEC Guidance (Appendix C, USFWS 2010b) authorizing the use of GECs when essential to accomplishing NWR goals and objectives and implemented in accordance with other Regional and National Policies. The Region's GEC Guidance 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. Best management practices (BMPs) are also utilized to minimize effects (Appendix C).

We also consider information and direction from other Federal agencies 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) in this PEA. 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 [U. S. D. A. APHIS Regulatory Process](#). APHIS's NEPA documents analyzing the environmental impacts of specific GECs can be found on [U. S. D. A. APHIS Petitions for Determining Regulatory Status web page](#).

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 where a private farmer and a NWR enter into a cooperative agriculture 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 similar to the model 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 the NWR. Due to budget constraints, reductions in staff and efficiency, and effectiveness of cooperative farmers due to their experience, most refuges implement their agricultural practices through cooperative partnerships with private farmers who, due to their experience, effectively engage in agricultural practices.

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 Region developed and implemented a process for approving the use of Genetically Modified Crops on NWRs 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 and vegetative material of wheat (green browse) that 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 non-GE seed. Due to the increased use of GECs on private lands, NWRs began using GECs, in accordance with the Region's Genetically Engineered Crop Use Guidance (Appendix C), to meet their objectives. Although non-GEC crop varieties have been genetically modified using selective breeding and other techniques, for the purposes of this PEA, a genetically engineered crop refers to crops with specific manipulation of an organism's genes by introducing, eliminating or rearranging specific genes using the methods of modern molecular biology, particularly those techniques referred to as recombinant DNA techniques (USDA 2020a). 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 the [EPA Overview of Plant Incorporated Protectants web page](#).

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, Hoelt et al. 2000, Cartwright et al. 2006, McLeod and Studebaker 2006, Leikam and Megel 2007, USDA ERS 2010, USFWS 2010a, 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 used to provide green forage for migrating geese. With respect to use of GECs prior to 2013, the current 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 (Hoelt 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 is the most commonly used soil management practice 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 used 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 BMPs that assist the NWR with use of the pesticide to reduce potential impacts to non-target 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).

PUBLIC COMMENT

The Service engaged the public early in the development of this PEA through the scoping process. Information and issues expressed during the scoping process are included in Appendix D.

The draft PEA is posted on the project website at <https://sites.google.com/site/fwsregion4gmcpeis/home> and on the Region's website at <http://www.fws.gov/southeast/>. Paper copies of the document mailed to be mailed to the public upon request via the web site, phone or mail.

The Service initially released the draft PEA to the public on March 18, 2020 for a 20 day review and comment period. Two requests to extend the comment period were made to the Service resulting in a 10-day extension for a 30-day comment period. The Service accepted comments on the draft PEA through April 19, 2020.

A news release regarding the comment period was sent via mail to individuals who had notified the Service that they wished to receive a copy of the draft PEA. In addition, media releases were sent to over 300 media outlets in the 10 states comprising the Region (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee).

The Service held two virtual public information sessions to provide information regarding the draft PEA, development of the document and accessing and commenting on the document. Approximately 60 individuals attended the sessions. A recording of each session including a summary of questions and answers was posted on the project web site.

A copy of the draft document was sent to each of the states in the Region with a request for input and comment. In addition, each tribe located in the Region states with an interest in the matter was provided a copy of the draft document and asked to provide input and comment. A list of tribes is in Appendix D.

The Service received 12,157 comment submissions, including 205 individual substantive comments on the draft PEA. A summary of the substantive comments and the Service's responses are provided in Appendix F.

ISSUES TREATED BY OTHER AGENCIES AND SCIENTIFIC ORGANIZATIONS

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

In the environmental assessments of these GEC varieties, 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; and,
- impacts on soil microorganisms.

These matters are addressed as appropriate in this PEA however, USDA's detailed source documents for crop varieties can be found at the

[U. S. D. A. APHIS Petitions for Determination of Nonregulated Status web page.](#)

More recently, the National Academies of Sciences, Engineering, and Medicine's Board of Agriculture and Natural Resources' Committee on Genetically Engineered Crops (NASEM Committee) published a report that addresses many of the same issues that APHIS and other agencies previously investigated (NASEM 2016). NASEM (2016) found that the available evidence at the time of publishing 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. Similarly, Mackelprang and Lemaux (2020) recently published a comprehensive review of genetic engineering in agricultural crops summarizing effects on yield, pesticide use, non-target effects, and other factors. In both comprehensive reviews, substantial evidence was presented that GECs provide economic and environmental benefits relative to non-GECs. More relevant to this assessment, NASEM (2016) found no conclusive overall evidence of cause-and-effect relationships between environmental and human health issues and the use of genetically engineered crops (additional discussion provided in Chapter IV Environmental Consequences). Of particular relevance to this PEA was a specific and detailed assessment provided by the NASEM 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 IV Environmental Consequences).

Chapter II: Affected Environment

REGIONAL SETTING

The National Wildlife Refuge System (NWRS) southeast includes 131 NWRs in 10 states, the Commonwealth of Puerto Rico, and the U.S. Virgin Islands. The region 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. (Figure 1). The combined area of NWRs in the southeast totals almost 4 million acres 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 of the NWRs (Appendix B) that could be analyzed under this PEA are in the refuge's respective Comprehensive Conservation Plan that can be found at the [National Wildlife Refuge System Planning web page](#), which 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 serves 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 are primarily responsible for the area's limestone landforms occur along the coasts. 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 and once was submerged during past episodes of higher sea levels, now exhibits features such as swamps, bogs, Carolina Bays and escarpments that are a hint to historic times. The interior areas in Florida, referred to as "Florida Uplands," are low in relief, less than 300 feet in elevation, and characterized by pine and shrubby vegetation interspersed with lakes resulting from the dissolution of limestone substrate.

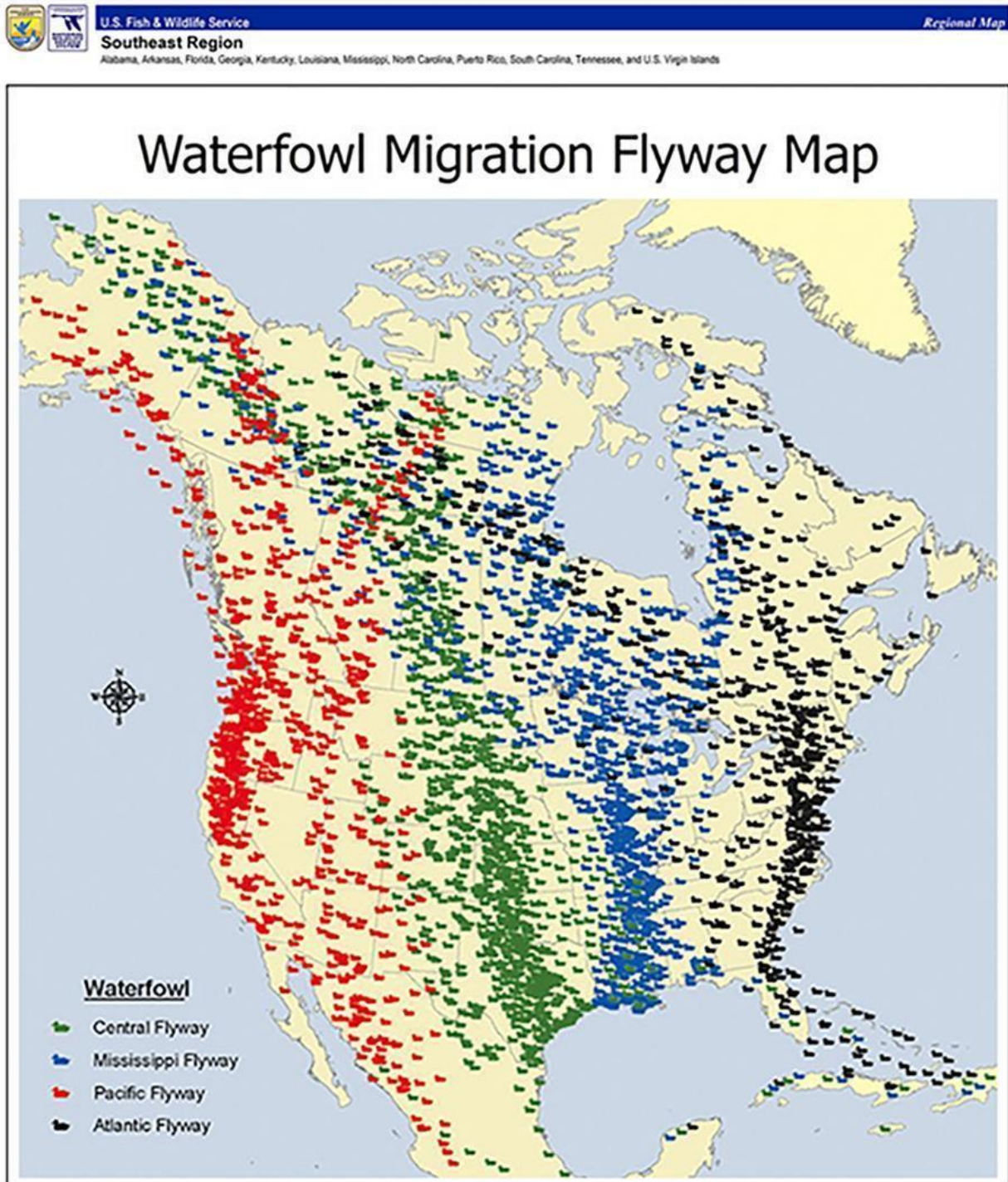
Further inland and with increasing elevation is the Piedmont, which was a large forested region prior to European settlement. Now, the Piedmont is characterized by low rolling hills with pine

and hardwood forests that extend 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 the 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 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*



[Flickr](#)

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 of such gases 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% in emissions from fuel combustion globally (Oliver et al. 2005). Less than 2% of this total 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). In an analysis of coastal North Carolina, Titus and Richmond (2001) 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 of climate change on agriculture is speculative, however, and varies. 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 is primarily 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 U.S., 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 have 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 km² and includes the Tennessee, Cumberland, Green, Wabash, and several other major rivers in the southeast. The Lower Mississippi region encompasses 880,000 km² 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 km² 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 km², range in size from 11,000 to 111,000 km², 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) that can be analyzed under this PEA are available in the Comprehensive Conservation Plan for each refuge that are incorporated by reference herein ([National Wildlife Refuge System Planning web page](#), USFWS 2017).

HABITAT RESOURCES

LAND COVER

Land cover on refuges in the southeast generally can be classified as open water; deciduous, evergreen and mixed forest; shrub/scrub; grassland/herbaceous; woody and herbaceous wetlands; and, cultivated cropland ([National Land Cover Database](#); 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. Inland NWRs are comprised 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 otherwise would be lost due to altered hydrology, fire suppression, invasive species, and other threats without active management.

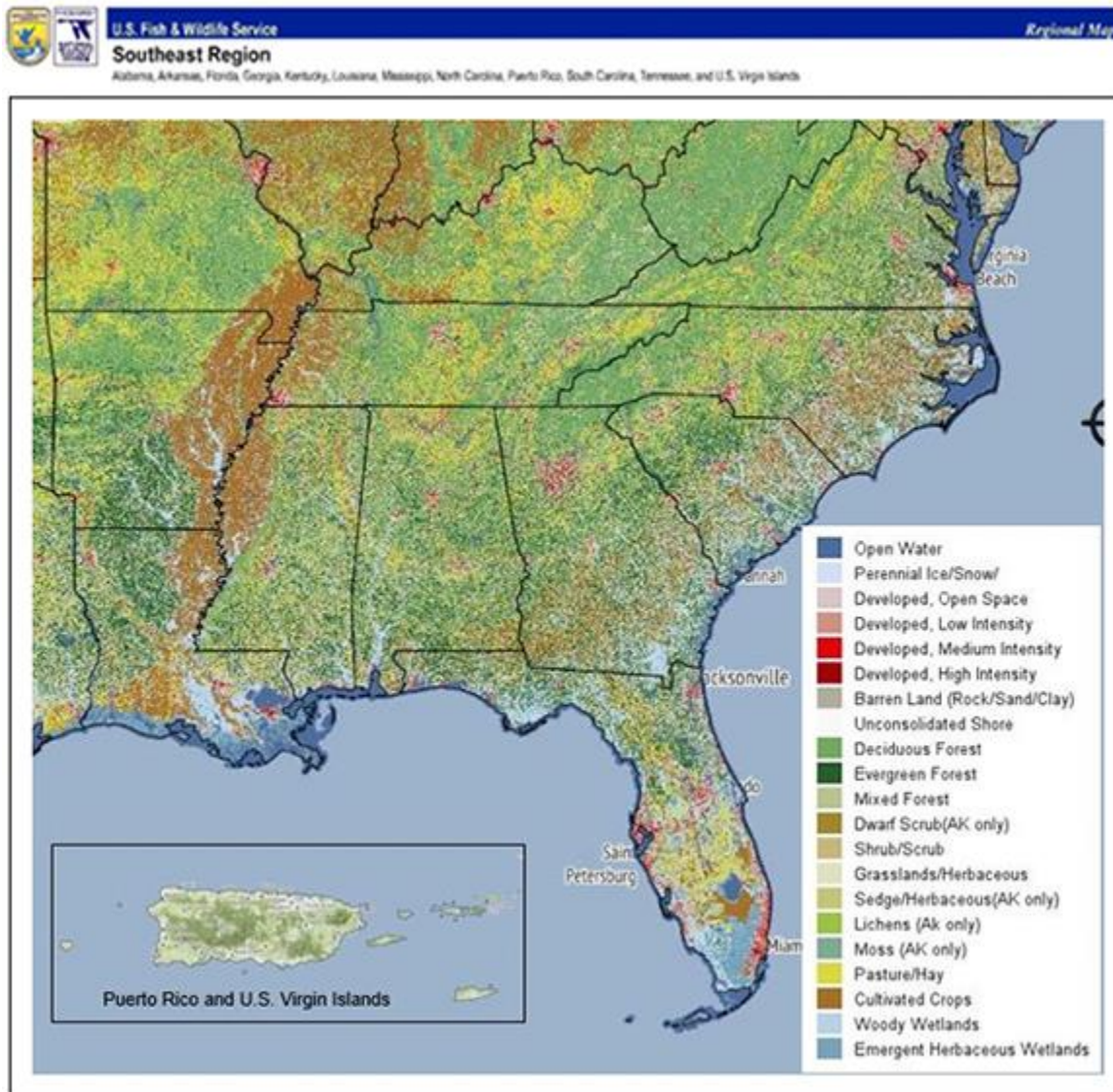
Wetlands are an important natural community covering 21% of the southeast and almost 50 million acres (Hefner et al. 1994). Nearly half of the freshwater wetlands and three-quarters of the estuarine wetlands in the continental United States were once located in the southeast (Hefner et al. 1994). Hefner et al. (1994) reported that wetland loss in the U.S. 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, Couvillan 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 (DED; i.e., one DED is equivalent to the energy requirements of 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 approximately 28% of the current energy objectives for geography in the Lower Mississippi Alluvial Valley Joint Venture.¹

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.

¹ Notwithstanding, the 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 [National Land Cover Database](#)

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 supplementarily feed in uplands, such as tundra swan, Canada geese, and snow geese.

Freshwater marsh is extensively used by many species of ducks and geese is 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 and 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 natural wetland types on NWRs combined with limited wetland availability surrounding many NWRs necessitates 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) rather than single or structurally simple wetlands were preferred by wintering ducks 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 one third of proportional use. Osborn et al. (2017) presented mean densities of dabbling ducks among important natural communities for the species 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, agriculture use 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 NWR's 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 a 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 were derived from larger-scale efforts coordinated by the Joint Ventures including the LMVJV in the southeast (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 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 Region'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 in 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 collectively host more than 1 million waterfowl in most winters (H. Hagy, personal communication). Additionally, more than 40% of the American black duck (*Anas rubripes*) population in the Mississippi Flyway historically winters 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 and hunting), which is assumed to provide economic and public support for conservation of continental waterfowl populations (USDOI EC ENRM 2012). The southeastern U. S. 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 provide 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

Management on NWRs 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 plovers and sandpipers including lesser yellowlegs (*Tringa flavipes*), greater yellowlegs (*Tringa melanoleuca*) and dowitchers (*Limnodromus* spp.), as well as Wilson's snipe (*Gallinago delicata*), 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, Wilcoxon et al. 2018). On the other hand, 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 that now typically reports a wintering population of >25,000 cranes that 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 the 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 [Anthracoridae], 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, such as the corn earworm (*Helicoverpa zea*), corn rootworm (*Diabrotica spp.*), and European corn borer (*Ostrina nubilalis*) (Willson & Easley, 2001, Hellmich and Hellmich 2012), that are detrimental to corn crops by 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 in the area. 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 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. The Threatened and Endangered Species Database identifies the species that occur on specific NWRs (USFWS 2019). Before issuance of our NEPA determination, we will comply with provisions of the ESA to ensure that the action under this PEA is not likely to jeopardize the continued existence of any “endangered” or “threatened” species in the future or modify or destroy a species’ critical habitat. We also will ensure that our action is consistent with conservation programs for those species. The Intra-Service Section 7 ESA consultation on this action is located 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 sodalists*), gray bat (*Myotis grisescens*), and subterranean species, such as the Alabama cavefish (*Orconectes alabamensis*).

Mississippi sandhill cranes 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 now supports 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 in 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 Service programs in the Region 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 Region 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 to preclude the need to list species under the ESA. More detailed information on endangered and threatened species can be found at the [U. S. Fish and Wildlife Service's Endangered Species web page](#) 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 Invasives Species Council](#)) 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 affect agricultural crops include alligatorweed (*Alternanthera philoxeroides*), *Phragmites* spp., and several woody species (e.g., *Triadica sebifera*, *Ligustrum sinense*). Similarly, several native species, such as redbone (*Brunnichia ovata*), coffeeweed (*Sesbania herbacea*), cocklebur (*Xanthium strumarium*), and creeping water primrose (*Ludwigia peploides*), also can become invasive and affect agricultural crops. Both types of invasive species can be controlled, however, with agricultural practices.

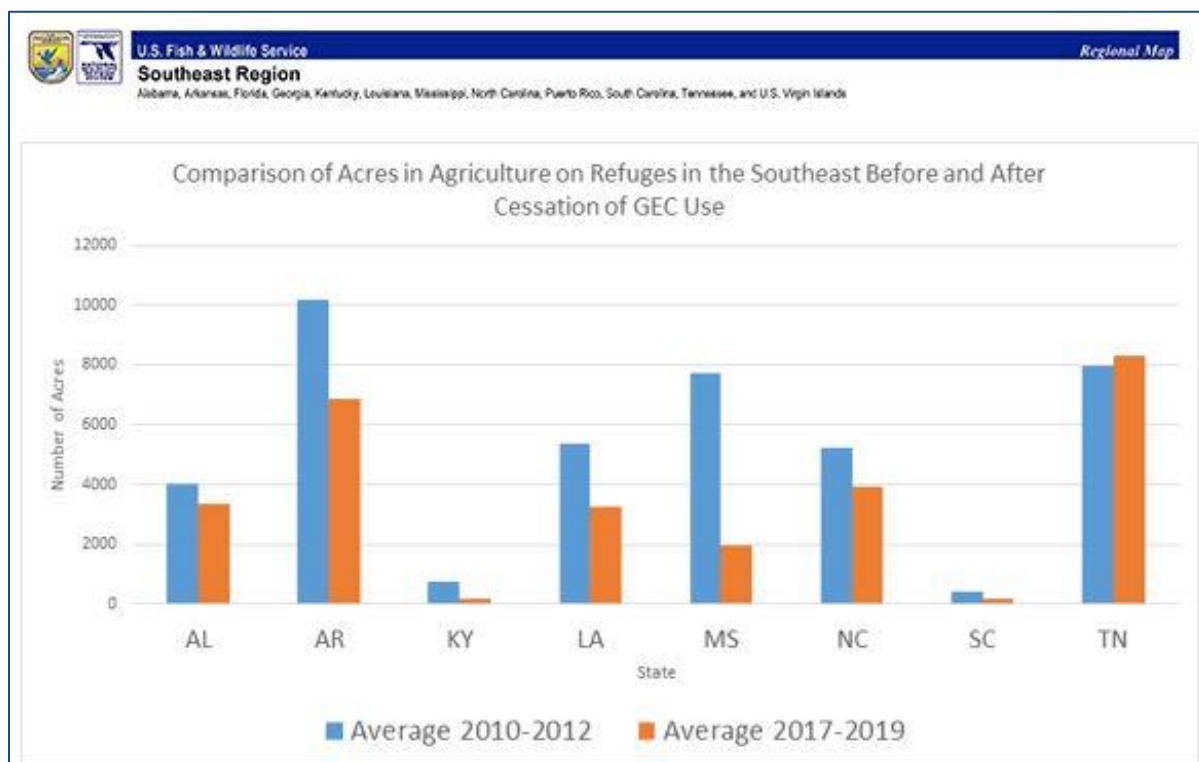
Invasive species alter wildlife habitat and pose challenges to managing NWRs. While difficult to determine, estimates of the costs of damage from invasive species in the United States have been as high as \$120 billion per year (Pimental et al. 2005). Pesticides, mechanical treatments, fire, physical removal, water management, and agricultural practices are among the measures used by the Service to battle these species. In traditional agriculture with non-GEC seeds on non-NWR lands, 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 due to its persistence in the environment, 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 in 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 2019, 92,603 acres of NWRs lands were used for agriculture (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 and photographing wildlife 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 U.S. with approximately 2.6 million people directly employed on farms 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 U. S.'s gross domestic product constituting a 5.5% share (USDA/ERS 2018a). The commodity market values of corn and soybeans in the U. S. in 2012 were \$67 billion and \$38 billion, respectively.

ECONOMIC SIGNIFICANCE OF WILDLIFE-DEPENDENT RECREATION

The National Wildlife Refuge System Improvement Act of 1997 identifies hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation as priority wildlife-dependent recreation activities that occur on NWRs 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 usage by wildlife. In Fiscal Year 2017, 15.2 million people visited NWRs in the southeast generating \$938.7 million in economic activity and supporting 12,016 private sector jobs (Caudill and Carver 2019).

Wildlife dependent recreation is a significant economic sector in the U. S. Over 103 million people participated in hunting, fishing and wildlife watching generating over \$156 billion in 2016 (USDOJ/FWS and USDOC/Census Bureau 2016). Hunting participants alone numbered over 11 million people for a combined total of 184 million days spending \$26.2 billion in the process (USDOJ/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 occurring on NWRs added \$3.2 billion to local economies, supported more than 41,000 jobs, and produced \$1.1 billion in job income for local communities in Fiscal Year 2017 (Caudill and Carver 2019).

In 2017, NWRs in the southeast hosted over 213,000 participants in environmental education programs (USFWS RAPP 2017). Although it is difficult to assign a monetary value to these programs, there is long lasting value to 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 the refuge's CCPs and incorporated by reference herein ([National Wildlife Refuge System Planning web page](#), 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 Region, 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 an action 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 to farm lands is defined as the "modern plow zone," which is the depth at which a modern plow disturbs the soil during field preparation. The zone 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. The east coast of North Carolina has been subject to plow zone disturbance since the early colonial period and the Mississippi Valley since the early 1800s.

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 (e.g., waterfowl objectives stepped down from NAWMP) to its 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, USDO I 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;), and the Region's current 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;
- The comments submitted during the Region's internal and external scoping processes on preparation of this PEA; and,
- The best available science on the use and non-use of GECs as part of agricultural practices on NWRs in the southeast as a wildlife management tool.

ALTERNATIVES ANALYZED

This PEA analyzes the following alternatives for southeast NWRs' use of GECs in agricultural practices as a natural resource management tool:

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

Alternative 2: Allow the use of GECs on NWRs. (Preferred 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 for natural resource management in agricultural practices to cultivate supplemental foods for wildlife, manage invasive species, and provide opportunities for public recreation, 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 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 NWR and farmers' respective shares (percentages) of crops. Refuges would continue to implement Best Management Practices, when possible, especially with respect to maintaining conservation buffers.

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

Under this alternative, NWRs in the southeast would use only GECs for natural resource management in agricultural practices to cultivate supplemental foods for wildlife, manage invasive species, and provide opportunities for public recreation, such as wildlife observation. Only APHIS evaluated and deregulated or exempted 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 refuge and the farmer's respective shares of the crops. Refuges would continue to implement Best Management Practices, such as crop rotation, conservation tillage, limited soil preparation, direct drill planting, nutrient management including conservation buffers, cover crops, and integrated pest management (Anderson et al. 2019), and other techniques.

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

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

- 4) Analysis of whether such GEC use would meet 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 accomplish the specific purpose(s) for which the NWR was established and its approved objectives for habitat and wildlife; and, as appropriate, to fulfill the overall mission of the NWRS;
- 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 [National Wildlife Refuge System Planning web page](#).

Adherence to the Department of Interior Departmental Manual, Integrated Pest Management Policy (517 DM 1) and the 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 that 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 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 the exclusive use of Organic Farming from analysis for the following reasons (NC State Extension 2014, Bomford et. al 2015, and McBride et. al 2016):

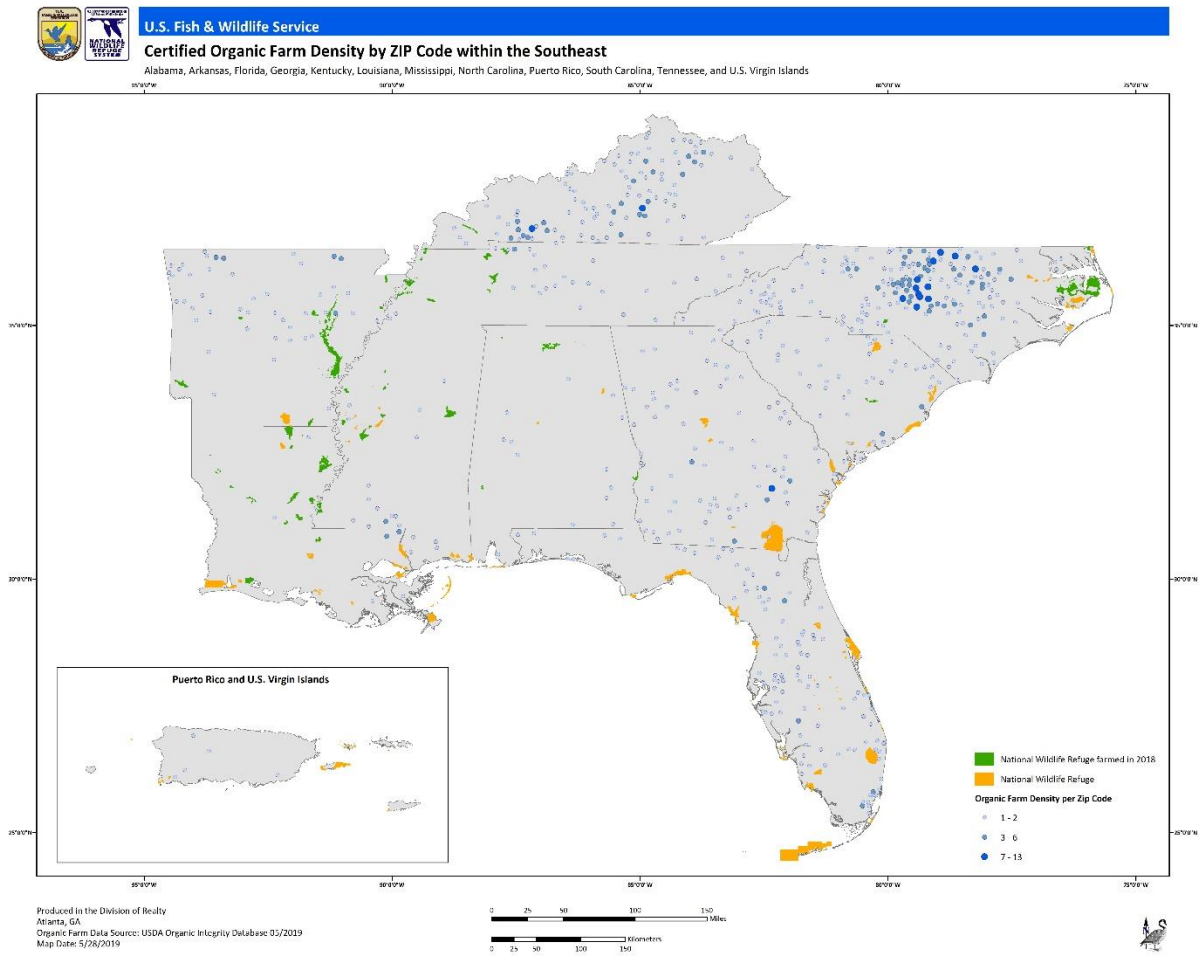
- Established guidance (NC State Extension 2014) on implementation of organic farming recommends avoiding planting fields that could severely limit crop growth and health such as low wet fields that are prone to flooding. These fields result in poor plant health and provide a low tolerance to pests. These fields are also poor choices for rotation of crops such as wheat and alfalfa. Most refuge agriculture fields are low-lying areas prone to flooding, thus making them a poor site for this method of farming and limiting crop rotation options compared to most private lands.

- Organic farm operations rely on annual disking and other intensive tillage practices to control soil insects and for weed control in lieu of herbicides. These practices would increase soil erosion along low-lying refuge fields and fields with slopes greater than two percent (e.g., highly erodible soil).
- Organic farming is more attractive where crop pests are fewer such as in the northern U.S. Corn borer and fall army worms are major pest species affecting corn production in the southeast, especially where planting dates are delayed as is typical on NWRs. Organic farmers are limited in treatment options and rely upon crop rotations and spacing of corn fields, early planting, and site selection away from pest populations, which are not always available options on NWRs.
- Weed control is challenging especially in poorly drained soils and along river bottoms. Johnson grass (*Sorghum halepense*) is an exotic invasive weed that creates major problems in the southeastern U. S, especially for organic farmers. Failure to control Johnson grass will quickly ruin an organic farm operation. Primary control measures in organic farming operations involve cover crops and use of cultural control measures, which are not always effective or available on NWRs due to the aforementioned temporal and spatial limitations, multi-species management efforts, and other restrictions. Cultural control methods include properly selecting and rotating crops, sanitizing and solarizing the soil, choosing the best planting and harvest times, using resistant varieties and certified plants, taking advantage of allelopathy, and intercropping
- Several studies have indicated yields are comparable between GECs and organic crops, especially as organic farmers gain more experience (Delate et. al. 2003, Delate et al. 2013). However, other studies from the University of Kentucky Agriculture Extension Service (Bomford et. al 2015) and USDA (McBride et. al 2016) indicate that these studies are overly optimistic in most field settings with high pest issues, later planting dates due to flood issues, and potential to reduce cross contamination from neighboring GEC fields.
- USDA (2015) showed “organic and non-organic crop yields reported in much of the published experimental research have been similar, but average organic yields in the Agriculture Resource Management Survey data for each crop were significantly lower than those of non-organic production.” The average yield for organic corn was 118 bushels per acre in 2010, compared to 161 bushels for non-organic corn. Organic wheat producers had an average yield of 30 bushels per acre in 2009, compared to 44 bushels for non-organic production. Average yields for organic soybean producers in 2006 were also significantly lower, 31 versus 47 bushels per acre for non-organic production. The preceding amount to an average yield penalty for organic production on commercial farms of 27 percent for corn, 32 percent for wheat, and 34 percent for soybeans. Given restrictions and challenges on most NWRs, we suspect that the yield disparity would be even greater between organic farming and GEC use on refuges and greatly reduce economic viability of cooperative farming partnerships and, in turn, reduce feasibility of using agriculture as a wildlife management practices on NWRs.
- Organic farming requires increased labor and materials costs with reduced crop yield (USDA 1980). The Region lacks sufficient resources to utilize organic farming on the scale required to attain the wildlife goals and objectives established by the refuges’ CCPs and associated HMPs that use agriculture for natural resource management.
- An inadequate number of organic farmers operate in reasonable proximity to NWRs to make exclusive organic farming a reasonably feasible alternative. A review of USDA 2019 data for the southeast 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).

- Organic farming regulations make it unsuitable to use as the sole model for implementing agricultural practices 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 and other wildlife that annually inhabit their lands and, thusly, fail to further the mission of the NWRs. Additionally, buffers (at least 50 ft.) are required from non-GEC crops or pesticide use which could reduce plantable areas and create conflict with adjacent landowners. Soil tillage would likely increase under an organic farming model due to pest problems and the inability to use pesticides. Organic seeds, whose availabilities are limited, must be used in this method of farming. Choosing seed varieties that maximize benefits given local soil conditions is very important for limiting pesticide use and sustaining consistent yields on NWRs (USDA 2020b).
- There are challenges to handling organic crops without commingling them with non-organic crops during harvest and commercial distribution when such is required to maintain the crop's organic designation. Using organic crops also would impact the feasibility of maintaining cooperative farming partnerships.

The above issues would not preclude the Service utilizing organic farming on refuges for natural resource management when available and appropriate under either alternative considered further.

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 NWR in the southeast, 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 BOTH ALTERNATIVE

Some of the effects will be the same for each alternative. We have analyzed the resource areas of environmental justice and human health, endangered and threatened species, pesticide use, 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 in making its decision regarding 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). The NASEM also reported that farm-worker health in the United States does not show any significant increases in cancer or other health problems due to the use of glyphosate. Evidence to date does not contradict the expectation that the use of Bt insertions would 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 Service's Refuge section and Ecological Services division engaged in Section 7 consultation on the proposed action with Ecological Services concluding that the proposed action is not likely to adversely affect any threatened or endangered species or to adversely modify the designated critical habitat of a species and issuing an Intra-Service Section 7 Biological Evaluation (Appendix E).

As part of the environmental review process, APHIS reviews all GEC product information and data. 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 did not identify any stressor that could affect the reproduction, numbers, distribution, or critical habitat of a species (USDA APHIS 2006, 2007, 2013a,b, 2014a,b, 2016).

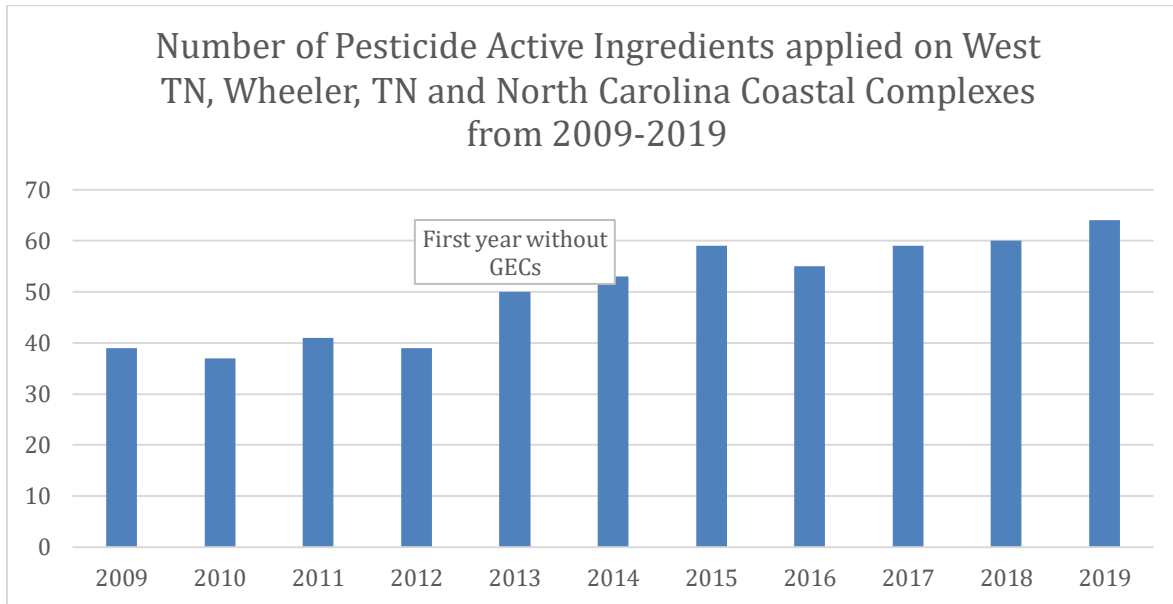
PESTICIDE USE

Considerable precautions and BMPs are utilized in all aspects of NWRs' agricultural practices, including but not limited to pesticide use. Although pesticide use is beyond the scope of this Final PEA, the Service uses considerable caution when pesticides are used in conjunction with agricultural crops (both GEC and non-GEC). The Service only uses EPA registered pesticides that have been 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 to comply with NEPA. In addition to being EPA-registered, each pesticide that is used on a NWR must first be approved under the Service's Pesticide Use Proposal (PUP) process (569 FW 1) where each pesticide is analyzed for toxicological effects in relation to human/environmental aspects associated with the NWR. The Regional IPM Coordinator (and the National IPM Coordinator for restricted use pesticides) evaluates each chemical through the PUP process and approves or disapproves its use. The review process provides BMPs that advise the NWR on using the

pesticide to reduce potential impacts to non-target species. The Service typically administers a pesticide in a more restrictive manner than required by the label, particularly as it pertains to buffers. Moreover, the Service engages in Section 7 consultation under the ESA on each pesticide to evaluate whether threatened and/or endangered species near and/or adjacent to the treatment areas would be adversely affected. 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).

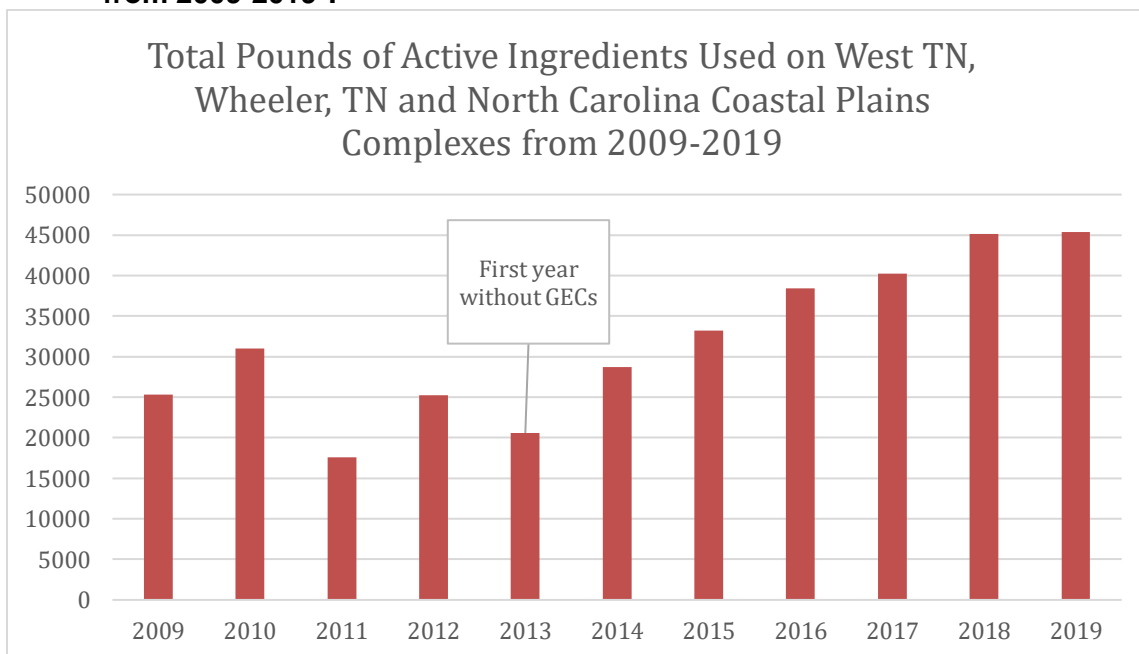
The number of active ingredients and pounds of pesticides per acre applied to agricultural crops increased on select NWRs after 2012 when GEC use was prohibited within the southeast U.S and increased use needed to control pest issues associated with non-GE crops. The amount of pesticides applied on NWRs in the southeast has steadily increased since 2013. The total number of pesticides (active ingredients) and associated pounds of active ingredients on Wheeler, West Tennessee, Tennessee, and North Carolina Coastal NWR Complexes have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (43,413 lbs.) in 2019 (Figure 6 and 7). The number and associated pounds of restricted use pesticides increased from one (7.5 lbs.) in 2012 (GEC use) to seven (1,339 lbs.) in 2019 (non-GEC use). The U. S. D. A. has tracked the amount of pesticide use on 21 crop types since the 1960s. A summary of this research, which was published in 2014, showed peaks in recorded pesticides prior to the wide use of GECs across the country (Fernandez-Cornejo et al. 2014b).

Figure 6. Number of Agricultural pesticides (active ingredients) applied on West Tennessee, Wheeler, Tennessee and North Carolina Coastal Plains Complexes from 2009-2019.*



* USFWS Pesticide Use Proposal Database 2019

Figure 7. Pounds of Agricultural pesticides (active ingredients) applied on West Tennessee, Wheeler, Tennessee and North Carolina Coastal Plains Complexes from 2009-2019*.



* USFWS Pesticide Use Proposal Database 2019

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 the refuge's CCP and incorporated by reference herein ([National Wildlife Refuge System Planning web page](#), USFWS 2017). Cultural resource review and compliance process are initiated by contacting the Service's Regional Historic Preservation Officer/Regional Archaeologist (RHPO/RA), who determines whether an action 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 on refuge lands will have a significant effect on cultural resources, particularly on buried archeological sites. Agricultural activities have historically occurred on refuges in the Region. Any 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 alternative.

Climate Change

Both the use and non-use of GECs indirectly affect emissions through: (1) the production of CO₂ from equipment use; and, (2) the production of nitrous oxide (N₂O) 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 CO₂ sequestered in upper soil layers.

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

The use of non-GECs increases the need to apply 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 also have necessitated increases in the number of trips over fields and increases in releases of N₂O and PM into the atmosphere. GECs, on the other hand, promote conservation tillage, use of fewer pesticides, and decreases fossil fuel emissions and soil disturbances that can increase the release of sequestered CO₂ 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)

GEC use has been shown to increase the application of conservation tillage (USDA 2013) and reduce the need, 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 and, therefore, reduce carbon emissions (Cerdeira and Duck 2006, Scheffe 2008, Carpenter 2011, Brookes and Barfoot 2013). 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 including the 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 application), crop rotations, and cover crops, have the potential to impact soil quality by affecting soil fertility, increasing erosion, and causing off-site transport of sediments into aquatic ecosystems. 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 pests

and weeds (Figures 6 and 7). This increase in pesticide applications has necessitated more frequent trips over fields on heavy machinery, which has exacerbated 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 becomes 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 maintain active crop rotations on all of the 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 substantial direct negative effects on microorganisms; however, use of non-GECs may increase implementation 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). Conventional tillage and partial tillage would increase soil disturbance and decrease the amount of crop residue, both of which could increase soil erosion and 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. The new organic matter would be beneficial to omnivores in the soil, such as bacteria and nematodes, that 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, Romeis et al. 2019). 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 GECs 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.

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 efficiency (Schaible and Aillery 2012).

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

Using non-GECs on refuges has resulted in the increased application of conventional tillage 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 only of non-GECs on refuges has also caused an increase in the amount, types, and applications of pesticides of less environmentally benign chemicals that could directly impact water resources. Pesticides typically used with non-GECs generally have more potential to move off site, leach into groundwater, and take much longer to break down to inert substances (Cerdeira and Duke 2006, Ferry and Gatehouse 2008, Brookes and Barfoot 2010, COBFLES 2010).

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 (Anderson et al. 2019).

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 application 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 tolerant 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 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 lesser volumes of pesticides were applied on Service farmland prior to 2013, when GECs were used (Figures 6 and 7).

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 NWRs, 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 number 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). Increased tillage 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 prohibition of GEC use on refuges in 2013, the amount and types of pesticide use were much lower than those utilized in a non-GEC system (Figures 6 and 7). 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 used for 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 on refuges will likely result in a continuing decline in cropland acres and an increase in natural habitat resources with lower food densities. Due to the difference in energy between agricultural and natural habitat resources, this alternative could substantially reduce energy supply for waterfowl and other wildlife. Although they should never completely replace natural foods, grain crops are essential if some NWRs within the southeast 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 impacts 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).

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 this 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*), which are a threat for non-GEC seed varieties, can be readily controlled using GECs.

Effects on Adjacent Private Lands

Impacts to adjacent private lands are analyzed including the potential for refuges to become pest reservoirs and increased crop depredation by wildlife due to reduced production 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 private lands and 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 non-GEC, non-organic farming operations potentially include insect resistance and suppression of regional insect pest populations (halo effect; Tabashnik 2010, Dively et al. 2018).

Given the widespread use of GE corn and soybeans immediately adjacent to most refuges, the likelihood of 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 use 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.

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 ([International Herbicide-Resistant Weed Database](#)). 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 for many consecutive years 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 ([University of Tennessee Institute of Agriculture web page](#)) 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, 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 could result in a decrease in waterfowl use of refuges and nearby areas. The lack of food also could affect the physical condition of waterfowl, especially during winter, reducing recruitment during the subsequent breeding season. Lastly, given refuges' support of waterfowl harvest opportunities on and beyond their boundaries, reductions in waterfowl use of refuges 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 used (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 use of non-GECs 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 some refuges' ability to maintain cooperative farming partnerships and to meet refuge objectives.

More specifically, using non-GEC varieties rather than GECs requires a substantially greater amount of refuge staff time for pest scouting, pesticide applications, between-row tillage, alternative pest-control practices, pesticide use tracking, and cooperative farmer oversight. Refuges saw a substantial increase in staff time following the switch from GEC to non-GEC varieties in 2012. The prohibition of 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 engaging and maintaining farmers' participation in refuge cooperative farming partnerships.

Use of non-GECs 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 not only decreases yields but increases the occurrence of fungal diseases, which produce mycotoxins, that cause health problems in waterfowl (Pellegrino et al. 2018).

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

As presented in Alternative 1, refuges in the 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 NWRs in the southeast to satisfy their NAWMP stepped-down objectives of more than 400 million energy days (Reinecke and Kaminski 2006). GEC use with managed natural habitat resources (e.g., bottomland forest and moist-soil) provide the best option for NWRs in the southeast to meet their waterfowl habitat objectives.

The adoption of GEC and Bt crops increased yields by mitigating yield losses from competition from weeds and insects (Fernandez-Cornejo et. al. 2014a). However, this empirical evidence regarding the effect of herbicide tolerant crops on yields is mixed. Generally, stacked seeds (seeds with more than one GE trait) tend to have higher yields than conventional seeds or seeds with only one GE trait depending on the weed pressure and environmental conditions. By protecting the plant from certain pests, GE crops can prevent yield losses and allow the plant to approach its yield potential. Most experimental field tests and farm surveys show that Bt crops produce higher yields than non-GEC (Fernandez-Cornejo et. al. 2014a). The study showed Bt adopters are more likely to obtain higher yields than non-adopters by controlling insects and thus reducing yield losses to pests. The yield gain of Bt crops has become larger in recent years as new Bt traits have been incorporated into seeds and multiple (stacked) traits have become available. The study also showed mixed impacts of herbicide tolerant seeds on soybean and corn yields with several researchers finding no difference in GEC and non-GEC yields. The study did show, however, that stacked seeds with two herbicide tolerant traits and three types of insect resistant had an average yield of 171 bushels/acre compared to conventional seeds with an average yield of 134 bushels/acre (Fernandez-Cornejo et. al. 2014a).

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 6 and 7). 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, GEC 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 the 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-GECs and GECs.

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. 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 include 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 results 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 the 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 refuge shares to mitigate the reduced economic viability of non-GEC farming could require refuges to increase the amount of farmland needed to meet waterfowl and other wildlife objectives.

As with waterfowl, cranes take advantage of corn because it is 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 during 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 be increasingly

difficult for Wheeler NWR to sustain agriculture economically through cooperative farming partnerships, which would substantially reduce habitat resources for cranes.

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

There are no data to indicate 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 that 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 Kremetz 1998). As noted in Alternative 1, the increased economic viability of cooperative farming partnerships with GEC use could benefit whooping cranes, sandhill cranes, and many other wintering birds.

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-GECs or their residue (Aumaitre et al. 2002, Flachowsky et al. 2007). Conventional tillage, which is most associated with non-GEC use, will decrease residual cover and potential habitat and cover for small mammals and the insects upon which they prey. The use of non-GECs rather than GECs poses more overall risk to wildlife on NWRs in the southeast due to the increase in the variety, amount, and toxicity of the pesticides (Klumper and Qaim 2014; Figures 6 and 7). 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 use agricultural practices to provide habitat and forage for large mammal species, such as black bear and deer, and to reduce crop depredation on private property. The reduction in agricultural practices on refuges could cause mammals to relocate to private properties increasing 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), NWR staff 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 GECs 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 non-GEC 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 and more benign pesticides to manage GE crop systems (Figures 6 and 7) 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

This section analyzes potential impacts to amphibian and reptile species occurring on refuges from tillage, agricultural chemicals, habitat availability, and habitat makeup.

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 and 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, we have observed and quantified an increase in the usage of restricted use pesticides (USFWS Pesticide Use Proposal Database 2018; Figures 6 and 7). The number and associated pounds of restricted use pesticides increased from one (7.5 lbs) in 2012 (GEC use) to seven (1,339 lbs) in 2019 (non-GEC use). 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 was the only option available, refuges used more benign and lesser amounts of chemicals with fewer impacts to reptiles and amphibians (Figures 6 and 7). Conservation tillage increases residual cover and 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

This section analyzes potential impacts to insect species on NWRs using agricultural practices, including use of chemicals associated with such practices 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 broad-spectrum insecticides where non-*Bt* inserted crops are planted.

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

NASEM (2016) found no conclusive link between GECs and any environmental issue that has been identified but recognized that some of the issues are complex, especially those that have involved long-term changes 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 based on information available up through the 2016 report publication date and include more detailed assessments on specific non-target insect species with purported declining trends. Use of GECs should overall reduce the likelihood of negative effects on insects with the exception of targeted pest species that *Bt* crops are specifically used to control. The toxins produced by *Bt* crops 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* 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). 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") (AABSTC 2001). Event 176 was shown to have harmful effects on monarchs and on black swallowtail butterflies (*Papilio polyxenes*; Zangerl et al. 2001), and the NASEM reported on the same events and results. Corn varieties derived from insertion of Event 176 have been withdrawn from the market (NASEM 2016), however, 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 also been the subject of some controversy 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 declined dramatically as a result of the introduction of insect-resistant (e.g., *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 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 (Romeis and Meissle 2020).

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 milkweed which supports monarch caterpillars. The NASEM Committee concluded that studies and analyses at the time of their 2016 publication did not demonstrate that the reduction of milkweed by glyphosate caused monarch decline. The Committee went further, however, 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 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 any as yet known problems with glyphosate use.

Resistance to at least certain toxins used in GECs in the U.S. has evolved in at least three species of insect pests *Helicoverpa 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 U.S. (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 U.S. (Capinera 2005). The western corn rootworm, *Diabrotica virgifera virgifera*, has evolved resistance to the *Bt* toxin Cry3Bb1 in Iowa (Gassmann et al. 2011, 2012).

Mitigating factors have contributed to the slow emergence of insect resistance to GECs. First, EPA requires farmers to plant “refugia” 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 pests such 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.

A second reason that resistance has been slow to appear is because 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 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 on NWRs 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 non-GECs. This effect, termed "Halo Effect", results in the decline of pest populations in areas where large acreages are planted with insect-resistant crops and reduction in crop damage even on susceptible non-GEC plants (Tabashnik 2010, Dively et al. 2018). 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), for *Heliothis virescens* and *H. zea* in the Mississippi Delta where *Bt* cotton is the dominant crop, and for various target pests in Arizona, California, and northern China (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, NWRs in the southeast have implemented a mandatory 50-foot minimum spray

buffer to surface water for all terrestrial use chemicals. This buffer requirement goes above and beyond the requirements on EPA labels for each chemical application and has been adopted as a BMP by the Service.

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), which could increase the disturbance of the soil and decrease the amount of crop residue. Both 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 into 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. Conservation and no-tillage practices would decrease the disturbance of 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 pollen deposition or runoff (USEPA 2001).

SOCIOECONOMIC RESOURCE EFFECTS

The impacts to economic factors related to GEC use on 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 the use of non-GEC and GEC in

agricultural practices on NWRs. 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-GEC use could increase the costs per acre and or cost per bushel 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 economic viability when production costs are included (A. 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 as 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 and machinery needed as well as 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. The increased need for insecticide use associated with non-GECs leads to the increased usage of large specialized equipment for application and increased 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. The amount of pesticides applied on NWRs in the southeast has steadily increased since 2013. The total number of pesticides (active ingredients) and associated pounds of active ingredients used on Wheeler, West Tennessee, Tennessee, and North Carolina Coastal NWR Complexes have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (43,413 lbs.) in 2019 (Figure 6 and 7). The number and associated pounds of restricted use pesticides increased from one (7.5 lbs.) in 2012 (GEC use) to seven (1,339 lbs.) in 2019 (non-GEC use). The U. S. D. A. has tracked the amount of pesticide use on 21 crop types since the 1960s. A summary of this research that was published in 2014, showed peaks in pesticide use that were recorded before GECs became widely used across the country (Fernandez-Cornejo et al. 2014b).

Use of agriculture on NWRs across the southeastern U. S. has been associated with an increased cost in pesticide application since 2013, due to the use of 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 pesticide applications also increase the cost to cooperative farmers and refuges. Recent communications with Project

Leaders in the southeast 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) 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 failing to meet the 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 southeast, cooperative farming partnerships provide millions of dollars to local economies while helping 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 on NWRs allows for sustained partnerships with local cooperative farmers, which in turn bolster local economies, provide an economically efficient means of natural resource management, and enable 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 IPM Policy through reductions in chemical applications, labor and machinery costs, and carbon footprints (T. Smith, personal communication). GEC use also optimizes crop yields that increase and sustain the economic feasibility of cooperative farming. Economic impacts are a particularly sensitive issue in that cooperative farming must be economically feasible 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 economic gain by 69% compared to non-GEC use.

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, Tennessee NWR experienced a significant reduction in corn yield because of excessive pest problems in 2016. 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. GECs 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 is that 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 (Mackelprang and Lemaux 2020).

The National Research Council (2010; NRC) reports the following indirect cost benefits from the use of GECs: 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 GECs. 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 more economically viable (National Research Council 2010, Fernandez-Cornejo et. al 2014ab).

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 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 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. This festival 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 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 southeast is the widespread use of GECs in the U.S. including the southeastern United States. Based on USDA survey data, 94% of domestic soybean, 91% of cotton, and 90% of corn acres were herbicide tolerant GEC varieties in 2014 (USDA ERS 2018). Similarly, domestic *Bt* corn acreage was 82% in 2018, with 80% cultivated in stacked seeds with both HT and *Bt* traits (USDA ERS 2018)

Mitigation measure, best management practices, and the current Regional GEC Guidance limit 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 current Regional GEC Guidance provides for recommendations for crop types, crop rotation, and pesticide spray buffers for Roundup Ready® crops that will avoid or minimize the potential negative effects of using some 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

Farming practices on NWRs 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 BMPs with GECs could protect water resources. As such, a determination authorizing the use of GECs on NWRs in the southeast 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 in context of the southeastern U.S. Of the almost 4 million acres of refuge land in the southeast, agricultural practices are conducted on less than 30,000 acres (<1%) annually. In fact, GEC use on refuges in the southeast would constitute only 0.01% percent of the total cropland within the United States.

Positive impacts of GEC use 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 herbicide tolerant crops and deter resistant weed development. In addition, the NWRs would incorporate and implement BMPs in association with GEC use to protect biodiversity and deter resistance.

From a “wildlife first” perspective as well as in conjunction with an IPM system, GEC use would allow NWRs in the southeast to maximize yields to meet their respective objectives for waterfowl stepped down from NAWMP and other planning documents, minimize chemical use on refuge lands and exposure to species utilizing these lands, and minimize staff time associated with pest scouting in agricultural practices. Plant and wildlife diversity would remain a top priority in establishing BMPs for refuges. The current BIDEH Policy (USFWS 2006) would continue to apply to refuges as regards agricultural practices and associated GEC use. 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 private farmers' 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, use of GECs on refuges in the southeast, would allow the use of only APHIS-deregulated or exempted GECs.

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 GEC USES 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 the southeast for natural resource management purposes is the most effective way to achieve the NWRS's regional and national waterfowl and wildlife management goals and objectives.

MITIGATION MEASURES

As described in the PEA (starting on page 8, referenced throughout the document, and in Appendix C), the Service will apply regionally consistent BMPs and mitigation measures to reduce the likelihood of adverse impacts associated with the implementation of use of GECs. These BMPs include an integrated pest management program, conservation tillage practices, conservation buffers, crop type rotations and non-Bt refugia as well as other measures to detect and avoid resistance development. The Service uses the latest information regarding BMPs and IPM strategies to address pest resistance and consults with local university extension agents concerning best control options for pest species (Anderson et al. 2019). The Service also meets with cooperative farmers on a yearly basis to determine the crops to be planted and methods for addressing pest issues. Mitigation measures would be applied and considered before implementing the use of GECs.

In addition, considerable precautions and BMPs are utilized in all aspects of agricultural practices management, including but not limited to pesticide use. Although pesticide use is beyond the scope of this Final PEA, the Service will comply with APHIS, EPA and Service policies in determining whether and when pesticides may be used in conjunction with

agricultural crops (both GEC and non-GEC). 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 for use on a NWR must first be approved under the Service's Pesticide Use Proposal 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 (and the National IPM Coordinator for restricted use pesticides) evaluates each chemical through the PUP process and approves or disapproves its use. The review process provides BMPs that advise and assist the NWR with use of the pesticide to reduce potential impacts to non-target species. The Service typically administers a pesticide in a more restrictive than that required by the label, particularly as pertains to buffers. The Service engages in an Intra-Service Section 7 consultation under the ESA on each pesticide to evaluate whether threatened and/or endangered species near and/or adjacent to the treatment areas would be adversely affected. 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).

SUMMARY OF ANALYSIS

The purpose of this PEA is to provide 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. This alternative is not likely to consistently meet the purpose and needs of the Service in achieving waterfowl foraging objectives, the purposes for which a NWR 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 in efficiently, effectively, and consistently achieving their respective waterfowl foraging objectives, contribute to the respective purposes for which refuges were established and accomplishing 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	No effects.	No effects.
Organic and Non-GECs Crop Issues	None to minimal effects for non-GEC 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 non-GEC 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	Potential negative effects to waterfowl and public waterfowl hunters and other recreationists due to not achieving objectives.	No known effects to waterfowl.

Other Birds	Conventional tillage systems decrease residual cover and increase insecticide use, potentially decreasing prey items	Conservation tillage associated with GEC use allows residual vegetation which can increase prey items available.
Amphibians and Reptiles	Potential increase in secondary pesticide toxicity from use and restricted use pesticides but given the use of EPA labeling restrictions and the Service's PUP and IPM, overall effects would be minimal.	Potential decrease in secondary pesticide toxicity but 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 non-GEC 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

Agricultural Biotechnology Stewardship Technical Committee--Non-target Organism Subcommittee and Novigen Sciences, Inc. (ABSTC) 2001. Amended revised response to EPA's data call-in notice concerning the potential for adverse effects of *Bt* corn on non-target lepidopterans', Agricultural Biotechnology Stewardship Technical Committee--Non-target Organism Subcommittee. U.S. Environmental Protection Agency.
http://www.epa.gov/oppbopd1/biopesticides/pips/executive_summary_and_preface.pdf.

Alisauskas, R. T., D. Ankey, and E. E. Klass. 1988. Winter diets and nutrition of midcontinental lesser snow geese. *Journal of Wildlife Management* 52:403-441.

Álvarez-Alfageme, F., F. Bigler, and J. Romeis. 2011. Laboratory toxicity studies demonstrate no adverse effects of Cry1Ab and Cry3Bb1 to larvae of *Adalia bipunctata* (Coleoptera: Coccinellidae): the importance of study design. *Transgenic Research* 20:467-479.

Anderson, J. A., P. C. Ellsworth, J. C. Faria, G. P. Head, M.D.K. Owen, C. D. Pilcher, A. M. Shelton, and M. Meissle. 2019. Genetically Engineered Crops: Importance of Diversified Integrated Pest Management for Agricultural Sustainability *Frontiers in Bioengineering and Biotechnology* 20. doi.org/10.3389/fbioe.2019.00024

Aneja, V. P., W. H. Schlesinger, J. W. Erisman. 2009. Effects of Agriculture upon the Air Quality and Climate: Research, Policy, and Regulations. *Environmental Science and Technology* 43:4234-4240.

Aumaitre, A., K. Aulrich, A. Chesson, G. Flachowsky, and G. Piva. 2002. New feeds from genetically modified plants: substantial equivalence, nutritional equivalence, digestibility, and safety for animals and the food chain. *Livestock Production Science* 74:223-238.

Austin J.E., D.L. Humburg, and L.H. Fredrickson. 1998. Habitat management for migrating and wintering Canada geese: a moist-soil alternative. In Rusch, D. H, M. D. Samuel, D. D. Humburg, and B.D. Sullivan (Eds.). *Biology and management of Canada geese. Procedures of the International Canada Goose Symposium*. Milwaukee, WI, USA. Pp. 291-297.

Backlund, P., A. Janetos, D. S. Schimel, J. Hatfield, M. G. Ryan, S. R. Archer, and D. Lettenmaier. 2008. Executive Summary In: *The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research*. Washington, DC., USA, 362 pp.

Baldassarre, G. A. and E. G. Bolen. 1984. Field-feeding ecology of waterfowl wintering on the Southern High Plains of Texas. *The Journal of Wildlife Management* 48:63-71.

Baldassarre, G. 2014. *Ducks, Geese, and Swans of North America*. Johns Hopkins University Press, Baltimore, Maryland.

Ballard, B.M. and J.E. Thompson. 2000. Winter Diets of Sandhill Cranes from Central and Coastal Texas. *The Wilson Bulletin* 112(2), 263-268.

- Baumgarte, S., and C. Tebbe. 2005. Field studies on the environmental fate of the Cry1Ab *Bt*-toxin produced by transgenic maize (MON810) and its effect on bacterial communities in the maize rhizosphere. *Molecular ecology*. 14. 2539-51.
- Beckie, H. J. 2006. Herbicide-Resistant Weeds: Management Tactics and Practices. *Weed Technology*, 20(3):793-814.
- Beetz, A. 1999. Worms for Composting (Vermicomposting); ATTRA-National Sustainable Agriculture Information Service, Livestock Technical Note, June 1999.
- Bellrose, F. C. 1980. Ducks, geese, and swans of North America, Third ed. Stackpole Books, Harrisburg, PA. 540 pp.
- Bellrose, F. C. and D. J. Holm. 1994. Ecology and Management of the Wood Duck. Stackpole Books, Mechanicsburg, PA, USA.
- Benbrook, C. M. 2012. Impacts of genetically engineered crops on pesticide use in the U.S.--the first sixteen years. *Environmental Sciences Europe* 24. [web link](http://www.enveurope.com/content/24/1/24)
<http://www.enveurope.com/content/24/1/24>.
- Berdeen, J. B., and D. G. Krementz. 1998. The use of fields at night by wintering American woodcock. *Journal of Wildlife Management* 62(3):939-947.
- Benson, J. F., and M. J. Chamberlain. 2006. Food habits of Louisiana black bears (*Ursus americanus luteolus*) in two subpopulations of the Tensas River Basin. *American Midland Naturalist* 156:118–127.
- Benson, J. F., and M. J. Chamberlain. 2007. Space Use and Habitat Selection by Female Louisiana Black Bears in the Tensas River Basin of Louisiana. *Journal of Wildlife Management* 71: 117–126.
- Betz, F. S., B. G. Hammond, and R. L. Fuchs. 2000. Safety and advantages of *Bacillus thuringiensis*-protected plants to control insect pests. *Regulatory Toxicology and Pharmacology* 32:156-173.
- Bielefeld, R. R., M. G. Brasher, T. E. Moorman and P. N. Gray. 2010. Mottled duck (*Anas fulvigula*). In A. Poole, editor. *The Birds of North America*. Cornell Lab of Ornithology, Ithica, New York.
- Blackwood, C. B. and J. S. Buyer. 2004. Soil Microbial Communities Associated with *Bt* and Non-*Bt* Corn in Three Soils. *Journal of Environmental Quality* 33:832–836.
- Brasher, M. G., J. D. James, and B. C. Wilson. 2012. Gulf Coast Joint Venture priority waterfowl science needs. Gulf Coast Joint Venture, Lafayette, LA, USA. 54 pp.
- Bomford, Michael, Lee Meyer, Sam McNeill and Mike Montross, Edwin Ritchey and Chad Lee. 2015. Organic Corn Production in Kentucky.
<http://www2.ca.uky.edu/aqcomm/pubs/ID/ID225/ID225.pdf>
- Brookes, G. and P. Barfoot. 2013. GM crops: global socio-economic and environmental impacts 1996-201. PG Economic Ltd., UK, Dorchester, UK.

- Busari, M. A., S. S. Kukal, A. Kaur, R. Bhatt, and A. A. Dulazi. 2015. Conservation tillage impacts on soil, crop and the environment. *International Soil and Water Conservation Research* 3:119-129.
- Calderone, N. W. 2012. Insect pollinated crops, insect pollinators, and US agriculture: Trend analysis of aggregate data for the period 1992-2009. *PLoS ONE* 7(5):e37235.
- Capinera, J. L. 2005. Featured Creatures: Fall Armyworm IFAS, University of Florida Extension. viewed 31 July 2013, <[web link](http://entnemdept.ufl.edu/creatures/field/fall_armyworm.htm) http://entnemdept.ufl.edu/creatures/field/fall_armyworm.htm>.
- Carpenter, J. 2011. Impacts of GM crops on biodiversity. *GM Crops* 2:1-17.
- Carrière, Y., D. W. Crowder, B. E. Tabashnik. 2010. Evolutionary ecology of insect adaptation to *Bt* crops. *Evolutionary Applications* 3:561-573.
- Cartwright, R., D. TeBeest, and T. Kirkpatrick. 2006. Diseases and Nematodes. *Corn Production Handbook*. Eds. Espinoza, L. and J. Ross. Little Rock: University of Arkansas, Division of Agriculture, Cooperative Extension Service, 2006. 95.
- Carver, E. and J. Caudill. 2007. Banking on Nature 2006: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation. Division of Economics, U.S. Fish and Wildlife Service. Washington, DC.
- Carver, E. and J. Caudill. 2013. Banking on Nature: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation. U.S. Fish and Wildlife Service, Division of Economics, Arlington, V.A., USA. [web link](https://www.fws.gov/refuges/about/RefugeReports/pdfs/BankingOnNature2013.pdf) <https://www.fws.gov/refuges/about/RefugeReports/pdfs/BankingOnNature2013.pdf>
- Caudill, James and E. Carver. 2019. Banking on Nature 2017: The Economic Contributions of National Wildlife Refuge Recreational Visitation to Local Communities. U.S. Fish and Wildlife Service, Falls Church, Virginia.
- Causarano, H. J., A. J. Fransluebbbers, D. W. Reeves, and J. N. Shaw. 2006. Soil Organic Carbon Sequestration in Cotton Production Systems of the Southeastern United States: A Review. *Journal of Environmental Quality* 35:1374–1383.
- Cerdeira, A. L. and S. O. Duke. 2006. The current status and environmental impacts of glyphosate-resistant crops: a review. *Journal of Environmental Quality* 35:1633-1658.
- Christensen, L. 2002. Soil, Nutrient, and Water Management Systems used in U.S. Corn Production. *Information Bulletin* 774. October 6 (2002).
- Clements, M. J., K. W. Campbell, C. M. Maragos, C. Pilcher, J. M. Headrick, J. K. Pataky, and D. G. White. 2003. Influence of Cry1Ab protein and hybrid genotype on fumonisin contamination and *Fusarium* ear rot of corn. *Crop Science* 43(4):1283–1293.
- Committee on the Impact of Biotechnology on Farm-Level Economics and Sustainability: National Research Council (COBFLES). 2010. *Impact of genetically engineered crops on farm sustainability in the United States*. Washington, D.C.: National Academies Press. 250 p.
- Combs, D. L., and L. H. Fredrickson. 1996. Foods used by male mallards wintering in southeastern Missouri. *The Journal of Wildlife Management* 60:603-610.

- Costanza, R., G. R. de Groot, P. Sutton, S. van der Ploeg, S. J. Anderson, I. Kubiszewski, S. Farber, and R. K. Turner. 2014. Changes in the global value of ecosystem services. *Global Environmental Change-Human and Policy Dimensions* 26:152–158.
- Couvillion, B. R., J. A. Barras, G. D. Steyer, W. Sleavin, M. Fischer, H. Beck, N. Trahan, B. Griffin and D. Heckman. 2011. Land area change in coastal Louisiana from 1932 to 2010: U.S. Geological Survey Scientific Investigations Map 3164, scale 1:265,000, 12 p. pamphlet.
- Cullen, E. 2013. Understanding western corn rootworm field-evolved resistance to *Bt* corn and best management practices. *Procedures 2013 Wisconsin Crop Management Conference* 52. [web link http://alfi.soils.wisc.edu/extension/wcmc/2013/pap/Cullen_wcr.pdf](http://alfi.soils.wisc.edu/extension/wcmc/2013/pap/Cullen_wcr.pdf), Madison, WI.
- Dahl, T. E. 1990. Wetlands losses in the United States 1780's to 1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 13pp.
- Dahl, T. E. 2011. Status and trends of wetlands in the conterminous United States 2004 to 2009. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 107 pp.
- Davis, B. E., A. D. Afton, and R. R. Cox, Jr. 2009. Habitat use by female mallards in the lower Mississippi Alluvial Valley. *Journal of Wildlife Management* 73:701–709.
- Davis, J. B., M. Guillemain, R. M. Kaminski, C. Arzel, J. M. Eadie, and E. C. Rees. 2014. Habitat and resource use by waterfowl in the northern hemisphere in autumn and winter. *Wildfowl Special Issue No. 4*:17–69.
- Delate, K., Duffy, M., Chase, C., Holste, A., Friedrich, H., & Wantate, N. 2003. An economic comparison of organic and conventional grain crops in a long-term agroecological research (LTAR) site in Iowa. *American Journal of Alternative Agriculture*, 18(2), 59-69. <https://doi.org/10.1079/AJAA200235>
- Delate, K., Cambardella, C.A., Chase, C., Johanns, A., Turnbull, R. 2013. The long-term agroecological research (LTAR) experiment supports organic yields, soil quality, and economic performance in Iowa. *Crop Management*. <https://DOI:10.1094/CM-2013-0429-02-RS>
- Delnicki, D., and K. J. Reinecke. 1986. Mid-winter food use and body weights of mallards and wood ducks in Mississippi. *Journal of Wildlife Management* 50:43-51.
- Dively, G.P., P. D. Venugopal, D. Bean, J. Whalen, K. Holmstrom, T. P. Kuhar, H. B. Doughty, T. Patton, W. Cissel, W. D. Hutchison. 2018. Regional pest suppression associated with widespread Bt maize adoption benefits vegetable growers. *Proceedings of the National Academy of Sciences* 115:3320-3325; DOI: 10.1073/pnas.1720692115
- Donalaty, S., S. E. Henke, and C. L. Kerr. 2003. Use of winter food plots by nongame wildlife species. *Wildlife Society Bulletin* 31:774-778.
- Dugger, K.M. and L.H. Fredrickson. 2001. Life history and habitat needs of the wood duck. In K.D. Nelms editor. *Wetland Management for Waterfowl Handbook*. Pages 53-59
- Dunfield, K. E., and J. J. Germida. 2004. Impact of Genetically Modified Crops on Soil- and Plant-Associated Microbial Communities. *Journal of Environmental Quality* 33:806–815.
- Edwards, T., D. Fuqua, D. James, T. Kreher, P. Link, L. Naylor, F. Nelson, E. Penny, G. Pogue, S. Reagan, K. Reinecke, and J. Tirpak. 2012. Allocation of Waterfowl Habitat Objectives within

the Mississippi Alluvial Valley: An Analytical Framework and Results. Lower Mississippi Valley Joint Venture. 49 pp.

Ely, C. R., and D. G. Raveling. 2011. Seasonal variation in nutritional characteristics of the diet of greater white-fronted geese. *The Journal of Wildlife Management* 75:78–91.

Fawcett, R., and D. Towery. 2002. Conservation Tillage and Plant Biotechnology: How New Technologies Can Improve the Environment By Reducing the Need to Plow. West Lafayette: Conservation Technology Information Center.

Ferry, N., and A. M. R. Gatehouse. 2008. Environmental Impact of Genetically Modified Crops. Pondicherry, India: MPG Books Group. 424 p.

Fernandez-Cornejo, J. and M. Caswell. 2006. The first decade of genetically engineered crops in the United States. Electronic Report, Economic Research Service, U.S. Department of Agriculture, Washington, DC.

Fernandez-Cornejo, J., C. Hallahan, R. Nehring, and S. Wechsler. 2012. Conservation tillage, herbicide use, and genetically engineered crops in the United States: The case of soybeans. *AgBioForum*, 15(3):231-241. Retrieved from [web link](http://www.agbioforum.org/v15n3/v15n3a01-fernandez-cornejo.pdf)
<http://www.agbioforum.org/v15n3/v15n3a01-fernandez-cornejo.pdf>

Fernandez-Cornejo, J., S. Wechsler, M. J. Livingston, and L. Mitchell. 2014a. Genetically Engineered Crops in the United States. U. S. Department of Agriculture Economic Research Service Economic Research Report Number 162.

Fernandez-Cornejo, J., R. Nehring, C. Osteen, S. Wechsler, A. Martin, and A. Vialou. 2014b. Pesticide Use in US Agriculture: 21 Selected Crops, 1960-2008. U.S. Department of Agriculture, Economic Research Service, Washington, DC, 2014, [web link](http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib124.aspx)
www.ers.usda.gov/publications/eib-economic-information-bulletin/eib124.aspx.

Field, C. B., L. D. Mortsch, M. Brklacich, D. L. Forbes, P. Kovacs, J. A. Patz, S. W. Running, and M. J. Scott. 2007. North America Climate Change 2007: Impacts, Adaptation and Vulnerability, M. L. Parry et al., Eds., Cambridge University Press, 617–652.

Field, R. H., W. B. Kirby and R. B. Bradbury. 2007. Conservation tillage encourages early breeding by Skylarks, *Alauda arvensis*. *Bird Study* 54(1):137-141.
DOI:10.1080/00063650709461467

Flachowsky, G., K. Aulrich, H. Bohme, and I. Halle. 2007. Studies on feeds from genetically modified plants (GMP) – Contributions to nutritional and safety assessment. *Animal Feed Science and Technology*. 133:2-30.

Fleming, K. K., M. G. Brasher, D. D. Humburg, M. J. Petrie, and G. J. Soulliere. 2017. Derivation of regional, non-breeding duck population abundance objectives to inform conservation planning. North American Waterfowl Management Plan Science Support Team Technical Report 2017-01. 32pp.

Foster, M. A., M. J. Gray, and R. M. Kaminski. 2010. Agricultural seed biomass for migrating and wintering waterfowl in the southeastern United States. *Journal of Wildlife Management* 74:489-495.

- Fredrickson, L. H. 2005. Contemporary bottomland hardwood systems: structure, function and hydrologic condition resulting from two centuries of anthropogenic activities. In L. H. Fredrickson, S. L. King, and R. M. Kaminski, editors. Ecology and management of bottomland hardwood systems: the state of our understanding. University of Missouri-Columbia, Gaylord Memorial Laboratory Special Publication No. 10, Puxico, Missouri, USA. pp 19-35.
- Fredrickson, L. H. 1996. Moist-soil management, 30 years of field experimentation. International Waterfowl Symposium 7:168-177.
- Fredrickson, L. H. and D. L. Batema. 1992. Greentree reservoir management handbook. Wetland Management Series No. 1. University of Missouri-Columbia, Gaylord Memorial Laboratory, Puxico, MO. 88pp.
- Fredrickson, L. H., and T. S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. U. S. Fish and Wildlife Service Resource Pub. 148.
- Gassmann, A. J., M. Petzold, R. S. Keweshan, and M. W. Dunbar. 2011. Field-evolved resistance to *Bt* maize by western corn rootworm. PLOS One 6:7.
- Gassmann, A. J., M. Petzold, R. S. Keweshan, and M. W. Dunbar. 2012. Western corn rootworm and *Bt* maize challenges of pest resistance in the field. GM Crops and Food: Biotechnology in Agriculture and the Food Chain. 3(3):235-244.
- Gates, R. J., D. F. Caithamer, W. E. Moritz, and T. C. Tacha. 2001. Bioenergetics and nutrition of Mississippi Valley population Canada geese during winter and migration. Wildlife Monographs 146: 1–65.
- Genito, D., W. J. Gburek, and A. N. Sharpley. 2002. Response of stream macroinvertebrates to agricultural land cover in a small watershed. Journal of Freshwater Ecology 17:109–19.
- Givens, W., D. Shaw, G. Kruger, W. Johnson, S. Weller, B. Young, and D. Jordan. 2009. Survey of Tillage Trends Following the Adoption of Glyphosate-Resistant Crops. Weed Technology. 23(1):150-155. doi:10.1614/WT-08-038.1
- Gordon, D. H., B. T. Gray, R. D. Perry, M. B. Prevost, T. H. Strange, and R. K. Williams. 1989. South Atlantic coastal wetlands. In L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds. Habitat management for migrating and wintering waterfowl in North America. Texas Tech Univ. Press, Lubbock, TX. Pages 57-92
- Gray, J. M. 2010. Habitat use, movements, and spring migration chronology and corridors of female gadwalls that winter along the Louisiana Gulf Coast. M.S. Thesis, Louisiana State University, Baton Rouge.
- Gray M. J., H. M. Hagy, J. A. Nyman, and J. D. Stafford. 2013. Management of Wetlands for Wildlife. In: Anderson J., Davis C. (eds) Wetland Techniques. Springer, Dordrecht
- Green, J. M., and M.D. K. Owen. 2011. Herbicide-resistant crops: Utilities and limitations for herbicide-resistant weed management. Journal of Agricultural and Food Chemistry. 59(2011):5819-5829.

- Greene, C., S. J. Wechsler, A. Adalja, and J. Hanson. 2016. Economic Issues in the Coexistence of Organic, Genetically Engineered (GE), and Non-GE Crops. Washington, DC: U.S. Department of Agriculture Economic Research Service.
- Griffith, B. J. M. Scott, R. Adamcik, D. Ashe, B. Czech, R. Fischman, P. Gonzalez, J. Lawler, A.D. McGuire, and A. Pidgorna. 2009. Climate Change Adaptation for the US National Wildlife Refuge System. *Environmental Management* 44:1043-1052.
- Groepper, Sr. R., S. E. Hygnstrom, B. Houck, and S. E. Vantassel. 2013. Real and perceived damage by wild turkeys: a literature review. *Journal of Integrated Pest Management* 4:1 DOI: <http://dx.doi.org/10.1603/IPM12013>
- Guthery, F. S. 1972. Food habits, habitat, distribution, numbers, and subspecies of Sandhill cranes wintering in southern Texas. M.S. Thesis, Texas A&M Univ., College Station. 81 pp.
- Hagy, H. M., G. M. Linz, W. J. Bleier. 2010. Wildlife conservation sunflower plots and croplands as fall habitat for migratory birds. *American Midland Naturalist* 164: 119–135.
- Hagy, H. M., and R. M. Kaminski. 2012a. Apparent seed use by ducks in moist-soil wetlands of the Mississippi Alluvial Valley. *Journal of Wildlife Management* 76:1053–1061.
- Hagy, H. M., and R. M. Kaminski. 2012b. Winter food and waterfowl dynamics in managed moist-soil wetlands of the Mississippi Alluvial Valley. *Wildlife Society Bulletin* 36:512–523.
- Havera, Stephen P. 1999. Waterfowl of Illinois. Illinois natural history survey special publication 21. 628 pp.
- He, J., L. Hongwen, R. Rasaily, Q. Wang, G. Cai, Y. Su, X. Qiao, and L. Liu. 2011. Soil properties and crop yields after 11 years of no tillage farming in wheat–maize cropping system in North China Plain. *Soil and Tillage Research* 113. 48-54.
- Hefner, J. M., B. O. Wilen, T. E. Dahl, and W. E. Frayer. 1994. Southeast wetlands: status and trends, mid-1970's to mid-1980's. U.S. Department of the Interior, U. S. Fish and Wildlife Service, Atlanta, GA. 32 pp.
- Hefner, J. M., and J. D. Brown. 1984. Wetland trends in the Southeastern United States. *Wetlands* 4:1-11.
- Heitmeyer, M. E. 1988. Body composition of female mallards in winter in relation to annual cycle events. *Condor* 90:669-680.
- Heitmeyer, M. E. 2006. The importance of winter floods to mallards in the Mississippi Alluvial Valley. *Journal of Wildlife Management* 70:101-110.
- Hillbeck, A, M. Meier, and M. Trtikova. 2012. Underlying reasons of the controversy over adverse effects of *Bt* toxins on lady beetle and lacewing larvae. *Environmental Sciences Europe* 24(1):1-9. p. <http://www.enveurope.com/content/24/1/9>.
- Hellmich, R. L. and K. A. Hellmich. 2012. Use and Impact of *Bt* Maize. *Nature Education Knowledge* 3(10):4

- Hine, C. S., H. M. Hagy, M. M. Horath, A. P. Yetter, R. V. Smith, and J. D. Stafford. 2017. Response of aquatic vegetation communities and other wetland cover types to floodplain restoration at Emiquon Preserve. *Hydrobiologia* 804:59–71.
- Hindman, L. J., and V. D. Stotts. 1989. Chesapeake Bay and North Carolina sounds. In L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds. *Habitat management for migrating and wintering waterfowl in North America*. Texas Tech Univ. Press, Lubbock, TX. Pages 27-55
- Hoelt, R. G., E. D. Nafziger, R. R. Johnson, and S. R. Aldrich. 2000. *Modern Corn and Soybean Production*, First Ed. Champaign, IL: MCSP Publications.
- Holland, J. M. 2004. The environmental consequences of adopting conservation tillage in Europe: reviewing the evidence. *Agriculture Ecosystems and Environment* 103:1–25.
- House, G. J. and R. W. Parmelee. 1985. Comparison of soil arthropods and earthworms from conventional and no-tillage agroecosystems. *Soil and Tillage Research* 5(4):351-360.
- Hunt, H. E., and R. D. Slack 1989. Winter diets of whooping and Sandhill cranes in south Texas. *Journal of Wildlife Management* 53:1150–1154.
- Hutchison, W., E. Burkness, P. Mitchell, R. Moon, T. Leslie, S. Fleischer, M. Abrahamson, K. Hamilton, K. Steffey, M. Gray, R. Hellmich, L. Kaster, T. Hunt, R. Wright, K. Pecinovsky, T. Rabaey, B. Flood, and E. Raun. 2010. Areawide suppression of European corn borer with *Bt* maize reaps savings to non-*Bt* maize growers. *Science* 330:222-225.
- Icoz I., and G. Stotzky. 2008. Cry3Bb1 protein from *Bacillus thuringiensis* in root exudates and biomass of transgenic corn does not persist in soil. *Transgenic Research* 17:609–620.
- Intergovernmental Panel on Climate Change (IPCC). 2007. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson (eds.) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- International Panel on Climate Change (IPCC). 2013. Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T. F., D. Qin, G. K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P. M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. [<web link https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf>](https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf)
- International Panel on Climate Change (IPCC). 2014. *Climate Change: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change* [Edenhofer, O., R. Bichs-Madruga, Y. Sokona, E. Farahan, S. Kudner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlomer, C. von Stechow, T. Zwicke and J.C. Mins (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Jenkins, C. N., K. S. Van Houtan, S. L. Pimm, and J. O. Sexton. 2015. How the USA protects biodiversity. *Proceedings of the National Academy of Sciences* 112(16):5081-5086.

- Jones, J. D. G. 2011. Why genetically modified crops?. *Philosophical Transactions of the Royal Society of London* 369:1807-1816.
- Jones, M. D., and M. R. Pelton. 2003. Female American black bear use of managed forest and agricultural lands in coastal North Carolina. *Ursus* 14:188–197.
- Jorde, D. G., G. L. Krapu, and R. D. Crawford. 1983. Feeding ecology of Mallards wintering in Nebraska. *Journal of Wildlife Management* 47:1044-1053.
- Kaminski, R. M. 1986. Habitat suitability index models: greater white-fronted goose (wintering). U. S. Fish and Wildlife Service Biological Report 82(10.116):14 pp.
- Kaminski, R. M., J. B. Davis, H. W. Essig, P. D. Gerard, and K. J. Reinecke. 2003. True metabolizable energy for wood ducks from acorns compared to other waterfowl foods. *Journal of Wildlife Management* 67:542-550.
- Kemp, A. C., B. P. Horton, J. P. Donnelly, M. E. Mann, M. Vermeer, and S. Rahmstorf. 2011. Climate related sea-level variations over the past two millennia. *Proceedings of the National Academy of Sciences* 108 (27):11017-11022.
- Kemper, N., A. Flanders, B. Watkins, and M. Popp. 2012. Impact of the 2012 Drought on Field Crops and Cattle Production in Arkansas: Preliminary Report. University of Arkansas, Division of Agriculture, Research and Extension. Arkansas Extension Service. Pp. 10.
- Klümper, W., and M. Qaim. 2014. A Meta-Analysis of the Impacts of Genetically Modified Crops. *PLOS ONE* 9(11): e111629.
- Korschgen, L. J. 1962. Foods of Missouri deer with some management implications. *Journal of Wildlife Management* 26:164-172.
- Krapu, G. L., K. J. Reinecke, D. G. Jorde, and S. G. Simpson. 1995. Spring staging ecology of midcontinent greater white-fronted geese. *Journal of Wildlife Management* 59:736–746.
- Krapu, G., D. Brandt and R. Cox. 2004. Less Waste Corn, More Land in Soybeans, and the Switch to Genetically Modified Crops: Trends with Important Implications for Wildlife Management. *Wildlife Society Bulletin*. 32.
- Lancaster, J. D. 2018. Winter Ecology of Radiomarked Female Mallards in Mississippi's Alluvial Valley. Mississippi State University, 154; 10745443.
- Landers, J., R. Hamilton, A. Johnson, and R. Marchinton, R. 1979. Foods and Habitat of Black Bears in Southeastern North Carolina. *The Journal of Wildlife Management* 43(1):143-153. doi:10.2307/3800645
- Landis, D. A., F. C. Menalled, A. C. Costamagna, and T. K. Wilkinson. 2005. Manipulating plant resources to enhance beneficial arthropods in agricultural landscapes. *Weed Science* 53:902– 908.
- Leikam, D. and D. Mengel. 2007. Nutrient Management. In: *Corn Production Handbook*. C-560. Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Manhattan, Kansas.

- Lenat, D. R., and J. K. Crawford. 1994. *Hydrobiologia* 185. [web link
https://doi.org/10.1007/BF00021291](https://doi.org/10.1007/BF00021291)
- Lewis, J.C. 1974. Ecology of the Sandhill crane in the southeast central flyway. Ph.D. Thesis. Oklahoma State Univ., Stillwater. 213 pp.
- Link, P. T, A. D. Afton, R. R. Cox, Jr. and B. E. Davis. 2011. Use of habitats by female mallards wintering in southwestern Louisiana. *Waterbirds* 34(4):429-438.
- Liu, Z., and A. Delach. 2012. Impacts of Sea-Level Rise on National Wildlife Refuges. <[web link
https://defenders.org/publications/impacts-of-sea-level-rise-on-refuge-land-protection-priorities.pdf](https://defenders.org/publications/impacts-of-sea-level-rise-on-refuge-land-protection-priorities.pdf)>
- Locke, M. A., and R. M. Zablotowicz. 2004. [Pesticides in soil: Benefits and limitations to soil health](#). In P. Schjonning, S. Elmholt, and B.T. Christensen., eds., *Managing soil quality - Challenges in modern agriculture*. CABI Publishing, UK, pp. 239-260.
- Loesch, C. R. and R. M. Kaminski. 1989. Winter bodyweight patterns of female Mallards fed agricultural seeds. *Journal of Wildlife Management* 53:1081-1087.
- Loesch, C., R. Kaminski, and D. Richardson. 1992. Endogenous Loss of Body Mass by Mallards in Winter. *The Journal of Wildlife Management*, 56(4):735-739. doi:10.2307/3809467
- Low, J. B., and F. C. Bellrose, Jr. 1944. The seed and vegetative yield of waterfowl food plants in the Illinois River Valley. *Journal of Wildlife Management* 8:7-22.
- MacDonald, P.O., W. E. Frayer, and J. K. Clauser. 1979. Documentation, Chronology, and Future Projections of Bottomland Hardwood Habitat Loss in the Lower Mississippi Alluvial Plain. Volume I, Basic Report. U.S. Fish and Wildlife Service, Ecological Services, Vicksburg, MI. 133 pp.
- MacGowan, B. J., L. A. Humberg, J. C. Beasley, T. L. DeVault, M. I. Retamosa, and O. E. Rhodes, Jr. 2006a. Corn and soybean crop depredation by wildlife. Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, Publication FNR 265-W, 13pp.
- MacGowan, B. J., L. A. Humberg, J. C. Beasley, and O. E. Rhodes Jr. 2006b. Identification of wildlife crop depredation. Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, Publication FNR 267, 29pp.
- Mackelprang, R., and P. G. Lemaux. 2020. Genetic Engineering and Editing of Plants: An Analysis of New and Persisting Questions. *Annual Review of Plant Biology* 71:1.
- Madden, N. M., R. J. Southard, and J. P. Mitchell. 2009. Soil Water Content and Soil Disaggregation by Disking Affects PM10 Emissions. *Journal of Environmental Quality* 38:36-43. doi:10.2134/jeq2008.0209
- Maddrey, R. C. 1995. Morphology, reproduction, food habits, crop depredation, and mortality of black bears on the Neuse-Pamlico Peninsula, North Carolina. Thesis. University of Tennessee. Knoxville. USA.
- Manley, S. W., R. M. Kaminski, K. J. Reinecke, and P. D. Gerard. 2004. Waterbird foods in winter-managed rice-fields in Mississippi. *Journal of Wildlife Management* 68:74–83.

- Marty, J. R. 2017. Estimates of waste rice, natural seeds, and wetland birds in Gulf Coast Prairie ricelands during fall–winter. Dissertation, Mississippi State University, Mississippi State, USA.
- Massey, E. R. 2017. Winter diet and body condition of arctic geese in the Mississippi Alluvial Valley of Arkansas. University of Arkansas, Monticello, USA
- Mattson D. J. 1990. Human impacts on bear habitat use. *International Conference on Bear Research and Management* 8:33 – 56
- McBride, William D., Catherine Greene, Linda Foreman, and Mir Ali. 2016. *The Profit Potential of Certified Organic Field Crop Production*, ERR-188, U.S. Department of Agriculture, Economic Research Service.
https://www.ers.usda.gov/webdocs/publications/45380/53409_err188.pdf?v=42212
- McClain, S. E., H. M. Hagy, C. S. Hine, A. P. Yetter, C. N. Jacques, and J. W. Simpson. 2019. Energetic implications of floodplain wetland restoration strategies for waterfowl. *Restoration Ecology* 27:168–177. DOI:10.1111/rec.12818.
- McLeod, P., and G. Studebaker. 2006. Major Insect Pests of Field Corn in Arkansas and Their Management. *Corn Production Handbook*. Eds. Espinoza, L and J Ross. Little Rock: University of Arkansas, Division of Agriculture, Cooperative Extension Service, 2006. 95.
- Mendelsohn, M. M., J. Kough, Z. Vaituzis, and K. Matthews. 2003. Are *Bt* crops safe? *Nature Biotechnology* 21(9):1003-1009.
- Mineau, P., and C. Palmer. 2013. The impact of the nation's most widely used insecticides on birds, American Bird Conservancy. 99pp. [web link](http://www.abcbirds.org/abcprograms/policy/toxins/Neonic_FINAL.pdf)
http://www.abcbirds.org/abcprograms/policy/toxins/Neonic_FINAL.pdf.
- Mortensen, D. A., J. F. Egan, B. D. Maxwell, M. R. Ryan, and R. G. Smith. 2012. Navigating a critical juncture for sustainable weed management, *BioScience* 62(1):75-84.
- National Academies of Sciences, Engineering, and Medicine (NASEM). 2016. *Genetically Engineered Crops: Experiences and Prospects*. Washington, DC: The National Academies Press. doi: 10.17226/23395. <https://agbiotech.ces.ncsu.edu/wp-content/uploads/2016/05/NAS-Genetically-Engineered-Crops-Full-Report.pdf?fwd=no>
- National Research Council (NRC). 2010. *The Impact of Genetically Engineered Crops on Farm Sustainability in the United States*. Ed. Council, National Research. Washington: National Academies Press, Washington, DC. [web link https://doi.org/10.17226/12804](https://doi.org/10.17226/12804).
- Neely, W. W., and V. E. Davison. 1971. Wild ducks on farmlands in the south. U.S. Department of Agriculture Farmers' Bulletin 2218.
- Nelson, G. C., and D. S. Bullock. 2003. Simulating a relative environmental effect of glyphosate-resistant soybeans. *Ecological Economics* 45:189-202.
- Newcomb, K. C. 2014. Survival and habitat selection of American black ducks in Tennessee. Thesis, Mississippi State University, Starkville, USA.

- Nixon, C., L. Hansen, P. Brewer, and J. Chelsvig. 1991. Ecology of White-Tailed Deer in an Intensively Farmed Region of Illinois. *Wildlife Monographs* 118:3-77. Retrieved from [web link](http://www.jstor.org/stable/3830680) <http://www.jstor.org/stable/3830680>
- North Carolina Extension. 2014. Managing Insect Pests in Organically Certified Corn. *Entomology: Insect Biology and Management*. <https://entomology.ces.ncsu.edu/managing-pests-in-organically-certified-corn/>
- Oberhauser, K. S., M. D. Prysby, H. R. Mattila, D. E. Stanley-Horn, M. K. Sears, G. Dively, E. Olson, J. M. Pleasants, W. F. Lam, and R. L. Hellmich. 2001. Temporal and spatial overlap between monarch larvae and corn pollen. *PNAS* 98(21):11913-11918.
- Oberhauser, K. S., and E. R. L. Rivers. 2003. Monarch butterfly (*Danaus plexippus*) larvae and *Bt* maize pollen: a review of ecological risk assessment for a non-target species. *AgBioTechNet* 5:ABN117.
- Obyrcki, J. J., J. E. Losey, O. R. Taylor, and L. C. H. Jesse. 2001. Transgenic insecticidal corn: beyond insecticidal toxicity to ecological complexity. *BioScience* 51(5):353-361.
- Olivier, J. G. J. , J. A. Van Aardenne , F. J. Dentener , V. Pagliari , L. N. Ganzeveld, and J. A. H. W. Peters. 2005. Recent trends in global greenhouse gas emissions: regional trends 1970–2000 and spatial distribution of key sources in 2000. *Environmental Sciences* 2:2-3, 81-99, DOI: 10.1080/15693430500400345
- Olson, R. A., and D. H. Sander. 1988. Corn production, In Sprague, G. F. and J. W. Dudley, (eds.), *Corn and Corn Improvement*, 3rd edn., *Agronomy Monograph 18*, American Society of Agronomy, Crop Science Society of America and Soil Science Society of America, Madison, Wisconsin, pp. 639–686.
- Osborn, J. M., H. M. Hagy, M. D. McClanahan, J. D. Davis, and M. J. Gray. 2017. Habitat selection and activities of dabbling ducks during nonbreeding periods. *Journal of Wildlife Management* 81:1482– 1493.
- Palmer, W. E., P. T. Bromley, and J. R. Anderson, Jr. 2011. *Wildlife and Pesticides - Corn*. North Carolina Cooperative Extension Service AG-463-2
- Parsons, K. C., P. Mineau, and R. B. Renfrew. 2010. Effects of pesticide use in rice fields on birds. *BioOne* 33:193-218.
- Pearse, A. T., R. M. Kaminski, K. J. Reinecke, and S. J. Dinsmore. 2012. Local and landscape associations between wintering dabbling ducks and wetland complexes in Mississippi. *Wetlands* 32:852–862.
- Pearse, A. T., and Stafford, J. D. 2014. Error propagation in energetic carrying capacity models. *Journal of Conservation Planning* 10:17– 24.
- Pellegrino, E., S. Bedini, M. Nuti, and L. Ercoli. 2018. Impact of genetically engineered maize on agronomic, environmental and toxicological traits: a meta-analysis of 21 years of field data. *Scientific Reports* 8:#3113.
- Petrie, M. J., R. D. Drobney, and D. A. Graber. 1998. True metabolizable energy estimates of Canada goose foods. *Journal of Wildlife Management* 62:1147-1152.

- Pimentel, D., R. Zuniga, and D. Morrison, D. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52:273-288.
- Price, A. J., K. S. Balkcom, S. A. Culpepper, J. S. Kelton, R. L. Nichols, R. L., and H. Schomberg. 2011. Glyphosate-resistant Palmer amaranth: a threat to conservation tillage. *Journal of Soil Water Conservation* 66:265–275.
- Luttrell, R. G., and R. E. Jackson. 2012. *Helicoverpa zea* and *Bt* Cotton in the United States. *GM Crops & Food* 3(3):213-227, DOI: [10.4161/gmcr.20742](https://doi.org/10.4161/gmcr.20742)
- Raftovich, R.V., S. C. Chandler, and K. K. Fleming. 2017. Migratory bird hunting activity and harvest during the 2015-16 and 2016-17 hunting seasons. U.S. Fish and Wildlife Service, Laurel, Maryland, USA
- Reinecke, K. J., R. M. Kaminski, D. J. Moorhead, J. D. Hodges, and J. R. Nassar. 1989. Mississippi Alluvial Valley. Pp.203-247 in *Habitat management for migrating and wintering waterfowl in North America*, eds. L.M Smith, R.L. Pederson, and R.M. Kaminski. 1989. Texas Tech University Press. 560 pp.
- Reinecke, K. J., and R. M. Kaminski. 2006. Final revision of table 5: duck-energy days; DEDs. Memorandum submitted to the Lower Mississippi Valley Joint Venture Waterfowl Working Group on 28 July 2006, Vicksburg, Mississippi.
- Reinecke, K. J., and G. L. Krapu. 1986. Feeding ecology of Sandhill cranes during spring migration in Nebraska. *Journal of Wildlife Management* 50:71–79.
- Reinecke, K. J. and C. R. Loesch. 1996. Integrating research and management to conserve wildfowl (Anatidae) and wetlands in the Mississippi Alluvial Valley, USA. *Gibier Faune Sauvage, Game Wildfowl* 13:927–940.
- Rice M. Transgenic rootworm corn: assessing potential agronomic, economic, and environmental benefits. *Plant Health Progress* 2004; doi:10.1094/PHP-2004-0301-01-RV.
- Roberts, A., P. Padding. 2018. Atlantic Flyway harvest and population survey data book. U.S. Fish and Wildlife Service, Laurel MD. Available at: [web link
https://www.fws.gov/migratorybirds/pdf/surveys-and-data/DataBooks/AtlanticFlywayDatabook.pdf](https://www.fws.gov/migratorybirds/pdf/surveys-and-data/DataBooks/AtlanticFlywayDatabook.pdf)
- Robinson, S. K., F. R. Thompson III, T. M. Donovan, D. R. Whitehead, and J. Faaborg. 1995. Regional forest fragmentation and the nesting success of migratory birds. *Science* 267:1987-1990.
- Roger-Estrade, J., and A. Christel, M. Bertrand, and R. Guy. 2010. Tillage and soil ecology: Partners for sustainable agriculture. *Soil and Tillage Research* 111:33-40. 10.1016/j.still.2010.08.010.
- Rogovoska, N. and R. M. Cruse. 2011. Climate Change Consequences for Agriculture in Iowa. In *Climate Change Impacts on Iowa 2010*. Des Moines, IA: Office of Energy Independence.

- Romeis J., Naranjo S. E., Meissle M., Shelton A. M. 2019. Genetically engineered crops help support conservation biological control. *Biological Control* 130:136-154. [web link](#)
<https://doi.org/10.1016/j.biocontrol.2018.10.001>.
- Romeis J., and M. Meissle. 2020. Stacked Bt Proteins Pose No New Risks to Nontarget Arthropods. *Trends in Biotechnology* 38:234-236, <https://doi.org/10.1016/j.tibtech.2019.12.001>.
- Ronald, P. 2011. Plant genetics, sustainable agriculture and global food security. *Genetics* 188:11-20.
- Ruiz, N., P. Lavelle, and J. Jiménez. 2008. *Soil Macrofauna Field Manual - Technical level*. Rome: FAO.
- Sanchis, V., and D. Bourguet. 2008. *Bacillus thuringiensis*: applications in agriculture and insect resistance management. A review. *Agronomy for Sustainable Development* 28:11-20.
- Schaible, G., M. Aillery. 2012. Water Conservation in Irrigated Agriculture: Trends and Challenges in the Face of Emerging Demands. USDA-ERS Economic Information Bulletin No. 99. Available at SSRN: [web link https://ssrn.com/abstract=2186555](#) or <http://dx.doi.org/10.2139/ssrn.2186555>
- Scheffe L. 2008. Benefits of conservation tillage. In *Integrated Cropping Systems and Water Management Handbook (AGRO-76)*, Sec. 10a. Washington, DC: US Dep. Agriculture Natural Resource Conservation Service.
- Schmidt, J. E., C. U. Braun, L. P. Whitehouse, and A. Hillbeck. 2009. Effects of activated *Bt* transgene products (Cry1Ab, Cry3Bb) on immature stages of the ladybird *Adalia bipunctata* in laboratory ecotoxicity testing. *Archives of Environmental Contamination and Toxicology* 56:221-228.
- Schummer, M.L., J. Palframan, E. McNaughton, T. Barney, and S. Petrie. 2012. Comparisons of Bird, Aquatic Macroinvertebrate, and Plant Communities Among Dredged Ponds and Natural Wetland Habitats at Long Point, Lake Erie, Ontario. *Wetlands* 32:945. [web link](#)
<https://doi.org/10.1007/s13157-012-0328-2>
- Seaber, P. R., F. P. Kapinos, and G. L. Knapp. 1987. Hydrologic Unit Maps. U.S. Geological Survey Water Supply Paper 2294. <[web link](#)
https://pubs.usgs.gov/wsp/wsp2294/pdf/wsp_2294.pdf>
- Sears, MK, R. L. Hellmich, E. E. Stanley-Horn, K. S. Oberhauser, J. M. Pleasants, H. R. Mattila, B. D. Siegfried, and G. P. Dively. 2001. Impact of *Bt* corn pollen on monarch butterfly populations: a risk assessment. *Proceedings of the National Academy of Sciences* 98(21):11937-11942.
- Sedinger, J. S. 1984. Protein and amino acid composition of tundra vegetation in relation to nutritional requirements of geese. *Journal of Wildlife Management* 48:1128–1136
- Sharma, P., and C. Abrol, 2012. Tillage Effects on Soil Health and Crop Productivity: A Review. In: Sharma, P. and Abrol, V., Eds., *Crop Production Technologies*, InTech, Rijeka, 245-262.
- Shelton, A. 2011. *Biological Control: A Guide to Natural Enemies in North America* Retrieved May 12, 2011, from [web link https://biocontrol.entomology.cornell.edu/index.php](https://biocontrol.entomology.cornell.edu/index.php)

- Shipitalo, M. J., R. W. Malone, and L. B. Owens. 2008. Impact of glyphosate-tolerant soybean and glufosinate-tolerant corn production on herbicide losses in surface runoff. *Journal of Environmental Quality* 37:401-408.
- Smith, R.K., P. L. Freeman, J. V. Higgins, K. S. Wheaton, T. W. FitzHugh, K. J. Ernstom, and A. A. Das. 2002. *Priority Areas for Freshwater Conservation Action: A Biodiversity Assessment of the Southeastern United States*. Washington DC: The Nature Conservancy, 68 pp.
- Stepenuck, K. F., R. L. Crunkilton, and L. Wang, L. . 2002. Impacts of urban land use on macroinvertebrate communities in southeastern Wisconsin streams. *Journal of the American Water Resources Association* 38(4):1041– 1051.
- Stetler, L.D., and K. E. Saxton. 1996. Wind erosion and PM10 emissions from agricultural fields on the Columbia Plateau. *Earth Surface Processes and Landforms* 21:673-685.
- Stewart, S.D., B. Layton, and A. Catchot. 2007. *Common Beneficial Arthropods Found in Field Crops*. University of Tennessee Cooperative Extension Service. Publication W127. 11 pp. ([web link https://www.google.com/url?q=https://extension.tennessee.edu/publications/Documents/W127.pdf&sa=D&ust=1545408975365000&usq=AFQjCNGDmUHt2p0h5GjNWMOfCBXHUpoM4Q](https://www.google.com/url?q=https://extension.tennessee.edu/publications/Documents/W127.pdf&sa=D&ust=1545408975365000&usq=AFQjCNGDmUHt2p0h5GjNWMOfCBXHUpoM4Q))
- Storer, N. P., G. P. Dively, and R. A. Herman. 2008. Landscape effects of insect-resistant genetically modified crops, in J Romeis, A. M. Shelton, G. G. Kennedy (eds.), *Integration of insect-resistant crops within IPM programs*, 30th edn, Springer, New York, NY.
- Straub, J.N., J. L. Gates, R. D. Schultheis, T. Yerkes, J. M. Coluccy, and J. D. Stafford. 2012. Wetland food resources for spring-migrating ducks in the upper-Mississippi River and Great Lakes Region. *Journal of Wildlife Management* 76:768 –777.
- Straub, J. N., R. M. Kaminski, A. G. Leach, A. W. Ezell, T. L. 2016. Acorn Yield and Masting Traits of Red Oaks in the Lower Mississippi River Alluvial Valley. *Forest Science* 62(1)18–27, [web link https://doi.org/10.5849/forsci.14-152](https://doi.org/10.5849/forsci.14-152).
- Sullivan, P. 2004. Sustainable soil management. ATTRA Publication #IP027/133. Available from http://attra.ncat.org/attrapub/soilmgmt.html#summary_sustainable.
- Tabashnik, B. E., J. B. J. Van Rensburg, and Y. Carrière. 2009. Field-evolved insect resistance to *Bt* crops: definition, theory, and data. *Journal of Economic Entomology* 102(6):2011-2025.
- Tabashnik, B. E. 2010. Communal benefits of transgenic corn. *Science* 330:189-190.
- Tacker, P., E. Vories, and G. Huitink. 2006. *Drainage and Irrigation. Corn Production Handbook*. Eds. L. Espinoza and J. Ross. Little Rock: University of Arkansas, Division of Agriculture, Cooperative Extension Service.
- Titus, J.G. and C. Richman. 2001. Maps of Lands Vulnerable to Sea Level rise: Modeled Elevations along the U.S. Atlantic and Gulf Coasts. [Climate Research](#) 18(3):205-228.
- Towery, D., and S. Werblow, S. 2010. *Facilitating conservation farming practices and enhancing environmental sustainability with agricultural biotechnology*. Conservation Technology Information Center, West Lafayette, IN.

Twedt, D.J., and C. R. Loesch. 1999. Forest area and distribution in the Mississippi Alluvial Valley: implications for breeding bird conservation. *Journal of Biogeography* 26:1215–1224.

U. S. Department of Agriculture (USDA). 1980. Report and Recommendations on Organic Farming. Pp110.

U.S. Department of Agriculture (USDA). 2011. U.S. Agriculture and Forestry Greenhouse Gas Inventory: 1990-2008. Climate Change Program Office, Office of the Chief Economist, U.S. Department of Agriculture. Technical Bulletin No. 1930. 159 pp.

U.S. Department of Agriculture (USDA). 2020a. Agricultural Biotechnology Glossary. [web link https://www.usda.gov/topics/biotechnology/biotechnology-glossary](https://www.usda.gov/topics/biotechnology/biotechnology-glossary) Accessed 30 April 2020.

U.S. Department of Agriculture (USDA). 2020b. Organic Standards. [web link https://www.ams.usda.gov/grades-standards/organic-standards](https://www.ams.usda.gov/grades-standards/organic-standards). Accessed 30 April 2020.

U. S. Department of Agriculture - Agriculture Research Service (USDA ARS). 2011. At ARS, the Atmosphere is Right for Air Emission Studies. *AgResearch Magazine* 59(6).

U. S. Department of Agriculture – Animal and Plant Health Inspection Service (USDA APHIS). 2000. Approval of Monsanto request (00-011-01p) seeking extension of determination of non-regulated status for glyphosate tolerant corn line NK603', Finding of No Significant Impact and Environmental Assessment, U.S. Department of Agriculture Animal and Plant Health Inspection Service, Washington, DC.

U. S. Department of Agriculture – Animal and Plant Health Inspection Service (USDA APHIS). 2006. Petition for Non-regulated Status for Soybean Line MON 89788 (APHIS 06-178-01p), Finding of No Significant Impact and Environmental Assessment, U.S. Department of Agriculture Animal and Plant Health Inspection Service, Washington, DC.

U. S. Department of Agriculture – Animal and Plant Health Inspection Service (USDA APHIS). 2007. Petition for non-regulated status for soybean line MON 89788 (APHIS 06-178-01p)', Finding of No Significant Impact and Environmental Assessment, U.S. Department of Agriculture Animal and Plant Health Inspection Service, Washington, DC.

U. S. Department of Agriculture – Animal and Plant Health Inspection Service (USDA APHIS). 2013a. Pioneer Hi-Bred International, Inc. petition (11-244-01p) for determination of nonregulated status of insect-resistant and herbicide-tolerant Pioneer 4114 Maize: event DP-004114-3, Final Environmental Assessment, DP-004114-3, U.S. Department of Agriculture APHIS, Riverdale, MD.

U. S. Department of Agriculture – Animal and Plant Health Inspection Service (USDA APHIS). 2013b. Syngenta Company Petition for Determination of Nonregulated Status of SYN-05307-1 Rootworm Resistant Corn, Final Environmental Assessment, SYN-05307-1, U.S. Department of Agriculture APHIS, Riverdale, MD.

U. S. Department of Agriculture – Animal and Plant Health Inspection Service (USDA APHIS). 2014a. Dow AgroSciences Petitions (09-233-01p, 09-349-01p, and 11234-01p) for Determination of Nonregulated Status for 2,4-D-Resistant Corn and Soybean Varieties, Final Environmental Impact Statement, U.S. Department of Agriculture APHIS, Riverdale, MD.

U. S. Department of Agriculture – Animal and Plant Health Inspection Service (USDA APHIS). 2014b. Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba-Resistant Soybean and Cotton Varieties, Final Environmental Impact Statement, U.S. Department of Agriculture APHIS, Riverdale, MD.

U. S. Department of Agriculture – Animal and Plant Health Inspection Service (USDA APHIS). 2016. Monsanto Company Petition 15-113-01 for Determination of Non-regulated Status for Dicamba and Glufosinate-Resistant Maize, Final Environmental Assessment, MON 87419, U.S. Department of Agriculture APHIS, Riverdale, MD.

U.S. Department of Agriculture - Economic Research Service (USDA ERS). 2018. Recent Trends in GE Adoption. Retrieved March 2019. [web link https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx](https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx)

US Department of Agriculture - Economic Research Service (USDA ERS). 2010. Table 6-Certified Organic Grain Crop Acreage, by State, 1997-2008 U.S. Department of Agriculture–Economic Research Service August 13 2011 [web link http://www.ers.usda.gov/Data/Organic/](http://www.ers.usda.gov/Data/Organic/)

U. S. Department of Agriculture - National Organic Program (USDA NOP). 2011. The Program Handbook: Guidance and Instructions for Accredited Certifying Agents and Certified Operations. NOP 1100. Washington DC.

U. S. Department of Agriculture - National Agricultural Statistics Service (USDA NASS). 2013. 2012 Agricultural Chemical Use Survey--Soybeans, viewed 13 August 2013, [web link https://www.agcensus.usda.gov/Publications/2012/index.php](https://www.agcensus.usda.gov/Publications/2012/index.php)

U. S. Department of Commerce Census Bureau (USDC Census Bureau). 2017. [web link https://www.census.gov/data/datasets/2017/demo/popest.html](https://www.census.gov/data/datasets/2017/demo/popest.html) Retrieved February 10, 2019.

U. S. Department of the Interior (USDOI). 2007. Integrated Pest Management Policy. Departmental Manual Part 517, Chapter 1. [web link https://training.fws.gov/resources/course-resources/pesticides/Pesticide%20Regulations%20and%20Policies/DOI-IPM-Policy.pdf](https://training.fws.gov/resources/course-resources/pesticides/Pesticide%20Regulations%20and%20Policies/DOI-IPM-Policy.pdf)

U.S. Department of the Interior, Environment Canada. 1986. North American Waterfowl Management Plan: a strategy for cooperation. U.S. Fish and Wildlife Service, Washington, D.C., USA. <https://www.fws.gov/birds/management/bird-management-plans/north-american-waterfowlmanagement-plan/plan-documents.php>. Accessed February 2019.

U.S. Department of the Interior, Environment Canada, and Environment and Natural Resources Mexico (USDOI EC ENRM). 2012a. North American Waterfowl Management Plan: People Conserving Waterfowl and Wetlands. U.S. Department of the Interior, Washington, D.C., USA. <https://nawmprevision.org/>. Accessed March 2019.

U.S. Department of the Interior, Environment Canada, and Environment and Natural Resources Mexico. Revised Objectives An Addendum to the 2012 North American Waterfowl Management Plan. (USDOI EC ENRM). 2012b. U.S. Department of the Interior, Washington, D.C., USA. 10pp.

U.S. Environmental Protection Agency (USEPA). 2001. Biopesticides registration action document (BRAD)--*Bacillus thuringiensis* plant-incorporated protectants. U.S. Environmental Protection Agency, Washington, DC.

U.S. Environmental Protection Agency (USEPA). 2012. "Chapter 6: Agriculture." Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010. Washington, DC: U.S. Environmental Protection Agency. p 6-1 through 6-41.

<http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html> >

U.S. Environmental Protection Agency (USEPA). 2019. Endangered Species. [web link
www.epa.gov/endangered-species/learn-more-about-threatened-and-endangered-species](http://www.epa.gov/endangered-species/learn-more-about-threatened-and-endangered-species)
Retrieved January 14, 2019.

U.S. Fish and Wildlife Service (USFWS). 2000. Compatibility. Fish and Wildlife Service Manual. 603 FW 2. 19pp. Accessed March, 2019. [web link
https://www.fws.gov/policy/603fw2.pdf](https://www.fws.gov/policy/603fw2.pdf)

U.S. Fish and Wildlife Service (USFWS). 2005. Atlantic Coast Joint Venture Waterfowl Implementation Plan, Revision, March 2005.

U. S. Fish and Wildlife Service (USFWS). 2006a. Biological Integrity, Diversity, and Environmental Health. 601 FW 3. <[web link https://www.fws.gov/policy/601fw3.html](https://www.fws.gov/policy/601fw3.html)>

U.S. Fish and Wildlife Service (USFWS). 2006b. Appropriate Refuge Uses. 603 FW 1. [web link https://www.fws.gov/policy/603fw1.html](https://www.fws.gov/policy/603fw1.html).

U.S. Fish and Wildlife Service (USFWS). 2007. Delegation of Authority and Process for Approving the Use of Genetically Modified Crops (GMCs) on National Wildlife Refuges in the Southeast Region. Memorandum FWS/R4/RF/RM-PL. Issued 2 April 2007.

U.S. Fish and Wildlife Service (USFWS). 2010a. Integrated Pest Management Policy. 569 FW 1. Issued August 3, 2010. Viewed March 2019, [web link
https://www.fws.gov/policy/569fw1.html](https://www.fws.gov/policy/569fw1.html).

U.S. Fish and Wildlife Service (USFWS). 2010b. Eligibility Questionnaire for the use of GMCs on Refuge System. Memorandum FWS/ANRS-NRCP/045654. Issued 28 June 2010. U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 2015. National Wildlife Refuge System Annual Performance Report FY2015. 18pp. [web link
https://www.fws.gov/refuges/about/RefugeReports/pdfs/RAPP_Rpt_2015_final.pdf](https://www.fws.gov/refuges/about/RefugeReports/pdfs/RAPP_Rpt_2015_final.pdf).

U. S. Fish and Wildlife Service (USFWS). 2017a. Cooperative Agricultural Use. 602 FW2. [web link https://www.fws.gov/policy/620fw2.html](https://www.fws.gov/policy/620fw2.html).

U.S. Fish and Wildlife Service (USFWS). 2017b. Conserving the Southeast's At-Risk Species. USFWS Southeast Region. Atlanta, GA. 2pp. [web link
www.fws.gov/southeast/candidateconservation](http://www.fws.gov/southeast/candidateconservation) Retrieved January 14, 2019.

U.S. Fish and Wildlife Service Refuge Annual Performance Plan (USFWS). 2017c. [web link
https://fishnet.fws.doi.net/regions/9/nwrs/apps/RAPP/Reports1/Forms/AllItems.aspx](https://fishnet.fws.doi.net/regions/9/nwrs/apps/RAPP/Reports1/Forms/AllItems.aspx)

U.S. Fish and Wildlife Service Refuge Annual Performance Plan (USFWS). 2019. <https://fishnet.fws.doi.net/regions/9/nwrs/apps/RAPP/Reports1/Forms/AllItems.aspx>

U.S. Fish and Wildlife Service (USFWS). 2018. Pesticide Use Proposal Database. Agency access only.

- U. S. Fish and Wildlife Service (USFWS). 2019. Threatened and Endangered Species on National Wildlife Refuges Database. [U. S. Fish and Wildlife Service Threatened and Endangered Species web page](#), retrieved January 11, 2019)
- U.S. Fish and Wildlife Service (USFWS). 2020. Environmental Conservation Online System (ECOS). Listed Species Summary. [web link https://ecos.fws.gov/ecp0/reports/box-score-report](https://ecos.fws.gov/ecp0/reports/box-score-report). Retrieved March 4, 2020.
- U.S. Fish and Wildlife Service, Lower Mississippi Valley Joint Venture Waterfowl Working Group (USFWS LMVJV). 2012. Allocation of waterfowl habitat objectives within the Mississippi Alluvial Valley: An analytical framework and results. 48pp. <[web link http://www.lmvjv.org/library/WWG_literature/WWGTS_AllocationReport_Approved_6-5-12.pdf](http://www.lmvjv.org/library/WWG_literature/WWGTS_AllocationReport_Approved_6-5-12.pdf)> Accessed 24 May 2019.
- U.S. Fish and Wildlife Service, Lower Mississippi Valley Joint Venture (USFWS LMVJV). 2015. MAV Waterfowl Stepdown State Summaries. LMVJV Waterfowl Working Group c/o Lower Mississippi Valley Joint Venture, Vicksburg, MS.
- U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Pp. 144. [web link https://wsfrprograms.fws.gov/subpages/nationalsurvey/nat_survey2016.pdf](https://wsfrprograms.fws.gov/subpages/nationalsurvey/nat_survey2016.pdf)
- Van Eerd, L., K. A. Congreves, A. Hayes, A. Verhallen, and D. C. Hooker. 2014. Long-term tillage and crop rotation effects on soil quality, organic carbon, and total nitrogen. Canadian Journal of Soil Science, 2014, 94(3):303-315, [web link https://doi.org/10.4141/cjss2013-093](https://doi.org/10.4141/cjss2013-093)
- VanGessel, MJ. 2001. Glyphosate-resistant horseweed from Delaware. Weed Science 49:703-705.
- Vencill, W., R. Nichols, T. Webster, J. Soteres, C. Mallory-Smith, N. Burgos, W. Johnson, and M. R. McClelland. 2012. Herbicide Resistance: Toward an Understanding of Resistance Development and the Impact of Herbicide-Resistant Crops. Weed Science. 60. 2-30.
- Wang, L., J. Lyons, P. Kanehl, R. Bannerman, and E. Emmons. 2000. Watershed urbanization and changes in fish communities in southeastern Wisconsin streams. Journal of the American Water Resources Association 36(5):1173– 1189.
- West, L. T., J. N. Shaw, and E. P. Mersiovsky, editors. 2016. Soils of the Southeastern USA. University of Wisconsin Madison. Madison, Wisconsin. Pp. 385.
- Wiatrak, P.J., D.L. Wright, J.J. Marois, and D. Wilson. 2005. Influence of planting date on aflatoxin accumulation in *Bt*, non-*Bt*, and tropical non-*Bt* hybrids. Agronomy Journal 97(2):440–445.
- Wiken, E., F. J. Nava, and G. Griffith. 2011. North American terrestrial ecoregions—Level III. Montreal, Canada: Commission for Environmental Cooperation. Montreal (Quebec), Canada. Pp. 149. <<http://www3.cec.org/islandora/en/item/10415-north-american-terrestrial-ecoregionslevel-iii-en.pdf>> Accessed 25 July 2016.
- Wilcoxon C. A., J. W. Walk, and M. P. Ward. 2018. Use of cover crop fields by migratory and resident birds. Agriculture, Ecosystems and Environment 252:42–50.

Williams, B. K., M. D. Koneff and D. A. Smith. 1999. Evaluation of waterfowl conservation under the North American Waterfowl Management Plan. *Journal of Wildlife Management* 63: 417-440.

Williams, W. P., G. L. Windham, P. M. Buckley, and J. M. Perkins. 2005. Southwestern corn borer damage and aflatoxin accumulation in conventional and transgenic corn hybrids. *Field Crops Research* 91(2-3):329–336.

Willson, H. R., J. B. Eisley. 2001. European corn borer. Extension fact sheet, Ohio State University Extension.

Wilson, R. R., J. M. Oliver, D. J. Twedt, and W. B. Uihlein. 2005. Bottomland hardwood restoration in the Mississippi Alluvial Valley: looking past the trees to see the forest. Pages 519-526 in L. H. Fredrickson, S. L. King, and R. M. Kaminski, editors. *Ecology and management of bottomland hardwood systems: the state of our understanding*. University of Missouri-Columbia, Gaylord Memorial Laboratory Special Publication No. 10, Puxico, Missouri, USA

Winslow, C. J. 2003. Estimation of waterfowl food abundance in coastal freshwater marshes of Louisiana and Texas. Thesis, Louisiana State University, Baton Rouge, LA, USA. 59 pp.

Zhao, J., D. A. Neher, S. Fu, Z. Li, and K. Lang. 2013. Non-target effects of herbicides on soil nematode assemblages. *Pest Management Science*, 69(6):279-284.

Zangerl, A. R., D. McKenna, C. L. Wraight, M. Carroll, P. Ficarello, R. Warner, and M.R. Berenbaum. 2001. Effects of exposure to event 176 *Bacillus thuringiensis* corn pollen on march and black swallowtail caterpillars under field conditions. *Proceedings of the National Academy of Sciences* 98(21):11908-11912.

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

Alabama

Choctaw NWR, Eufaula NWR, Key Cave NWR, Wheeler NWR

Arkansas

Big Lake NWR, Cache River NWR, Bald Knob NWR, Overflow NWR, Holla Bend NWR, Pond Creek NWR, Wapanocca NWR, Dale Bumpers White River NWR

Kentucky

Clarks River NWR

Louisiana

Red River NWR, Upper Ouachita NWR, Black Bayou Lake NWR, Handy Brake NWR, Lacassine NWR, Grand Cote NWR, Catahoula NWR, Tensas River NWR, Lake Ophelia NWR, Bayou Cocodrie NWR, Cat Island NWR,

Mississippi

Panther Swamp NWR, Yazoo NWR, St. Catherine Creek NWR, Sam D. Hamilton Noxubee NWR, MorganBrake NWR, Tallahatchie NWR, Dahomey NWR, Coldwater River NWR

North Carolina

Mattamuskeet NWR, Pee Dee NWR, Mackay Island NWR, Alligator River NWR, Pocosin Lakes NWR

South Carolina

Santee NWR

Tennessee

Cross Creeks NWR, Tennessee NWR, Lake Isom NWR, Reelfoot NWR, Lower Hatchie NWR, Hatchie NWR, Chickasaw NWR

Appendix C. Regional Genetically Modified Crop (GEC) Guidance.



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 *Jon Andrews*

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 glufosinate-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.

Some 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.
5 th 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 and public review and comment. This document incorporates information provided by interested citizens, conservation organizations, and local and state agencies.

SCOPING

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 the [Programmatic Environmental Assessment project web site](#).

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 the [Programmatic Environmental Assessment web page](#).

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? How would GEC use impact soil conditions and ecology?
6. 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.

PUBLIC REVIEW AND COMMENT

The Service announced the availability of the draft Programmatic Environmental Assessment on March 18, 2020. Notices were mailed directly to those individuals who had expressed interest in the action through the scoping process and in the time since scoping. In addition, information was provided to media outlets in 10 southeastern states including; Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina and Tennessee. A second media notice was sent on March 30, 2020. The Service also used agency social media to announce the availability of the draft document for review.

A website, established for the project during scoping, was available to the public with up to date information on the development of the PEA. The document was posted on the web site as well. The document was also posted on the U.S. Fish and Wildlife Service, Southeast Region web site.

COORDINATION

The management action has been thoroughly coordinated with all interested and affected parties. Parties contacted include:

- Congressional representatives
- Southeastern States Coastal Zone Management Programs
- Southeastern States Clearing Houses or appropriate State Agencies
- Affected Tribes including:
Catawba Indian Nation, Chitimacha Tribe of Louisiana, Coushatta Tribe of Louisiana, Eastern Band of Cherokee, Jena Band of Choctaw, Miccosukee Tribe of Indians of Florida, Mississippi Band of Choctaw Indians, Poarch Band of Creek Indians, Seminole Indian Tribe of Florida Tunica-Biloxi Indian Tribe of Louisiana, Absentee Shawnee Tribe of Indians, Alabama-Coushatta Tribe of Texas, Alabama-Quassarte Tribal Town, Caddo National of Oklahoma, Cherokee Nation of Oklahoma, Chickahominy Tribe, Chickahominy Tribe, Eastern Division, Chickasaw Nation, Choctaw Nation of Oklahoma, Delaware Nation of Oklahoma, Delaware Tribe of Indians, Eastern Shawnee Tribe of Oklahoma, Kialegee Tribal Town, Miami Tribe of Oklahoma, Monacan Indian Nation, Muscogee (Creek) Nation, Nansemond Tribe, Osage Nation, Pamunkey Indian Tribe, Peoria Tribe of Indians of Oklahoma, Quapaw Tribe of Indians, Rappahannock Tribe, Seminole Nation of Oklahoma, Seneca-Cayuga Nation, Shawnee Tribe of Oklahoma, Stockbridge Munsee Community, Thlopthlocco Tribal town, Tuscarora Nation of New York, United Keetooway Band of Cherokee Indians of Oklahoma, Upper Mattaponi Tribe, Wichita & Affiliated Tribes (Wichita, Keechi, Waco and Tawakonia)
- State Media Outlets
- Local community officials
- Interested citizens

COMMENT PERIOD

On March 20, 2020, the Service distributed a news release of the draft PEA to over 300 media outlets in 10 southeastern states including; Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. A second notice was distributed on March 30, 2020. Recipients included newspapers, radio stations, and television stations.

Two public information sessions were held via the electronic platform Zoom. One on April 6, 2020, at 1:00pm EDT had 37 participants, a second on April 7, 2020, at 7:00pm EDT had 29 participants. Those attending were provided a general summary of the process followed in developing the PEA and instructions on how to access and comment on the document. A question and answer period was provided at the end of each session. A recording of each session along with the questions and service answers were posted on the project web site.

The Service received 12,157 submissions on the draft PEA, with 157 unique submissions and the remainder duplicates (Appendix F). Two hundred five comments were included in the submissions. Comments are summarized in Appendix F and are categorized as comments related to: Public Outreach; Cooperating Agencies; Purpose and Need; Range of

Alternatives; Best Available Information; Relationship to Rules, Regulations, Policy and Statutes; Impacts Analysis, Direct and Indirect Effects; Impacts Analysis, Scope of Analysis; Impacts Analysis, Cumulative Impacts; Impacts Analysis, Physical Impacts and Climate Change; Impacts Analysis, Physical Resources – Soil Resources; Impacts Analysis, Physical Resources – Water Resources; Impacts Analysis – Biological Resources; Impacts Analysis, Wildlife Resources; Impacts Analysis, Threatened and Endangered Species. Impacts Analysis, Wildlife Resources – Invasive Species; Impacts Analysis, Wildlife Resources – Insects; Impacts Analysis, Socioeconomic Resources; Impacts Analysis, Environmental Justice and Human Health.

Appendix E. Intra-Service Section 7 Biological Evaluation

Originating Person: Tina Chouinard

Telephone Number: 731-432-0981

E-Mail: tina_chouinard@fws.gov

Date: February 14, 2020

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
- 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) Regional 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 an agricultural management program.

IV. Pertinent Species and Habitat:

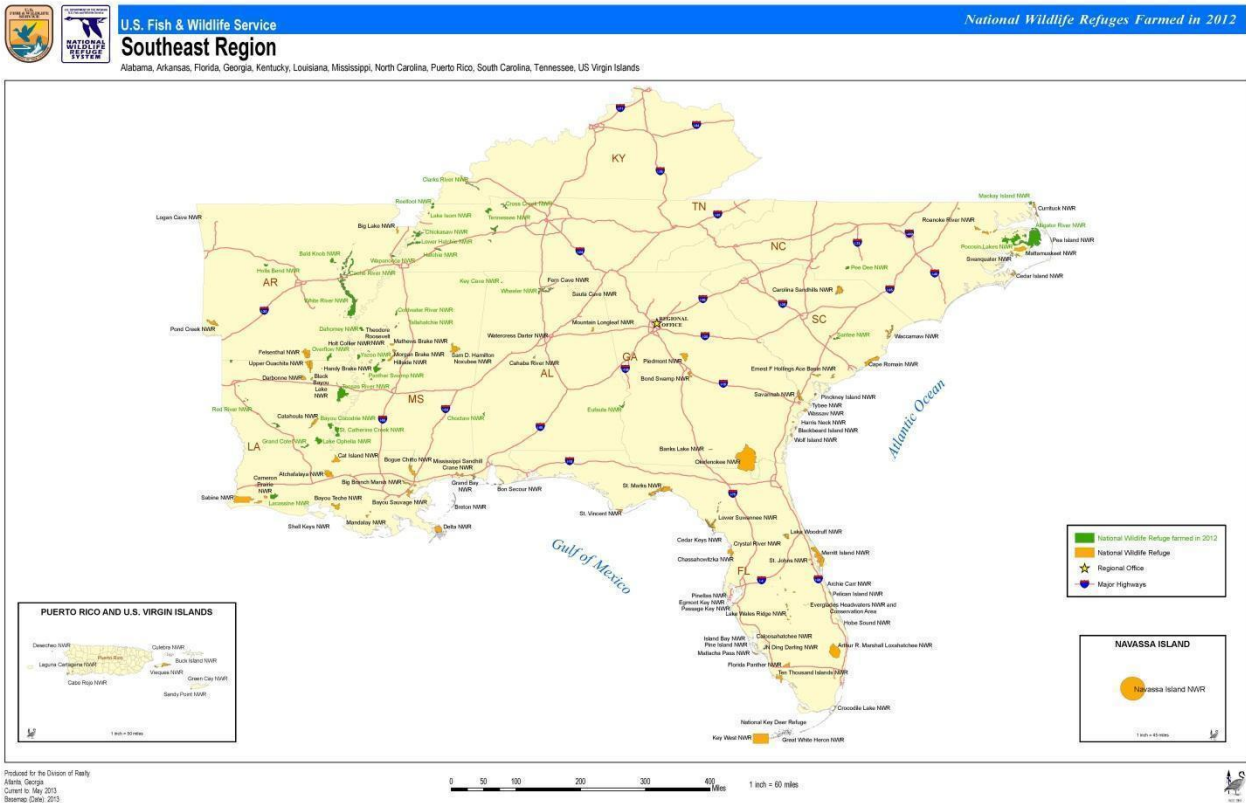
SPECIES/CRITICAL HABITAT	STATUS1
Red wolf (<i>Canus rufus</i>)	E
Mississippi sandhill crane (<i>Grus canadensis pulla</i>)	E
Interior Least Tern (<i>Sterna antillarum</i>)	E
Piping Plover (<i>Charadrius melodus</i>)	E/T
Red-cockaded woodpecker (<i>Picoides borealis</i>)	E
Yellow-shouldered blackbird (<i>Agelaius xanthomus</i>)	E
Whooping Crane (<i>Grus americana</i>)	E
Ivory-billed Woodpecker (<i>Campephilus principalis</i>)	E
Pallid sturgeon (<i>Scaphirhynchus albus</i>)	E
Indiana bat (<i>Myotis sodalis</i>)	E
Northern Long-eared Bat (<i>Myotis septentrionalis</i>)	T
Gray Bat (<i>Myotis grisescens</i>)	E
West Indian manatee (<i>Trichechus manatus</i>)	T
American burying beetle (<i>Nicrophorus americanus</i>)	E
Anthony's riversnail (<i>Atheurnia anthonyi</i>)	E
Gopher tortoise (<i>Gopherus polyphemus</i>)	T
Alabama cave shrimp (<i>Palaemonias alabamae</i>)	E
Kentucky cave shrimp (<i>Palaemonias ganteri</i>)	E, CH
Alabama cavefish (<i>Speoplatyrhinus poulsoni</i>)	E
Armored snail (<i>Pyrgulopsis pachyta</i>)	E
White warty-back pearlymussel (<i>Plethobasus cicatricosus</i>)	E*
Spectaclecase (<i>Cumberlandia monodonta</i>)	E
Slabside pearlymussel (<i>Pleuonaia dolabelloides</i>)	E, CH
Slender campeloma (<i>Campeloma decampi</i>)	E
Sheepnose (<i>Plethobasus cyphus</i>)	E
Rough pigtoe (<i>Pleurobema plenum</i>)	E*
Pink Mucket Mussel (<i>Lampsilis abrupta</i>)	E

SPECIES/CRITICAL HABITAT	STATUS ¹
Fat Pocketbook Mussel (<i>Potamilus capax</i>)	E
Rabbitsfoot Mussel (<i>Quadrula cylindrica</i>)	T, CH
Pondberry (<i>Lindera melissifolia</i>)	E
Wood stork (<i>Mycteria americana</i>)	T
Schaus Swallowtail butterfly (<i>Aristodemus ponceanus</i>)	E
Spring pygmy sunfish (<i>Elassoma alabamiae</i>)	T, CH
Snuffbox mussel (<i>Epioblasma triquetra</i>)	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

² * Non-Essential Experimental Population also exists.

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
Red wolf (<i>Canus rufus</i>)	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 (<i>Grus canadensis pulla</i>)	Is known to occur in Mississippi on Mississippi Sandhill Crane NWR.
Interior Least Tern (<i>Sterna antillarum</i>)	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 (<i>Charadrius melodus</i>)	Is known to occur in Mississippi, Arkansas, and Tennessee and on many NWRs within the southeast.
Red-cockaded woodpecker (<i>Picoides borealis</i>)	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

Species	Occurrence
	National Wildlife Refuge. May occasionally occur on other NWRs in the southeast.
Whooping Crane (<i>Grus americana</i>)	Experimental, non-essential population segment may occur in Kentucky, Tennessee, Arkansas, Mississippi, Louisiana, South Carolina, North Carolina, Florida, and Alabama.
Ivory-billed Woodpecker (<i>Campephilus principalis</i>)	May occur on Cache River and White River NWRs in Arkansas.
Pallid sturgeon (<i>Scaphirhynchus albus</i>)	Known to occur in Arkansas, Mississippi, Kentucky, Tennessee, and Louisiana on Atchafalaya National Wildlife Refuge and other NWRs in the Southeast Region.
Indiana bat (<i>Myotis sodalis</i>)	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 Bat (<i>Myotis grisescens</i>)	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 (<i>Trichechus manatus</i>)	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 (<i>Nicrophorus americanus</i>)	Known or may occur in NWRs in Arkansas and Kentucky.
Anthony's riversnail (<i>Athearnia anthonyi</i>)	Known to occur in Alabama and Tennessee and may occur on or near NWRs in the Southeast.
Gopher tortoise (<i>Gopherus polyphemus</i>)	Known to occur and wherever found west of Mobile and Tombigbee Rivers in AL, MS, and LA. Candidate everywhere else but its status is under review.
Alabama cave shrimp (<i>Palaemonias alabamae</i>)	Known to occur and wherever found in AL.
Kentucky cave shrimp (<i>Palaemonias ganteri</i>)	Known to occur in Kentucky.

Species	Occurrence
Alabama cavefish (<i>Speoplatyrhinus poulsoni</i>)	Known to occur on Key Cave NWR in Alabama
Armored snail (<i>Pyrgulopsis pachyta</i>)	Believed to occur in Alabama.
White warty-back pearlymussel (<i>Plethobasus cicatricosus</i>)	Known or believed to occur in Alabama, Kentucky and Tennessee and may occur on or near NWRs in the Southeast. Population, Non-Essential -TN - specified portions of the French Broad and Holston Rivers; see 17.85(b)(1))
Spectaclecase (<i>Cumberlandia monodonta</i>)	Known or believed to occur in Alabama, Arkansas, Kentucky, Tennessee and may occur on or near NWRs in the Southeast.
Slabside pearlymussel (<i>Pleuonaia dolabelloides</i>)	Known or believed to occur in Alabama, Kentucky, Tennessee and may occur on or near NWRs in the Southeast.
Slender campeloma (<i>Campeloma decampi</i>)	Known or believed to occur in Alabama, and may occur on or near NWRs in the Southeast.
Sheepnose (<i>Plethobasus cyphus</i>)	Known or believed to occur in Alabama, Mississippi, Tennessee and may occur on or near NWRs in the Southeast.
Rough pigtoe (<i>Pleurobema plenum</i>)	Known or believed to occur in Alabama, Kentucky, Tennessee and may occur on or near NWRs in the Southeast. Experimental Population TN - specified portions of the French Broad and Holston Rivers; see 17.85(b)(1)
Pink Mucket Mussel (<i>Lampsilis abrupta</i>)	Known or believed to occur in Alabama, Arkansas, Kentucky, Tennessee and may occur on or near NWRs in the Southeast.
Fat Pocketbook Mussel (<i>Potamilus capax</i>)	Known or believed to occur in Arkansas, Kentucky, Louisiana, Mississippi and may occur on or near NWRs in the Southeast.
Rabbitsfoot Mussel (<i>Quadrula cylindrica</i>)	Known or believed to occur in Alabama, Arkansas, Kentucky, Louisiana, Mississippi, and Tennessee and may occur on or near NWRs in the Southeast.
Pondberry (<i>Lindera melissifolia</i>)	Known to occur on some NWRs in Arkansas, Alabama, Georgia, Mississippi, North Carolina and South Carolina.

Species	Occurrence
Wood stork (<i>Mycteria americana</i>)	Known or believed to occur on some NWRs in Alabama, Georgia, Florida, Mississippi, North Carolina and South Carolina.
Schaus Swallowtail butterfly (<i>Heraclides aristodemus ponceanus</i>)	Known to occur only in peninsular Florida.
Spring pygmy sunfish (<i>Elassoma alabamae</i>)	Known to occur in Alabama
Snuffbox mussel (<i>Epioblasma triquetra</i>)	Known to or is believed to occur: Alabama , Arkansas, Kentucky, Mississippi, Tennessee
Northern long-eared bat (<i>Myotis septentrionalis</i>)	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
Red wolf (<i>Canus rufus</i>)	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 (<i>Grus canadensis pulla</i>)	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 (<i>Sterna antillarum</i>)	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 (<i>Charadrius melodus</i>)	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 (<i>Picoides borealis</i>)	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.

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
Whooping Crane (<i>Grus americana</i>)	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.
Ivory-billed Woodpecker (<i>Campephilus principalis</i>)	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 (<i>Scaphirhynchus albus</i>)	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 (<i>Myotis sodalist</i>)	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 (<i>Myotis septentrionalis</i>)	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 Bat (<i>Myotis grisescens</i>)	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

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
	treatment from dusk to sunrise. This species would not likely be impacted by the proposed action.
West Indian manatee (<i>Trichechus manatus</i>)	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 (<i>Nicrophorus americanus</i>)	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 (<i>Athearnia anthonyi</i>)	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 (<i>Gopherus polyphemus</i>)	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.
Kentucky cave shrimp (<i>Palaemonias ganteri</i>)	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

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
	required buffer distances). This species would not likely be impacted by the proposed action.
Alabama cave shrimp (<i>Palaemonias alabamae</i>)	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 (<i>Speoplatyrhinus poulsoni</i>)	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 (<i>Pyrgulopsis pachyta</i>)	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 (<i>Plethobasus cicatricosus</i>)	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.

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
Spectaclecase (<i>Cumberlandia monodonta</i>)	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 (<i>Pleuonaiia dolabelloides</i>)	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 (<i>Campeloma decampi</i>)	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 (<i>Plethobasus cyphus</i>)	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 (<i>Pleurobema plenum</i>)	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.

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
Pink Mucket Mussel (<i>Lampsilis abrupta</i>)	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 (<i>Potamilus capax</i>)	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 (<i>Quadrula cylindrica</i>)	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 (<i>Lindera melissifolia</i>)	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 (<i>Mycteria americana</i>)	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.

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
Schaus Swallowtail butterfly <i>(Papilio aristodemus ponceanus)</i>	This species only occurs within a limited range of south Florida and will not be impacted by the proposed action
Spring pygmy sunfish <i>(Elassoma alabamae)</i>	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 <i>(Epioblasma triquetra)</i>	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
Red wolf (<i>Canus rufus</i>)	Following Best Management Practices described above will minimize any impacts.
Mississippi sandhill crane <i>(Grus canadensis pulla)</i>	Following Best Management Practices described above will minimize any impacts.
Interior Least Tern <i>(Sterna antillarum)</i>	Following Best Management Practices described above will minimize any impacts.
Piping Plover (<i>Charadrius melodus</i>)	Following Best Management Practices described above will minimize any impacts.

SPECIES/ CRITICAL HABITAT	ACTIONS TO MITIGATE/MINIMIZE IMPACTS
Red-cockaded woodpecker (<i>Picoides borealis</i>)	Following Best Management Practices described above will minimize any impacts.
Whooping Crane (<i>Grus americana</i>)	Following Best Management Practices described above will minimize any impacts.
Ivory-billed Woodpecker (<i>Campephilus principalis</i>)	Following Best Management Practices described above will minimize any impacts.
Whooping crane (<i>Grus americana</i>)	Following Best Management Practices described above will minimize any impacts.
Pallid sturgeon (<i>Scaphirhynchus albus</i>)	Following Best Management Practices described above will minimize any impacts.
Indiana bat (<i>Myotis sodalis</i>)	Following Best Management Practices described above will minimize any impacts.
Gray bat (<i>Myotis grisescens</i>)	Following Best Management Practices described above will minimize any impacts.
West Indian manatee (<i>Trichechus manatus</i>)	Following Best Management Practices described above will minimize any impacts.
American burying beetle (<i>Nicrophorus americanus</i>)	Following Best Management Practices described above will minimize any impacts.
Anthony's riversnail (<i>Athearnia anthonyi</i>)	Following Best Management Practices described above will minimize any impacts.
Alabama cave shrimp (<i>Palaemonias alabamae</i>)	Following Best Management Practices described above will minimize any impacts.
Gopher tortoise (<i>Gopherus polyphemus</i>)	Following Best Management Practices described above will minimize any impacts.
Kentucky cave shrimp (<i>Palaemonias ganteri</i>)	Following Best Management Practices described above will minimize any impacts.
Alabama cavefish (<i>Speoplatyrhinus poulsoni</i>)	Following Best Management Practices described above will minimize any impacts.
Armored snail (<i>Pyrgulopsis pachyta</i>)	Following Best Management Practices described above will minimize any impacts.
White warty-back pearl mussel	Following Best Management Practices described above will minimize any impacts.

SPECIES/ CRITICAL HABITAT	ACTIONS TO MITIGATE/MINIMIZE IMPACTS
<i>(Plethobasus cicatricosus)</i>	
Spectaclecase <i>(Cumberlandia monodonta)</i>	Following Best Management Practices described above will minimize any impacts.
Slabside pearlymussel <i>(Pleuronaia dolabelloides)</i>	Following Best Management Practices described above will minimize any impacts.
Slender campeloma <i>(Campeloma decampi)</i>	Following Best Management Practices described above will minimize any impacts.
Sheepnose <i>(Plethobasus cyphus)</i>	Following Best Management Practices described above will minimize any impacts.
Rough pigtoe <i>(Pleurobema plenum)</i>	Following Best Management Practices described above will minimize any impacts.
Pink Mucket Mussel <i>(Lamsilis abrupt)</i>	Following Best Management Practices described above will minimize any impacts.
Fat Pocketbook Mussel <i>(Potamilus capax)</i>	Following Best Management Practices described above will minimize any impacts.
Rabbitsfoot Mussel <i>(Quadrula cylindrica)</i>	Following Best Management Practices described above will minimize any impacts.
Pondberry <i>(Lindera melissifolia)</i>	Following Best Management Practices described above will minimize any impacts.
Wood stork <i>(Mycteria americana)</i>	Following Best Management Practices described above will minimize any impacts.
Schaus Swallowtail butterfly <i>(Heraclides aristodemus ponceanus)</i>	Following Best Management Practices described above will minimize any impacts.
Spring pygmy sunfish <i>(Elassoma alabamæ)</i>	Following Best Management Practices described above will minimize any impacts.
Snuffbox mussel <i>(Epioblasma triquetra)</i>	Following Best Management Practices described above will minimize any impacts.
Northern long-eared bat <i>(Myotis septentrionalis)</i>	Following Best Management Practices described above will minimize any impacts.

VIII. Effect Determination and Response Requested:

SPECIES/CRITICAL HABITAT	DETERMINATION ¹			REQUESTED
	NE	NA	AA	
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
Ivory-billed Woodpecker		X		Concurrence
Whooping crane		X		Concurrence
Pallid sturgeon		X		Concurrence
Indiana bat		X		Concurrence
Gray bat		X		Concurrence
West Indian manatee		X		Concurrence
American burying beetle		X		Concurrence
Anthony's riversnail		X		Concurrence
Gopher tortoise		X		Concurrence
Alabama cave shrimp		X		Concurrence
Kentucky cave shrimp		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

SPECIES/CRITICAL HABITAT	DETERMINATION ¹			REQUESTED
	NE	NA	AA	
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

Appendix F. Response to Substantive Public Comments

On March 20, 2020, the Service distributed a news release of the draft PEA to over 300 media outlets in 10 southeastern states including; Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. A second notice was distributed on March 30, 2020. Recipients included newspapers, radio stations, and television stations.

Two public information sessions were held via the electronic platform Zoom. One on April 6, 2020, at 1:00pm EDT had 37 participants, a second on April 7, 2020, at 7:00pm EDT had 29 participants. Those attending were provided a general summary of the process followed in developing the PEA and instructions on how to access and comment on the document. A question and answer period was provided at the end of each session. A recording of each session along with the questions and service answers were posted on the project web site.

The Service received 12,157 submissions on the draft PEA, with 157 unique submissions and the remainder duplicates (Appendix F). Two hundred five comments were included in the submissions. Comments are summarized below and are categorized as comments related to: Public Outreach; Cooperating Agencies; Purpose and Need; Range of Alternatives; Best Available Information; Relationship to Rules, Regulations, Policy and Statutes; Impacts Analysis, Direct and Indirect Effects; Impacts Analysis, Scope of Analysis; Impacts Analysis, Cumulative Impacts; Impacts Analysis, Physical Impacts and Climate Change; Impacts Analysis, Physical Resources – Soil Resources; Impacts Analysis, Physical Resources – Water Resources; Impacts Analysis – Biological Resources; Impacts Analysis, Wildlife Resources; Impacts Analysis, Threatened and Endangered Species. Impacts Analysis, Wildlife Resources – Invasive Species; Impacts Analysis, Wildlife Resources – Insects; Impacts Analysis, Socioeconomic Resources; Impacts Analysis, Environmental Justice and Human Health.

Public Outreach

Concern 1: Commenters felt that they did not have sufficient time to review, analyze, and provide comments on the draft Programmatic Environmental Assessment (PEA) due to the outbreak of Coronavirus Disease (COVID-19), and requested that the U.S. Fish and Wildlife Service extend the comment period on the draft PEA by at least 60 days until June 9, 2020.

Response. The U.S. Fish and Wildlife Service has extended the public comment period on the PEA until April 19, 2020, a total of 30 days. The Service determined 30 days is an adequate amount of time to allow the public to thoroughly review, analyze, and provide comments on the PEA.

Concern 2: Commenters requested that the U.S. Fish and Wildlife Service consult more with local tribes during the development of the PEA.

Response. Pursuant to the National Historic Preservation Act Section 106, the U.S. Fish and Wildlife Service invited Tribal Leaders and staff to consult on the development of the draft PEA

and to review and comment on the draft document. A list of those tribes contacted is provided in the "Public Comment" section of the PEA and FONSI of the final PEA, and we received a comment from the Chickasaw Nation. In addition, the agency coordinated with each state in the southeast region of the FWS (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee), and each State Historic Preservation Officer was asked to review and comment on the draft PEA.

Concern 3: Commenters recommended that the U.S. Fish and Wildlife Service consult more with local farmers during the development of the PEA, and utilize their expertise to ensure the production of high-yielding crops to meet foraging goals on southeastern refuges.

Response. Most National Wildlife Refuges in the southeast that employ agricultural practices use cooperative agreements with local farmers to achieve specific wildlife habitat objectives that involve the production of cereal grain crops. Refuges regularly consult with Extension Services and are in regular discussions with neighboring farmers and often with farming organizations. Examples of comments received include those from scientists with the University of Tennessee Extension Service and the Mississippi Farming Bureau that offered their recommendations for our consideration during the review period. Through the cooperative arrangement, farmers are allowed to plant crops on a refuge and in exchange, leave a certain percent of the crops in the field for wildlife. Some National Wildlife Refuges undertake agricultural practices using U.S. Fish and Wildlife Service staff and equipment (force account); however, most National Wildlife Refuges in the southeast do not have the capability to use force account labor and equipment due to personnel limitations, the lack of specialized agricultural equipment, and opportunity costs of performing other tasks. Rarely do National Wildlife Refuges enter into contracts with local farmers to produce the desired acreage of cereal grain crops to meet wildlife objectives. By far, most National Wildlife Refuge managers in the southeast utilize cooperative agreements with local farmers to meet the agricultural needs.

Concern 4: Commenters asserted that the U.S. Fish and Wildlife Service did not conduct adequate public outreach and education efforts during the development of the PEA pursuant to the requirements of the National Environmental Policy Act (NEPA) and the Administrative Procedure Act by:

- failing to make available to the public for review and analysis the documents and literature that the Service relied on in support of the draft PEA;
- failing to provide details regarding the specific genetically engineered crops (GECs) that the Service anticipates approving for use on southeastern refuges; and
- failing to analyze the individual positive and negative environmental effects of each type of GEC that the Service anticipates approving for use on southeastern refuges.

Response. Only GECs that have been evaluated and deregulated or those that are exempted by the U.S. Department of Agriculture's Animal and Plant Inspection Service (APHIS), as described in 7 CFR 340.6, would be used on National Wildlife Refuges. All literature sources supporting analyses are referenced in the Literature Cited section of the PEA. Most sources are available on the internet, and hyperlinks were provided when appropriate. Most scientific journal articles are covered under copyright agreements with would preclude the U.S. Fish and Wildlife Service from posting them in their entirety, but they can be obtained from the publisher or through other sources. For more information please refer to page 34 of the PEA, Alternative 2: Allow the use of GECs on National Wildlife Refuges (Proposed Alternative). Under this alternative, National Wildlife Refuges in the southeast could use GECs for natural resource management as is done on private lands and wildlife management areas run by state agencies.

A National Wildlife Refuge would have the option of using GECs and non-GECs in rotation, as appropriate and guided by the overall National Wildlife Refuge System purpose(s), Comprehensive Conservation Plan (CCP) goals and objectives, other policy and guidance, and National Wildlife Refuge decision documents. 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 crop rotation, conservation tillage, limited soil preparation, direct drill planting, nutrient management including conservation buffers and cover crops, integrated pest management, and other techniques.

The Region would also use a tiered analysis to determine whether a GEC could be used based on the following: 1) USDA-APHIS specific NEPA analysis and de-regulation/exemption of the GEC, 2) the programmatic NEPA analysis of GEC use in the southeast, 3) NEPA analysis of GEC use on a specific National Wildlife Refuge or Complex tiered from the Region's programmatic NEPA analysis of GEC use as well as associated National Wildlife Refuges planning documents, and 4) analysis of whether such GEC use would satisfy the essentialness requirement of the Biological Integrity, Diversity, and Environmental Health Policy.

Cooperating Agencies

Concern 1: The Chickasaw Nation accepted the U.S. Fish and Wildlife Service's invitation to participate as a cooperating agency during the development of the PEA. The Chickasaw Nation requested that if the Service needs to initiate additional consultation or enforce other statutes, it should notify the Chickasaw Nation pursuant to the applicable legal statutes and Professional Standards.

Response. The U.S. Fish and Wildlife Service acknowledges receipt of this comment.

Purpose and Need

Concern 1: Commenters expressed concern that the measures suggested by the U.S. Fish and Wildlife Service in the draft PEA do not meet the stated Purpose and Need of the PEA.

Response. The U.S. Fish and Wildlife Service agrees to remove "Allow refuges to meet wildlife goals that cannot be reached through the use of traditional crop varieties alone" from the need statement and have changed, combined, and replaced that specific need statement to read: Ensure that we can consistently meet refuge goals and objectives while adhering to applicable laws and policies. As the commenter stated, the original statement precluded the Service from analyzing traditional crop varieties, which was not the intent of the Service. In fact, the Service fully analyzed the no action (non-GEC) and proposed action (GEC) Alternatives. The Service also agrees to alter the Need Statement "Ensure refuges have an economically feasible method of implementing agricultural practices" to state "Ensure refuges have minimized economic risks of implementing agricultural practices;" This statement more fully aligns with Service laws, policy and guidance. Both of the Alternatives were analyzed with this revised sideboard and did not create further change in the analysis. NEPA requires that alternatives must be feasible, both technically and economically (Page 20; [NEPA for Wildlife Refuges: A Handbook](#)). Thus, we believe with the amendment to the underlying need, the U.S. Fish and Wildlife Service has appropriately analyzed both alternatives.

Concern 2: Commenters felt that the U.S. Fish and Wildlife Service’s “preferred” alternative in the draft PEA does not meet many of the objectives listed in the draft PEA (i.e., higher crop yield to produce more food for migratory birds, economic feasibility, and interests related to socioeconomic resources). Specifically, commenters asserted that the profitability to local farmers that arises from planting GECs, rather than non-GECs, should not be a guiding principle for the U.S. Fish and Wildlife Service for refuge management, as economic benefits from GECs alone cannot meet the needs defined in the draft PEA.

Response. The adoption of GECs, including *Bt* crops, increases yields by mitigating yield losses from competition from weeds and insects. However, empirical evidence regarding the effect of herbicide-tolerance on crop yields is mixed. Generally, stacked seeds (seeds with more than one GE trait) tend to have higher yields than non-GEC seeds or than seeds with only one GE trait. Planting *Bt* corn is associated with higher net returns when pest pressure is high. The extent to which herbicide tolerance adoption affects net returns is mixed and depends primarily on how much weed control costs are reduced, and seed costs are increased. Herbicide tolerant soybean adoption is associated with an increase in total household income because herbicide tolerant soybeans require less management and enable farmers to generate income via off-farm activities or by expanding operations (see [U. S. Department of Agriculture Genetically Engineered Crops](#)). As indicated on page 55 of the PEA, GECs can 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, increased pest damage, increased weed pressure, reduced pesticide use, poor soil quality, and high soil moisture. Thus, GEC use on National Wildlife Refuges is disproportionately important for successful agricultural production and providing increased high energy food production for waterfowl. The PEA states that GECs are likely a more economically viable option for cooperative farming partnerships, but it appropriately does not cover profitability of the practice to individual farmers. Profitability of farming operations of private farmers varies according to many factors and is outside the scope of this PEA. Additionally, agricultural practices are used to meet specific wildlife management objectives in certain areas of National Wildlife Refuges, thus, socioeconomic considerations such as trends in farm size on private lands are not relevant to this PEA.

Concern 3: Commenters suggested that the U.S. Fish and Wildlife Service include an explanation in the PEA regarding the reasons for the legal action to eliminate GEC use on southeastern refuges, and the reasons why GECs caused concern among the interested parties.

Response: This information is described in the Public Involvement Appendix (D), to the PEA. In this appendix, the Service identifies the issues and concerns expressed by the public on the use of GECs on National Wildlife Refuges.

Concern 4: Commenters felt that the U.S. Fish and Wildlife Service improperly eliminated the need to consider any other potential alternative to satisfy the first “Need” statement listed in the draft PEA. Commenters asserted that the first “Need” statement is therefore too narrow, and requested that the Service remove it from the PEA. Regarding the second “Need” statement listed in the draft PEA, commenters asserted that the U.S. Fish and Wildlife Service unlawfully created a need that is arbitrary, and directly conflicts with the controlling law governing the National Wildlife Refuge System.

Response. The U.S. Fish and Wildlife Service agrees to remove "that cannot be reached through the use of traditional crop varieties alone" from the "Need" statement and have changed, combined and replaced that specific "Need" statement to read: Ensure that we can consistently meet refuge goals and objectives while adhering to applicable laws and policies. As the commenter stated, the original statement precluded the Service from analyzing traditional crop varieties, which was not the Service's intent. In fact, the Service fully analyzed the no action (non-GEC use) and proposed action (GEC use) alternatives. The Service also agrees to alter the "Need" Statement by removing 'Ensure refuges have an economically feasible method of implementing agricultural practices' and adding with 'Ensure refuges have minimized economic risks of implementing agricultural practices.' Such change fully aligns with Service laws, policies and guidance. Both of the Alternatives were analyzed with the revised sideboard yet did not necessitate any additional change in the analysis. NEPA requires that alternatives must be feasible, both technically and economically (page 20; [NEPA for National Wildlife Refuges: A Handbook](#)). With the preceding change to our Need statement, the U.S. Fish and Wildlife Service concluded that it has appropriately analyzed both alternatives.

Concern 5: Commenters asserted that the use of GECs on southeastern refuges does not meet conservation goals for waterfowl, and requested that the U.S. Fish and Wildlife Service consider restoring refuge lands to natural wetland hydrology cycles.

Response. As part of stepping down waterfowl objectives from the [North American Waterfowl Management Plan](#), biologists from the U.S. Fish and Wildlife Service and conservation partners have determined that significant energy deficits exist for waterfowl due to wetland loss and degradation across the landscape ([LMVJV MAV Waterfowl Stepdown State Summaries](#)). These deficits are so steep in the Lower Mississippi Valley, and potentially also in the Tennessee Valley and eastern North Carolina (where most of the farming Refuges occur), that despite aggressive wetland restoration efforts underway, making up for the energy losses would take many decades if not centuries to reverse. Biologists within the U.S. Fish and Wildlife Service establish objectives for National Wildlife Refuges using bioenergetic models based on forage production from natural wetlands and areas managed for waterfowl, such as croplands. National Wildlife Refuge managers use this information to determine the amount of various habitat types needed to meet these energy requirements for the number of waterfowl that winter on the specific refuge. Many National Wildlife Refuges do not have a large enough land base to meet these energy requirements with natural foods only and must rely on high energy cereal grains, such as corn, to supplement natural foods. Virtually all agricultural crops available have been genetically modified in some way, either by selective breeding or genetic engineering. As indicated in the PEA on pages 52-59, the best available science indicates that GECs are safe for consumption by wildlife. Moreover, wildlife feed extensively on GECs on private lands throughout the United States, as GECs comprise most commercial farming acreages nationwide.

Range of Alternatives

Concern 1: Commenters requested that the U.S. Fish and Wildlife Service consider an alternative in which the Service uses all organic seeds and planting on southeastern refuges.

Response. The PEA provides a reasonable range of alternatives in conformance with Section 1502.14 of the Council on Environmental Quality regulations. The alternatives listed in the PEA, including those alternatives considered but eliminated from further analysis and the analyzed action alternatives, consist of the practical and feasible options that would achieve the purpose

of and need described. Alternatives considered but eliminated from further consideration are described on page 36 of the PEA. This section shows that such alternatives were considered but eliminated from further analysis because they did not achieve the purpose of and need identified. The Service considered the alternative proposed by the commenter, and this analysis is covered on page 36 of the PEA. Therefore, this alternative does not require further consideration or analysis. Most farming that occurs on National Wildlife Refuges is conducted through the use of cooperative agriculture agreements with private farmers. Cooperative agriculture agreements (Service Manual 620 FW 2) are opened for competitive bids every five years. Through this process, organic farmers could choose to enter a bid and as long as they could demonstrate their ability to produce the required crop yields to meet wildlife objectives and control pests and invasive species. They would be considered under the current process outlined in the Service Manual 620 FW 2.

Concern 2: Commenters requested that the U.S. Fish and Wildlife Service consider an alternative in which the Service utilizes more “dirty” farming methods (i.e. native moist soil vegetation management and less costly wildlife seed mixes without pesticide use or other chemical inputs) as much as possible to meet wildlife and conservation objectives.

Response. The U.S. Fish and Wildlife Service utilizes various habitat management techniques in order to achieve National Wildlife Refuge purposes and wildlife objectives as stated in various management plans. Achieving "dirty" or "grassy" crop conditions whereby crops have an understory of natural vegetation is possible with both GECs and non-GECs. National Wildlife Refuge managers use natural wetland communities (e.g., bottomland hardwood forest, non-riverine swamp forests, herbaceous wetlands, freshwater marshes, open water areas, and others) and managed wetland communities (e.g., moist-soil impoundments and green tree reservoirs) along with supplemental cereal grain crops in order to meet objectives stepped down from the North American Waterfowl Management Plan. Natural wetland communities are unable to provide the approximately 400 million duck energy days that are needed to support current waterfowl populations using National Wildlife Refuges in the southeastern United States. The use of "dirty" farming practices that can limit yield might require converting additional natural habitat to agriculture production or acquiring additional acreage for agricultural use. As part of an integrated pest management program and BMPs, National Wildlife Refuge managers will use all options available to limit pesticide use, limit impacts to non-target species, and limit impacts to adjacent habitat types while controlling target pest species and meeting stated wildlife objectives.

Concern 3: Commenters requested that the U.S. Fish and Wildlife Service consider an alternative in which the Service employs only passive measures to provide adequate amounts of forage on southeastern refuges, including enlarging protected habitat and revising water usage and allocation.

Response. As part of stepping down waterfowl objectives from the [North American Waterfowl Management Plan](#), biologists from the U.S. Fish and Wildlife Service and conservation partners have determined that significant energy deficits exist for waterfowl due to wetland loss and degradation across the landscape ([LMVJV MAV Waterfowl Stepdown State Summaries](#)). These deficits are so steep in the Lower Mississippi Valley, and potentially also in the Tennessee Valley and eastern North Carolina (where most of the farming Refuges occur), that despite aggressive wetland restoration efforts underway, making up for the energy losses would take many decades if not centuries to reverse. Biologists within the U.S. Fish and Wildlife Service establish objectives for National Wildlife Refuges using bioenergetic models based on forage production from natural wetlands and areas managed for waterfowl, such as croplands. National

Wildlife Refuge managers use this information to determine the amount of various habitat types needed to meet these energy requirements for the number of waterfowl that winter on the specific refuge. Many National Wildlife Refuges do not have a large enough land base to meet these energy requirements with natural foods only and must rely on high energy cereal grains, such as corn, to supplement natural foods. Virtually all agricultural crops available have been genetically modified in some way, either by selective breeding or genetic engineering. As indicated in the PEA on pages 52-59, the best available science indicates that GECs are safe for consumption by wildlife. Moreover, wildlife feed extensively on GECs on private lands throughout the United States, as GECs comprise most commercial farming acreages nationwide.

Concern 4: Commenters requested that the U.S. Fish and Wildlife Service consider an alternative in which the U.S. Fish and Wildlife Service uses non-GECs or relies on alternatives to herbicides.

Response. The PEA provides a reasonable range of alternatives in conformance with Section 1502.14 of the Council on Environmental Quality regulations. The Service utilizes integrated pest management practices to the fullest extent possible including biological, mechanical, cultural, and chemical management. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. However, when the U.S. Fish and Wildlife Service contemplates the use of pesticides and herbicides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

Concern 5: Commenters requested that the U.S. Fish and Wildlife Service consider an alternative in which the Service relies on regenerative organic farming techniques that are known to benefit soil health and improve crop nutrition.

Response. Exclusive Organic Farming was considered but excluded from further analysis as reflected on page 36 of the PEA. Please refer to that section for a thorough discussion of consideration of Exclusive Organic Farming. Factors considered in brief include guidance on implementation of organic farming which recommends avoiding low-lying fields, tilling practices associated with organic farming, ability to control pests, ability to control weeds, and consistent yield. Further information on these considerations are provided in the PEA. The Programmatic Environmental Assessment does not preclude the use of organic farming on National Wildlife Refuges. Most farming that occurs on National Wildlife Refuges is conducted through the use of cooperative agriculture agreements with private farmers. Cooperative Agriculture Agreements (Service Manual 620 FW 2) are opened for competitive bids every five years. Through this process, organic farmers could choose to enter a bid and as long as they could demonstrate their ability to produce the required crop yields to meet refuge wildlife objectives and control

pests and invasive species. They would be considered under the current process outlined in the Service Manual 620 FW 2.

Concern 6: Commenters requested that the U.S. Fish and Wildlife Service consider an alternative in which the Service use only non-GEC seeds and let food sources for waterfowl grow naturally.

Response. In the current, human-modified landscape, the remaining habitat resources on National Wildlife Refuges must be actively managed to sustain population levels of many wildlife species, in this specific case population objectives stepped down from the North American Waterfowl Management Plan. To attain a National Wildlife Refuge's wildlife management objectives, the U.S. Fish and Wildlife Service must efficiently and effectively use a variety of management tools, including agriculture. A number of alternatives were considered (page 36), but were eliminated from further analysis because these alternatives did not yield quantities of food energy resources to attain the wildlife goals and objectives established by National Wildlife Refuge Comprehensive Conservation Plans and associated Habitat Management Plans. The proposal, as described by the commenter, is not a viable agricultural practice for National Wildlife Refuges and it would not allow a National Wildlife Refuge to meet its wildlife management objectives.

Concern 7. Commenters asserted that the U.S. Fish and Wildlife Service did not consider an adequate range of reasonable alternatives when it failed to evaluate alternatives that would limit or discontinue the agricultural use of pesticides and avoid or minimize the environmental harms associated with pesticides. These commenters requested that the U.S. Fish and Wildlife Service consider an alternative in which the Service relies on no agriculture, or only allows the use of non-GECs with high caloric value that demand less intensive pesticide use.

Response. The U.S. Fish and Wildlife Service uses a variety of natural foods and agricultural crops to meet wildlife objectives as identified in Comprehensive Conservation Plans and Habitat Management Plans. Most agricultural grains have a greater amount of energy than moist-soil seeds or acorns because of the high carbohydrate content and occur at greater densities than natural foods. Waterfowl require energy-rich foods in wintering areas to rebuild lipid reserves metabolized during southward migration, meet energy needs associated with thermoregulation and winter life-history activities (e.g., courtship), and to acquire sufficient resources for northward migration to the breeding grounds. Crops that are typically planted to provide forage for waterfowl on National Wildlife Refuges in the southeast are corn, rice, milo, and millet. Reinecke and Kaminski (2006) reported that unharvested corn yielding 6,000 lbs/acre (~100 bushels/acre) will provide for 28,591 DEDs per acre; rice that produced 5,500 lbs/acre supports 23,833 DEDs per acre; milo yielding 4,000 lbs/acre will provide 18,046 DEDs per acre; and Japanese millet at 1,300 lbs/ac will provide 5,203 DEDs/acre (LMVJV Waterfowl Working Group 2012). Lastly, while corn and other crops are important in supporting wintering waterfowl, a complex of habitat resources are required to meet physiological/nutritional requirements of waterfowl during winter.

The PEA provides a reasonable range of alternatives in conformance with Section 1502.14 of the Council on Environmental Quality regulations. The alternatives listed in the PEA, including those alternatives considered but eliminated from further analysis and the analyzed action alternatives, consist of the practical and feasible options that would achieve the purpose of and need described. Alternatives considered but eliminated from further consideration are described

on page 36 of the PEA. The U.S. Fish and Wildlife Service considered the alternative proposed by the commenter, and this analysis is covered on page 36 of the PEA. Therefore, this alternative does not require further consideration or analysis. The PEA does not preclude the use of organic farming on National Wildlife Refuges. Most farming that occurs on National Wildlife Refuges is conducted through the use of cooperative agriculture agreements with private farmers. Cooperative agriculture agreements (Service Manual 620 FW 2) are opened for competitive bids every five years. Through this process, organic farmers could choose to enter a bid and as long as they could demonstrate the ability to produce the required crop yields to meet wildlife objectives and control pests and invasive species. They would be considered under the current process outlined in the Service Manual 620 FW 2.

The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. When the Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

On pages 43-44 and Figures 6 and 7 of the PEA, the Service demonstrated the increase in the number of active ingredients and the pounds of pesticides per acre applied to agriculture crops on select NWRs, Wheeler, West TN, TN, and NC Coastal Refuges, within the southeastern United States after 2012, when GECs were prohibited for use on these National Wildlife Refuges. The amount of pesticides applied on these NWRs has steadily increased since 2013. The total number of pesticides (active ingredients) and associated pounds on these Refuges have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (45,413 lbs.) in 2019. The number of restricted use pesticides and associated lbs. have increased from 1 (7.5lbs.) in 2012 to 7 (1339 lbs.) in 2019. Use of the herbicide glyphosate for these refuges increased an average of 0.09 lbs. per acre since 2012. The U.S. Department of Agriculture has tracked the amount of pesticide use on 21 crop types since the 1960's. A summary of this research was published in 2014 which showed application rates for all corn pesticides peaked in 1987 at 3.6 pounds per planted acre, declined to 2.1-2.3 pounds per acre in 2000-06, and increased to 2.4 pounds per acre by 2008. Rates on soybeans peaked at around 2 pounds per planted acre in the early 1980s, declined to 1.1 pounds per acre in the late 1990s and early 2000s, and rose to 1.5 pounds per acre by 2008 (www.ers.usda.gov/publications/eib-economic-information-bulletin/eib124.aspx). These peaks in pesticide use were recorded before GECs became widely used across the country.

Concern 8: Commenters asserted that the U.S. Fish and Wildlife Service should continue the Cooperative Farming programs, as current staffing levels of the local refuges complexes do not offer enough manpower to manage the lands properly or meet desired habitat conditions.

Response. Comment noted. Adaptive management techniques and mitigation measures are incorporated into Service practices. These considerations have been evaluated and analyzed in PEA.

Concern 9: Commenters supported the use of conservation tillage, and requested that the U.S. Fish and Wildlife Service consider the use of rotation with green manure crops to help control weeds and improve soil conditions.

Response. Comment noted. Adaptive management techniques and mitigation measures are incorporated into Service practices. These considerations have been evaluated and analyzed in PEA.

Concern 10: Commenters asserted that the U.S. Fish and Wildlife Service should consider an alternative that does not allow any crops to be planted on refuges unless the refuges are hunted at least four times per week to control waterfowl populations.

Response. The stated purpose of the Programmatic Environmental Assessment is to evaluate the use of GECs on National Wildlife Refuges in the southeast in order to meet wildlife management objectives in accordance with National Wildlife Refuge purposes. National Wildlife Refuges provide food resources for a portion of the waterfowl populations that use the surrounding area as determined by bioenergetic models. Purposes for most of the Refuges engaged in agricultural practices entail providing food and sanctuary for waterfowl returning to the breeding grounds so they do so in good physical condition. Refuge purposes are defined with the establishment of the refuge (often requiring sanctuary based on establishing legislation) and management objectives are developed through the Comprehensive Conservation Planning process. The Service's Biological Integrity, Diversity, and Environmental Health policy (601 FW 3) requires that managers "use sound professional judgment when implementing this policy" and clearly denotes that "feasibility" relative to meeting National Wildlife Refuge purposes is a key consideration in implementing management practices. Waterfowl hunters are required to follow all Federal and State hunting regulations while hunting on National Wildlife Refuges. However, hunting regulations on specific NWRs may vary according to location, establishing purposes, surrounding land use, and other factors. Waterfowl hunting regulations are established through a separate process that also complies with the National Environmental Policy Act, but that analysis is outside the scope of this Programmatic Environmental Assessment.

Best Available Information

Concern 1: Commenters felt that the U.S. Fish and Wildlife Service did not consider best available information regarding the use and potential impacts of GECs and pesticide applications on southeastern refuges. Commenters submitted various peer-reviewed articles, references, and studies that they requested the U.S. Fish and Wildlife Service review, consider, and incorporate into the PEA.

Response. The U.S. Fish and Wildlife Service acknowledges the commenters for citing references for its review. U.S. Fish and Wildlife Service biologists have reviewed the suggested studies and citations, which were incorporated in the appropriate sections of the PEA. While there has been much literature produced in the past regarding GECs, the consensus from credible, published research is that GECs are safe for wildlife and human consumption. The Service refers commenters to the National Academies of Sciences, Engineering, and Medicine

(NASEM, 2016), [Genetically Engineered Crops Experiences and Processes](#) provides a current summary of the best available science on GECs used in agriculture.

The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

Relationship to Rules, Regulations, Policy, and Statutes

Concern 1: Commenters asserted that the U.S. Fish and Wildlife Service must prepare an environmental impact statement pursuant to NEPA, given the significant direct, indirect, and cumulative impacts of the proposed action. As part of its EIS preparation, commenters called for the U.S. Fish and Wildlife Service to use best available scientific information, analyze all reasonable alternatives, and identify all relevant and reasonable mitigation measures that could improve the proposed action.

Response. The U.S. Fish and Wildlife Service disagrees that the management action analyzed in the PEA constitutes a major federal action that would significantly affect the quality of the human environment under Section 102(2)(c) of NEPA of 1969 (as amended) so as to require preparation of an environmental impact statement.

Concern 2: Commenters asserted that because the U.S. Fish and Wildlife Service's proposal to allow for the use of GECs on southeastern refuges will likely jeopardize threatened and endangered species or adversely modify or destroy critical habitat, the Service must prepare a biological opinion and specify any reasonable and prudent alternatives it could take to avoid jeopardy of these species to comply with its Section 7 consultation obligations.

Response. Section 7(a)(2) of the Endangered Species Act (ESA) requires that Federal agencies, in consultation with the U.S. Fish and Wildlife Service 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 Service completed a Section 7 consultation which concluded the proposed action would not likely adversely affect any threatened or endangered species, and would not adversely modify designated critical habitat. Therefore, a biological opinion is unnecessary. Please refer to Appendix E. Site specific analysis stepped down from this PEA will be conducted prior to implementation of actions based on this analysis, including where appropriate additional Section 7 consultation.

Concern 3: Commenters expressed concern that the potential increase in the use of certain pesticides and insecticides as a result of using GECs on southeastern refuges may conflict with

the U.S. Fish and Wildlife Service Director's Memorandum on Biological Integrity, Diversity, and Environmental Health (601 FW 3).

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

As noted on pages 43-44 in the PEA, pesticide use has increased on National Wildlife Refuges in the southeast following the switch to non-GECs in 2013. These effects are discussed on pages 38-66 of the PEA.

Concern 4: Commenters noted that if work is conducted in Waters of the State or Waters of the United States, the U.S. Fish and Wildlife Service must obtain a short-term activity authorization from the Arkansas Department of Environmental Quality prior to working in the wetted area of a stream or water body.

Response. The U.S. Fish and Wildlife Service is aware of this requirement and complies with requirements for National Wildlife Refuges located in Arkansas and all other States as appropriate.

Concern 5: Commenters felt that the U.S. Fish and Wildlife Service inappropriately relied on the APHIS deregulation process to support compliance with its ESA obligations in the draft PEA.

Response. Section 7(a)(2) of the ESA requires that Federal agencies, in consultation with the U.S. Fish and Wildlife Service 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 Service completed a Section 7 consultation which concluded the proposed action would not likely adversely affect any threatened or endangered species, and would not adversely modify designated critical habitat. Please refer to Appendix E. Site specific analysis stepped down from this PEA will be conducted prior to implementation of actions based on this analysis, including, where appropriate, additional Section 7 consultation.

Concern 6: Commenters requested that the U.S. Fish and Wildlife Service analyze the impacts of GEC use on migratory birds and resident wildlife in the PEA, and consider how allowing leftover crops in fields may impact hunting prohibitions under the Migratory Bird Treaty Act.

Response. The U.S. Fish and Wildlife Service fully considered and analyzed impacts on migratory birds and resident wildlife, see pages 50-54 of the PEA. Regarding the issue of

hunting prohibitions under the Migratory Bird Treaty Act, waterfowl hunters are required to follow all Federal and State hunting regulations while hunting on National Wildlife Refuges. To hunt or bait waterfowl within a potential zone of influence is illegal regardless whether one is on a National Wildlife Refuge. Any hunting of migratory waterfowl must be in accordance with 50 CFR 20 (50 CFR 20.21). The Service did not analyze baiting regulations as they are beyond the scope of this PEA.

Concern 7: Commenters asserted that the biological evaluation failed to consider several impacts on endangered species (including pesticide drift and surface runoff), provides an arbitrary determination that conflicts with best scientific evidence, and attempts to implement insufficient mitigation practices. Consequently, commenters felt that the biological evaluation's determination that all but one listed species (the Schaus Swallowtail butterfly) are not adversely affected by GEC use in agricultural practices on southeastern refuges is arbitrary and capricious.

Response. Section 7(a)(2) of the ESA requires that Federal agencies, in consultation with the U.S. Fish and Wildlife Service 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 Service completed a Section 7 consultation which concluded the proposed action would not likely adversely affect any threatened or endangered species, and would not adversely modify designated critical habitat. Please refer to Appendix E. Site specific analysis stepped down from this PEA will be conducted prior to implementation of actions based on this analysis, including, where appropriate, additional Section 7 consultation.

Concern 8: Commenters asserted that the U.S. Fish and Wildlife Service violated its own policy on Biological Integrity, Diversity and Environmental Health for the Refuge System, which prohibits the use of GECs unless it is "essential" to the refuge purpose. Commenters felt that by issuing a PEA that allows GEC use on southeastern refuges, the Service contradicted its own policies and the Refuge Act without providing a reasonable rationale.

Response. The purpose of this Programmatic Environmental Assessment is to evaluate the use of genetically engineered crops on National Wildlife Refuges in the southeast in order to meet wildlife management objectives and achieve the specific goals of a National Wildlife Refuge's Comprehensive Conservation Plan (CCP), Habitat Management Plan (HMP), and other national and international conservation initiatives, including the North American Waterfowl Management Plan. The U.S. Fish and Wildlife Service's BIDEH Policy does not prohibit the use of GECs, but stipulates that the use must be determined to be essential to accomplishing National Wildlife Refuge purposes. We encourage a full reading of our BIDEH Policy (601 FW 3.14.D), which requires that refuges manage population levels of migratory birds (including waterfowl and shorebirds) at a larger landscape scale. Our Regional Genetically Modified Crop Guidance (Appendix C) provides the requirements that a refuge must satisfy in order to use GECs and specifies, in accordance with BIDEH Policy, that GEC use is limited to circumstances where farming with such crops is essential to a refuge satisfying its required purposes and objectives and the use of non-GECs would not. The role of agricultural practices on refuges is thoroughly discussed in the "Habitat Resources" section of the Programmatic Environmental Assessment. Cooperative farming is used on National Wildlife Refuges in the southeast as a habitat management tool to provide high-energy food sources for millions of wintering ducks, geese, swans, other migratory bird species, and other wildlife. Most National Wildlife Refuges in the southeast that have agricultural programs utilize cooperative farming agreements with local

farmers because they do not have the capability for refuge staff to implement these programs due to personnel limitations, the lack of specialized agricultural equipment, and opportunity costs of performing other tasks.

The U.S. Fish and Wildlife Service determined that the management action does not constitute a major federal action significantly affecting the quality of the human environment under the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969 (as amended). As such, an environmental impact statement is not required. In addition, current Service Policy delegates the determination for the use of GECs on a refuge to the Regional Refuge Chief, therefore this action follows Service policy. Finally, the Court decision ([Center for Food Safety, et al. v. Salazar](#), 900 F.Supp.2d 1 (D.D.C. 2012) ([Civil Action No. 11-1457 \(JEB\)](#))) left the determination for appropriate NEPA analysis to our discretion and expertise.

Impacts Analysis: Direct/Indirect Effects

Concern 1: Commenters requested that the PEA include a detailed assessment of the dietary requirements of the fish and fowl in areas that require restoration on the refuges in the southeast region.

Response. Biologists within the U.S. Fish and Wildlife Service establish objectives for National Wildlife Refuges using bioenergetic models based on forage production from natural wetlands and areas managed for waterfowl, such as croplands. In several portions of the southeastern United States such as the Lower Mississippi Valley Joint Venture geography, biologists from the U.S. Fish and Wildlife Service and conservation partners have determined that significant energy deficits exist for waterfowl due to wetland loss and degradation across the landscape ([LMVJV MAV Waterfowl Stepdown State Summaries](#)). National Wildlife Refuge managers in coordination with partners use this information to determine the amount of various habitat types needed to meet these energy requirements for the number of waterfowl that winter on specific refuges. Many National Wildlife Refuges do not have a large enough land base to meet these energy requirements with natural foods only and must rely on high energy cereal grains, such as corn, to supplement natural foods. Virtually all agricultural crops available have been genetically modified in some way, either by selective breeding or genetic engineering. As indicated in the PEA on pages 50-59, the best available science indicates that genetically engineered crops are safe for consumption by wildlife and fish. Moreover, wildlife feed extensively on GECs on private lands throughout the United States, as GECs comprise most commercial farming acreages nationwide.

Concern 2: Commenters requested that the PEA include a discussion of the potential effects of geoengineering, as well as detailed explanation of what/when pesticides are being sprayed in the project area, and their effects.

Response. As defined by the University of Oxford, geoengineering is the "deliberate large-scale intervention in the Earth's natural systems to counteract climate change," potentially including solar radiation management and greenhouse gas removal. The potential effects of GECs on climate change were analyzed on page 40 of the PEA. Additional analysis of geoengineering is outside the scope of the PEA.

Concern 3: Commenters stated that the U.S. Fish and Wildlife Service failed to adequately assess the direct and indirect impacts related to the cultivation of GECs and the use of

neonicotinoid seed treatments and seed coatings on wildlife and the environment in the draft PEA.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. The PEA analyzed potential impacts from the use of GECs on National Wildlife Refuges and believes that the effects would not be significant under NEPA. Moreover, we determined that the potential effects of GEC use would improve the agricultural practices for wildlife management on our refuges, enable refuges to meet the specific objectives and positively benefit wildlife. The PEA analyzed known and predicted effects of the action and the Service determined that most potential impacts from the use of GECs on National Wildlife Refuges in the southeast would be beneficial, and those activities that could potentially negatively affect current conditions would not cause significant impacts (See Chapter IV of the PEA). The National Academies of Sciences, Engineering, and Medicine recently completed a comprehensive analysis on genetically engineered crops which contains helpful information on this issue (<https://www.nap.edu/catalog/23395/genetically-engineered-crops-experiences-and-prospects>).

When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). The U.S. Fish and Wildlife Service will, however, review and consider the information submitted by the commenter and determine whether it warrants modifying the PEA or otherwise informs our decision making in this matter. In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex. The U.S. Fish and Wildlife Service will continue to consult with agricultural experts to determine to most appropriate approaches to crop management.

As noted on pages 43-44 in the PEA, pesticide use has increased on National Wildlife Refuges in the southeast following the switch to non-GECs in 2013. The Service refers the commenter to The National Academies of Sciences, Engineering, and Medicine (2016) report, which represents the best available scientific and commercial information on the potential for impacts on GEC use on plant biodiversity ([Genetically Engineered Crops Experiences and Prospects](#)).

Concern 4: Commenters asserted that the U.S. Fish and Wildlife Service failed to adequately address the potential for the increased use of herbicides associated with GEC use on southeastern refuges in the draft PEA.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. However, as noted on pages 43-44 and Figures 6 and 7, in the PEA, pesticide use has increased on National Wildlife Refuges in the southeast following the switch to non-GECs in 2013. The total number of pesticides (active ingredients) and associated pounds on Wheeler, West TN, TN, and NC Coastal Refuges have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (45,413 lbs.) in 2019. The number of restricted use pesticides and associated lbs. has increased from 1 (7.5lbs.) in 2012 to 7 (1339 lbs.) in 2019. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a

National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

Concern 5: Commenters asserted that the U.S. Fish and Wildlife Service failed to take the requisite "hard look" at the effects of its Preferred Alternative in the draft PEA, and felt that the U.S. Fish and Wildlife Service frequently mischaracterizes the effects of GEC use on refuge resources, wildlife, and resource sustainability.

Response. The PEA analyzed potential impacts from the use of GECs on National Wildlife Refuges and believes that the effects would not be significant under NEPA. Moreover, we determined that the potential effects of GEC use would improve the agricultural practices for wildlife management on our refuges, enable refuges to meet the specific objectives and positively benefit wildlife. The PEA analyzed known and predicted effects of the action and the Service determined that most potential impacts from the use of GECs on National Wildlife Refuges in the southeast would be beneficial, and those activities that could potentially negatively affect current conditions would not cause significant impacts (See Chapter IV of the PEA). The National Academies of Sciences, Engineering, and Medicine recently completed a comprehensive analysis on genetically engineered crops which contains helpful information on this issue (<https://www.nap.edu/catalog/23395/genetically-engineered-crops-experiences-and-prospects>). In addition, the Service points out that this is a Programmatic assessment from which site-specific analysis will be tiered.

Concern 6: Commenters felt that the U.S. Fish and Wildlife Service did not offer sufficient evidence in the draft PEA to show that GEC use is effective in reducing the number and quantity of pesticides used in agriculture practices in the NWRs, and expressed concern that GEC use on southeastern refuges may actually increase pesticide use.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. Information on amounts of pesticides used on refuges as it relates to the purpose of the analysis is presented Figures 6 and 7 of the PEA and demonstrates the increase in the number of active ingredients and the pounds of pesticides per acre applied to agriculture crops on select National Wildlife Refuges within the southeastern United States after 2012, when GECs became unavailable for use on these National Wildlife Refuges. The amount of pesticides applied on these National Wildlife Refuges has steadily increased since 2013. The total number of pesticides (active ingredients) and associated pounds of active ingredients on Wheeler, West Tennessee, Tennessee, and North Carolina Coastal Refuges have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (45,413 lbs.) in 2019. The number of restricted use pesticides and associated lbs. have increased from 1 (7.5lbs) in 2012 to 7 (1339 lbs.) in 2019. The U.S. Department of Agriculture has tracked the amount of pesticide use on 21 crop types since the 1960's. A summary of this research was published in 2014 showing that application rates for all corn pesticides peaked in

1987 at 3.6 pounds per planted acre, declined to 2.1-2.3 pounds per acre in 2000-06, and increased to 2.4 pounds per acre by 2008. Similarly, rates on soybeans peaked at around 2 pounds per planted acre in the early 1980s, declined to 1.1 pounds per acre in the late 1990s and early 2000s, and rose to 1.5 pounds per acre by 2008 (www.ers.usda.gov/publications/eib-economic-information-bulletin/eib124.aspx). These peaks in pesticide use were recorded before GECs became widely used across the country.

Concern 7: Commenters expressed concern that because the draft PEA does not include an evaluation of the efficacy of the best management practices and preventative measures recommended in the draft PEA, the U.S. Fish and Wildlife Service failed to provide a realistic environmental assessment.

Response. Best Management Practices and preventative mitigation measures are included throughout the PEA and common to both alternatives. Chapter IV (Environmental Consequences) of the PEA provides an in-depth assessment of the impacts of Alternatives 1 and 2 to the environment. Included are the impacts to the physical resources, biological resources, habitat, wildlife, and the socioeconomic resources. The cumulative impacts for each alternative are discussed and subsequently summarized in Table 1 of the PEA. For those resources with none to minimal or minimal effects, Departmental Policy 517 DM 1, Service Policy 569 FW 1, 601 FW 3, and current Regional Guidance for GECs (Appendix C) will be followed to ensure Best Management Practices, which are explicitly referred to in the PEA and Finding of No Significant Impact, are applied. National Wildlife Refuge managers monitor annual cooperative farming activities to ensure compliance with all Departmental, Service, and Regional Policies.

Concern 8: Commenters expressed concern that if GECs are permitted on wildlife refuges, but neonicotinoid seed treatments are not, then growers will not have an avenue to plant the most elite corn germplasm on refuges, resulting in lower crop yields.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. Pesticides are analyzed separately. In fact, when the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex. The U.S. Fish and Wildlife Service will continue to consult with agricultural experts to determine to most appropriate approaches to crop management.

Concern 9: Commenters called for the U.S. Fish and Wildlife Service to critically re-evaluate the potential impacts that could occur as a result of the link between GEC cultivation and increased pesticide use on wildlife and refuge lands, including the potential harms associated with herbicide-resistant superweeds.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. However, data included in the PEA show the total number of pesticides (active ingredients) and associated pounds of active ingredients used on Wheeler, West Tennessee, Tennessee, and North Carolina Coastal Refuges have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (45,413 lbs.) in 2019. The number of restricted use pesticides has increased from 1 during the 2009 - 2012 period to 7 during the 2013 - 2019 period. Use of the herbicide glyphosate for these refuges increased an average of 0.09 lbs. per acre since 2012. With respect to the potential for GEC use on National Wildlife Refuges to contribute significantly to weed resistance, our analysis indicated that the risk is minimal due to the use of non-GEC seed refugia, best management practices, and widespread use of herbicide-tolerant GECs outside of National Wildlife Refuges. The current Regional Genetically Modified Crop Guidance (Appendix C) recognizes the possibility of pest resistance to glyphosate and stipulates that a non-Roundup Ready GMC (non-GEC) will be planted after three consecutive years of Roundup Ready GMCs (GECs). Other stewardship practices for the use of glyphosate-resistant GMCs (aka GECs) are also included.

Concern 10: Commenters expressed concern that the U.S. Fish and Wildlife Service did not adequately address the uncertainty surrounding the potential impacts of GECs on southeastern refuges in the draft PEA, and requested that the U.S. Fish and Wildlife Service use the precautionary principle to assure that proof of safety, rather than incidental absence of harm, is established in the PEA.

Response. The PEA analyzed potential impacts from the use of GECs on National Wildlife Refuges and concluded that the effects would not be significant under NEPA. Moreover, we determined that the potential effects of GEC use would improve the agricultural practices for wildlife management on our refuges, enable refuges to meet the specific objectives, and positively benefit wildlife. The PEA analyzed known and predicted effects of the action and the Service determined that most potential impacts from the use of GECs on National Wildlife Refuges in the southeast would be beneficial, and those activities that could potentially negatively affect current conditions would not cause significant impacts (See Chapter IV of the PEA). Regarding the issue of uncertainty with respect to use of GECs currently in use, we refer commenters to the following document as providing the most current best available science on GECs used in agriculture today: National Academies of Sciences, Engineering, and Medicine (NASSEM). 2016. Genetically Engineered Crops: Experiences and Prospects. The USFWS specifically analyzed genetically engineered crops in this programmatic environmental assessment, not the use of pesticides. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance: <https://www.nap.edu/catalog/23395/genetically-engineered-crops-experiences-and-prospects>.

Concern 11: Commenters called for a 20-year experiment to ensure the safety of GECs before allowing GECs to be planted on any refuges.

Response. The U.S. Fish and Wildlife Service follows all regulatory and policy guidelines with respect to management practices on National Wildlife Refuges. GECs have been approved for use by the United States Department of Agriculture in the United States since the 1990s, and impacts have been most recently evaluated by the National Academies of Science, Engineering, and Medicine (2016). The USDA has additional information on the history of GECs in the U. S. (https://www.ers.usda.gov/webdocs/publications/45179/43668_err162.pdf).

Concern 12: Commenters expressed concern that the U.S. Fish and Wildlife Service did not fully consider the range of effects from the use of GECs on southeastern wildlife refuges in the PEA, including the potential impacts on water quality, ecosystem degradation, and fungal and bacterial dysbiosis for soil, plants, and wildlife.

Response. The U.S. Fish and Wildlife Service included appropriate analysis of these issues in the Programmatic Environmental Assessment as required by the National Environmental Policy Act (<https://www.doi.gov/nepa>). The National Academies of Sciences, Engineering, and Medicine (2016) recently completed a comprehensive analysis on genetically engineered crops which the Service has fully incorporated into the PEA.

Concern 13: Commenters asserted that the U.S. Fish and Wildlife Service did not consider research conducted by farmers that has proven that GECs do not produce nearly as much as a non-GECs, and have shorter lifespans, produce lower yields, and are less nutritious.

Response. The U.S. Fish and Wildlife Service included appropriate analysis of these issues in the PEA as required by the National Environmental Policy Act (<https://www.doi.gov/nepa>). The National Academy of Sciences, Engineering, and Medicine recently completed a comprehensive analysis on genetically engineered crops which contains helpful information on this issue ([Genetically Engineered Crops Experiences and Prospects](#)).

Concern 14: Commenters expressed concern about the lack of studies and research demonstrating that GECs are safe and effective in the long-term for humans, wildlife, and the environment. Commenters asserted that the U.S. Fish and Wildlife Service should evaluate and incorporate the results of studies on the long-term effects of GECs into the PEA, given that GECs can result in a variety of negative environmental effects in the long-term, including the release of invasive species, soil degradation, decrease in wildlife species, and food supply insecurity.

Response. The U.S. Fish and Wildlife Service included appropriate analysis of these issues in the Programmatic Environmental Assessment as required by the National Environmental Policy Act (<https://www.doi.gov/nepa>). Chapter IV (Environmental Consequences) of the Programmatic Environmental Assessment provides an in-depth assessment of the impacts of Alternatives 1 and 2 to the environment. Included are the impacts to the physical resources, biological resources, habitat, wildlife, and the socioeconomic resources. The cumulative impacts for each alternative are discussed and subsequently summarized in Table 1 of the Programmatic Environmental Assessment. Section 7(a)(2) of the Endangered Species Act requires that Federal agencies, in consultation with the U.S. Fish and Wildlife Service and 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 Service completed a Section 7 consultation which concluded that no adverse effects were likely to occur (Appendix E). Site specific analysis stepped down from this Programmatic EA will be conducted prior to implementation of actions based on this analysis. For those resources with none to minimal or minimal effects, Departmental Policy 517 DM 1, Service Policy 569 FW 1, 601 FW 3, and current Regional Guidance for GECs (Appendix C) will be followed to ensure Best Management Practices, which are explicitly referred to in the Programmatic Environmental Assessment and Finding Of No Significant Impact, are applied. National Wildlife Refuge managers monitor annual cooperative farming activities to ensure compliance with all Departmental, Service, and Regional Policies. The National Academies of Sciences, Engineering, and Medicine recently completed a comprehensive analysis on genetically engineered crops which contains additional information

on genetically engineered crops (<https://www.nap.edu/catalog/23395/genetically-engineered-crops-experiences-and-prospects>).

Biologists within the U.S. Fish and Wildlife Service establish objectives for National Wildlife Refuges using bioenergetic models based on forage production from natural wetlands and areas managed for waterfowl, such as croplands. In several portions of the southeastern United States such as the Lower Mississippi Valley Joint Venture geography, biologists from the U.S. Fish and Wildlife Service and conservation partners have determined that significant energy deficits exist for waterfowl due to wetland loss and degradation across the landscape (https://www.lmvjv.org/s/MAV_Waterfowl_Stepdown_Aug2015_FINAL_12-2-15.pdf). National Wildlife Refuge managers use this information to determine the amount of various habitat types needed to meet these energy requirements for the number of waterfowl that winter on their refuge.

Many National Wildlife Refuges do not have a large enough land base to meet these energy requirements with natural foods only and must rely on high energy cereal grains, such as corn, to supplement natural foods. Virtually all agricultural crops available have been genetically modified in some way, either by selective breeding or genetic engineering. As indicated in the Programmatic Environmental Assessment on pages 52-59, the best available science indicates that genetically engineered crops are safe for consumption by wildlife. Moreover, wildlife feed extensively on GECs on private lands throughout the United States, as GECs comprise most commercial farming acreages nationwide.

Concern 15: Commenters felt that the U.S. Fish and Wildlife Service incorrectly asserted in the draft PEA that GECs, as opposed to non-GECs, use fewer commercial pesticides and result in fewer impacts on wildlife due to decreased pesticide use.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. Information directly related to the analysis presented in this PEA found on pages 43-44, demonstrate the increase in the number of active ingredients and the pounds of pesticides per acre applied to agriculture crops on select National Wildlife Refuges within the southeastern United States after 2012, when GECs became unavailable for use on these National Wildlife Refuges. The amount of pesticides applied on these National Wildlife Refuges has steadily increased since 2013. The total number of pesticides (active ingredients) and associated pounds of active ingredients on Wheeler, West Tennessee, Tennessee, and North Carolina Coastal Refuges have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (45,413 lbs.) in 2019. The number of restricted use pesticides and associated amounts. Have increased from 1 (7.5 lbs.) in 2012 to 7 (1339 lbs.) in 2019. The U.S. Department of Agriculture has tracked the amount of pesticide use on 21 crop types since the 1960's. A summary of this research was published in 2014 showing that application rates for all corn pesticides peaked in 1987 at 3.6 pounds per planted acre, declined to 2.1-2.3 pounds per acre in 2000-06, and increased to 2.4 pounds per acre by 2008. Similarly, rates on soybeans peaked at around 2 pounds per planted acre in the early 1980s, declined to 1.1 pounds per acre in the late 1990s and early 2000s, and rose to 1.5 pounds per acre by 2008 (www.ers.usda.gov/publications/eib-economic-information-bulletin/eib124.aspx). These peaks in pesticide use were recorded before GECs became widely used across the country.

When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex. The U.S. Fish and Wildlife Service will continue to consult with agricultural experts to determine to most appropriate approaches to crop management.

The U.S. Fish and Wildlife Service consults with University-affiliated Agricultural Extensions agents on Best Management Practices and Integrated Pest Management Strategies for the control of targeted pest species associated with crops. GECs include herbicide tolerant, insect resistant, and stacked varieties, but use of GECs does not necessitate the use of any single insecticide or herbicide. Moreover, we are unaware of any published findings identifying direct negative affects of GECs on waterfowl or other wildlife. Many published studies have evaluated and found GECs to be safe for human and animal consumption.

Concern 16: Several commenters supported the U.S. Fish and Wildlife Service's analysis of the potential use of GECs on southeastern refuges, and offered research and studies to demonstrate the safe and effective use of GECs to include effects on non-target insects and plant diversity.

Response. Comment noted. These considerations have been evaluated and analyzed in the PEA.

Concern 17: Commenters asserted that if the U.S. Fish and Wildlife Service allows GE crop use on national wildlife refuges in the southeastern United States, migratory birds, resident and surrounding wildlife, and refuge lands will be adversely impacted, including from trans-genetic contamination, the proliferation of "superweeds," and increased pesticide use associated with GE crops.

Response. The PEA analyzed potential impacts from the use of GECs on National Wildlife Refuges and the Service determined that the effects would not be significant under NEPA. Current Regional GEC Guidance (Appendix C), limits GEC use to crops that have been evaluated and deregulated by the Animal and Plant Health Inspection Service (APHIS). APHIS's evaluation has found no evidence for the potential for trans-genetic contamination from the crops being considered for using GEC seed (primarily corn and soybean) that are presently planted on Refuges.

Also in the current Regional Genetically Modified Crop Guidance, the Region recognizes the possibility of pest resistance to glyphosate and stipulates that a non-Roundup Ready GMC (aka GEC) will be planted after three consecutive years of Roundup Ready GMCs. Regional data for refuges identified in Figures 6 and 7 indicate a minimal average increase (0.09 pounds per acre) of glyphosate since 2012. Other stewardship practices for the use of glyphosate-resistant GMCs (aka GEC) are also included. With respect to the use of GECs on National Wildlife Refuges, we continue to support the position that the potential for weed resistance is minimal with BMPs employed, especially rotating fields every three years with a non-roundup ready seed variety.

Moreover, we believe that the potential effects of GEC use would improve the agricultural practices for wildlife management on our refuges, enable refuges to meet the specific objectives

and positively benefit wildlife. The U.S. Fish and Wildlife Service determined that the management action does not constitute a major federal action significantly affecting the quality of the human environment under the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969 (as amended). As such, an environmental impact statement is not required. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

Concern 18: Commenters felt that the U.S. Fish and Wildlife Service's draft PEA failed to thoroughly address the harms associated with GEC cultivation and the resulting overabundant use of the herbicide glyphosate on southeastern refuges.

Response. The PEA analyzed potential impacts from the use of GECs on National Wildlife Refuges and determined that the effects would not be significant under NEPA. Moreover, we believe that the potential effects of GEC use would improve the agricultural practices for wildlife management on our refuges, enable refuges to meet the specific objectives and positively benefit wildlife. In Appendix C, the current Regional Genetically Modified Crop Guidance, the Region recognizes the possibility of pest resistance to glyphosate and stipulates that a non-Roundup Ready GMC (aka GEC) will be planted after three consecutive years of Roundup Ready GMCs. Use of the herbicide glyphosate for refuges identified in Figures 6 and 7 indicate a minimal average increase of 0.09 pounds per acre since 2012. Other stewardship practices for the use of glyphosate-resistant GMCs (aka GEC) are also included. With respect to the use of GECs on National Wildlife Refuges, we continue to support the position that the potential for weed resistance is minimal with Best Management Practices employed, especially rotating fields every three years with a non-roundup ready seed variety. In addition, the Service relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

Concern 19: Commenters asserted that the draft PEA failed to adequately address the increased use of herbicides that are associated with GECs.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. Information directly related to the analysis

presented in this PEA found on pages 43-44, Figures 6 and 7, demonstrate the increase in the number of active ingredients and the pounds of pesticides per acre applied to agriculture crops on select National Wildlife Refuges within the southeastern United States after 2012, when GECs became unavailable for use on these National Wildlife Refuges. The amount of pesticides applied on these National Wildlife Refuges has steadily increased since 2013. The total number of pesticides (active ingredients) and associated pounds of active ingredients on Wheeler, West TN, TN, and NC Coastal Refuges have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (45,413 lbs.) in 2019. The number of restricted use pesticides for these refuges has increased from 1 (7.5 lbs.) in 2012 to 7 (1,339 lbs.) in 2019. Use of the herbicide glyphosate for these refuges increased an average of 0.09 lbs. per acre since 2012. The U.S. Department of Agriculture has tracked the amount of pesticide use on 21 crop types since the 1960's. A summary of this research was published in 2014 which showed application rates for all corn pesticides peaked in 1987 at 3.6 pounds per planted acre, declined to 2.1-2.3 pounds per acre in 2000-06, and increased to 2.4 pounds per acre by 2008. Rates on soybeans peaked at around 2 pounds per planted acre in the early 1980s, declined to 1.1 pounds per acre in the late 1990s and early 2000s, and rose to 1.5 pounds per acre by 2008 (www.ers.usda.gov/publications/eib-economic-information-bulletin/eib124.aspx). These peaks in pesticide use were recorded before GECs became widely used across the country.

Concern 20: Commenters called for the U.S. Fish and Wildlife Service to critically re-evaluate the potential impacts that could occur as a result of the link between GEC cultivation and increased glyphosate use on wildlife and refuge lands, including the harms associated with herbicide-resistant superweeds.

Response. The current Regional Genetically Modified Crop Guidance (Appendix C) recognizes the possibility of pest resistance to glyphosate and stipulates that a non-Roundup Ready GMC (aka GEC) will be planted after three consecutive years of Roundup Ready GMCs (aka GEC). Other stewardship practices for the use of glyphosate-resistant GMCs (aka GECs) are also included. With respect to the potential for GEC use on National Wildlife Refuges to contribute significantly to weed resistance, our analysis indicated that the risk is minimal due to the use of non-GEC seed refugia, best management practices, and widespread use of herbicide-tolerant GECs outside of National Wildlife Refuges. Regional data indicate for refuges identified in Figures 6 and 7 a minimal average increase (0.09 pounds per acre) of glyphosate since 2012.

Impacts Analysis: Scope of Analysis

Concern 1: Commenters requested further information regarding whether the regulations that the U.S. Fish and Wildlife Service follows on GEC use in the southeast region apply to other regions in the United States.

Response. This PEA applies to National Wildlife Refuges located in the southeast, including Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. The U.S. Fish and Wildlife Service recommends that commenters contact their Regional U.S. Fish and Wildlife Service office regarding the applicability of the regulations to their state.

Concern 2: Commenters inquired why the scope of analysis in the draft PEA was limited to the legacy R4 refuges and did not include the IR 2/4 refuges.

Response. As stated in Chapter 3 of the PEA, the analysis is focused primarily on National Wildlife Refuges in the southeastern United States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee) and the

document included a list of National Wildlife Refuges that have used agricultural practices as part of the natural resource management since 2007 (page 38).

Concern 3: Commenters requested that the U.S. Fish and Wildlife Service update the guidance in Appendix C of the PEA to account for the range of GECs that are commercially available, and include recommendations for mitigation measures that account for the differences between the goals of agriculture on NWRs and those on commercial lands. Additionally, commenters called for the U.S. Fish and Wildlife Service to consider how best to use cooperative agreements with farmers who would be planting GECs on NWRs to ensure that locality specific integrate pest management best practices or mitigation measures related to herbicide resistant weeds are consistently practiced.

Response. The U.S. Fish and Wildlife Service uses the latest information regarding Best Management Practices and integrated pest management strategies to address pest resistance and consultation with local university extension agents concerning best control options for these pest species. The U.S. Fish and Wildlife Service meets with cooperative farmers on a yearly basis to determine crops to be planted and methods for addressing pest issues. Specific management practices are covered by state and local regulations and several U.S. Fish and Wildlife Service Policies.

Concern 4: Commenters inquired about whether GECs are the same as GMOs, and whether Monsanto brand crops would be planted in southeastern refuges. Additionally, commenters inquired about why refuge land would not be able to support wildlife populations without the use of GECs.

Response. Genetically engineered and non-genetically engineered crop varieties are made by many different corporations, including Monsanto. National Wildlife Refuge managers and cooperative farmers use seed varieties based on many different factors, including local regulations, availability, soil conditions, and others. Although most agricultural plants are genetically modified in some way through selective or cross breeding, genetically engineered crops under consideration have herbicide tolerance or insect resistance through a specific gene alteration or insertion. As explained on pages 21-27 of the PEA, National Wildlife Refuges strive to provide a set portion of habitat resources needed by waterfowl during the non-breeding period in the southeast. Because of extensive landscape modification and loss of many natural wetlands, many National Wildlife Refuges in the southeast intensively manage wetlands and uplands to provide food for waterfowl in order to help make up for these losses and sustain waterfowl populations. In some areas, agriculture is an important component of those management practices.

Impacts Analysis: Cumulative Impacts

Concern 1: Commenters called for the U.S. Fish and Wildlife Service to conduct an adequate environmental review process for both the national programmatic change reflected in the 2018 Decision and the more limited regional proposal reflected in the PEA.

Response. The U.S. Fish and Wildlife Service determined there is not a discrepancy between the 2018 Decision and the scope of its analysis in the PEA. The stated purpose of the PEA is to evaluate the use of GECs on National Wildlife Refuges in the southeast in order to meet wildlife management objectives in accordance with National Wildlife Refuge purposes. GECs can be used with and without pesticides. The Service uses a separate process for the approval of all

pesticides 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). The National Academies of Sciences, Engineering, and Medicine recently completed a comprehensive analysis on genetically engineered crops which contains helpful information on this issue ([Genetically Engineered Crops Experiences and Prospects](#)).

Concern 2: Commenters asserted that the U.S. Fish and Wildlife Service's failure to assess widespread impacts of GECs and the associated herbicides on all refuges in the southeast region affected the U.S. Fish and Wildlife Service's analysis of cumulative impacts under NEPA and resulted in a fundamentally flawed "not likely to adversely affect" determination for all listed threatened and endangered species on Refuges.

Response. Section 7(a)(2) of the Endangered Species Act requires that Federal agencies, in consultation with the U.S. Fish and Wildlife Service and 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 Service completed a region-wide Section 7 consultation which concluded the proposed action would not likely adversely affect any threatened or endangered species, and would not adversely modify designated critical habitat. Please refer to Appendix E. Site specific analysis stepped down from this PEA will be conducted prior to implementation of actions based on this analysis, including where appropriate, additional Section 7 consultation.

An analysis of the potential cumulative impacts is provided in Chapter IV of the PEA. In addition, the commenter is referred to Page 34 of the document for a description of the tiered analysis process followed prior to the use of GECs on individual refuges. Analysis of pesticides is beyond the scope of this PEA. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

Impacts Analysis: Physical Resources – Climate Change

Concern 1: Commenters requested that the U.S. Fish and Wildlife Service remove the climate change analysis from the PEA.

Response. The Department of the Interior's Policy on Climate Change Adaptation (523 DM1) and the Fish and Wildlife Service's Climate Change Adaptation Policy (056 FW 1) require that climate change be addressed in Service planning, decision-making, consultation and evaluation, management, and restoration efforts.

Concern 2: Commenters feel that the U.S. Fish and Wildlife Service cited to misleading figures regarding the impacts of agriculture on the climate in the climate change section of the draft PEA. Commenters recommended that the draft PEA include a comparison of the impacts of growing native grasses versus GECs on the climate.

Response. Native grasses do not provide a viable alternative to meeting forage objectives for most wetland-dependent wildlife species, especially waterfowl during the non-breeding season. Many native grasses cannot tolerate extensive flooding and would not survive in many bottomland areas where agriculture is currently used as a wildlife management tool. Wildlife objectives on National Wildlife Refuges are based on the best available science and public input documented in Comprehensive Conservation Plans for each National Wildlife Refuge. Alternatives for carbon sequestration to address climate change without directly relating to the purpose of this analysis (Page 4) are outside the scope of this PEA.

Impacts Analysis: Physical Resources – Soil Resources

Concern 1: Commenters felt that the U.S. Fish and Wildlife Service improperly concluded that the cultivation of GECs and associated herbicide use would have fewer negative impacts on soil quality in southeast refuges. Additionally, commenters felt that the U.S. Fish and Wildlife Service did not provide adequate reasoning in the draft PEA that GEC use would increase conservation tillage, cover crop use and rotation, soil organic matter, crop residue, or decrease crop pests/weeds or soil compaction, disturbance, and erosion.

Response. Pages 41-42 of the PEA address the impacts to soils and provide specific references related to both Alternative 1 and Alternative 2. These references serve as the bases for the conclusions related to the holistic IPM approach.

Impacts Analysis: Physical Resources – Water Resources

Concern 1: Commenters felt that the analysis of the impacts of GECs on water resources in the draft PEA was inadequate, and asserted that the U.S. Fish and Wildlife Service failed to:

- adequately discuss how the cultivation of GECs is better suited to promote water quality than non-GECs;
- recognize the issues related to surface runoff from herbicides associated with GECs; and
- consider the potential impacts on aquatic species due to increased herbicide use associated with GECs, including the negative effects of glyphosate to freshwater mussels.

Response. Pages 44-46 of the Programmatic Environmental Assessment address relevant issues and provide references related to water quality for Alternative 1 and Alternative 2. Evidence suggests adoption of herbicide-tolerant crops can minimize environmental impacts through reduced pesticide use and increased use of conservation tillage practices. The impacts to aquatic species associated with each Alternative are discussed on pages 59-60. Although outside the scope of this Programmatic Environmental Assessment, minimum conservation buffers from all permanently standing and or running water are required when using pesticides, including those associated with GECs. Associated references are included in the discussion of each Alternative. The Service completed a region-wide Section 7 consultation, including for aquatic species, which concluded the proposed action would not likely adversely affect any threatened or endangered species, and would not adversely modify designated critical habitat. Please refer to Appendix E. Site-specific analysis stepped down from this PEA will be

conducted prior to implementation of actions based on this analysis, including where appropriate additional Section 7 consultation.

Impacts Analysis: Biological Resources

Concern 1: Commenters asserted that the U.S. Fish and Wildlife Service must consider the potential effects of GECs on the loss of plant biodiversity on national wildlife refuges in the National Wildlife Refuge System in the PEA.

Response. Pages 56 and 65 of the PEA address biodiversity. For more information, the Service refers the commenter to the National Academies of Sciences, Engineering, and Medicine (2016) report which represents the best available scientific and [commercial] information on] the [potential for impacts on GEC use on plant biodiversity ([Genetically Engineered Crops Experiences and Prospects](#)).

Impacts Analysis: Wildlife Resources

Concern 1: Commenters requested that the U.S. Fish and Wildlife Service include more detail in the PEA regarding mycotoxins and the potential impacts on waterfowl. Specifically, commenters asked that responses to the following questions be considered and included in the final PEA:

- What level of mycotoxins can waterfowl handle?
- Wouldn't some evolved tolerance to mycotoxins be expected that should be produced by wild grains?
- What are the mycotoxin levels in normal wild forage to cropped forage?

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the occurrence and toxicity levels of mycotoxins for waterfowl and other wildlife. As referenced in the PEA document, GECs may reduce the occurrence of mycotoxins in crops planted on National Wildlife Refuges compared to non-GECs. At a minimum, occurrence of mycotoxins in GECs is not expected to be more than non-GECs. Several published studies have suggested that mycotoxin occurrence is reduced in GECs compared to non-GECs (Wu 2006 [DOI: 10.1007/s11248-005-5237-1]; Pellegrino et al. 2018 [doi:10.1038/s41598-018-21284-2]). The Service agrees that the occurrence of mycotoxins in crops is widespread (Alshannaq and Yu 2017; DOI:10.3390/ijerph14060632), and the factors driving the occurrence are often complicated and often based on many local conditions that are outside the scope of the analysis.

Concern 2: Commenters expressed concern that the PEA did not include an adequate analysis of the potential significant adverse impacts that GECs and associated herbicide and insecticide use may have on waterfowl species in the southeast region. In particular, commenters felt that the Service failed to acknowledge that there is a connection between the cultivation of GECs and neonicotinoid seed treatments, and the impacts such seed treatments have on migratory and resident waterfowl and other birds in the draft PEA.

Response. The stated purpose of the PEA is to evaluate the use of GECs on National Wildlife Refuges in the southeast in order to meet wildlife management objectives in accordance with National Wildlife Refuge purposes. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy

requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

The U.S. Fish and Wildlife Service consults with University-affiliated Agricultural Extensions agents on Best Management Practices and Integrated Pest Management Strategies for the control of targeted pest species associated with crops. GECs include both herbicide tolerant, insect resistant, and stacked varieties, but use of GECs does not necessitate the use of any single insecticide or herbicide. Moreover, we are unaware of any published findings identifying direct negative effects of GECs on waterfowl or other wildlife. Many published studies have evaluated and found GECs to be safe for human and animal consumption.

Concern 3: Commenters expressed concern regarding how the use of GECs and associated pesticide applications on southeastern refuges may impact waterfowl species in southeastern refuges, including their populations, habitat, diets, migration patterns, susceptibility to baiting, and behaviors. One of these commenters specifically inquired about waterfowl hunting regulations in Texas.

Response. This Programmatic Environmental Assessment is limited to those 10 states identified in the document. Texas is not one of the states included. Waterfowl migration is affected by many factors, including weather, day length, large-scale land use, and other factors. There is no information to indicate that waterfowl migration or distribution at large scales is related to food availability on individual National Wildlife Refuges. National Wildlife Refuges provide food resources for a portion of the waterfowl populations that use the surrounding area as determined by bioenergetic models. Waterfowl hunters are required to follow all Federal and State hunting regulations while hunting on National Wildlife Refuges. To hunt or bait waterfowl within a potential zone of influence is illegal regardless whether one is on a National Wildlife Refuge. Any hunting of migratory waterfowl must be in accordance with 50 CFR 20 (50 CFR 20.21). The Service did not analyze baiting regulations as they are beyond the scope of this Programmatic Environmental Assessment.

As part of the North American Waterfowl Management Plan ([2018 North American Waterfowl Management Plan \(NAWMP\) Update](#)) and in several portions of the southeastern United States, such as the Lower Mississippi Valley Joint Venture geography, biologists from the U.S. Fish and Wildlife Service and other conservation partners have determined that significant energy deficits exist for waterfowl due to wetland loss and degradation across the landscape ([LMVJV MAV Waterfowl Stepdown State Summaries](#)). Biologists within the U.S. Fish and Wildlife Service establish objectives for National Wildlife Refuges using bioenergetic models based on forage production from natural wetlands and areas managed for waterfowl, such as croplands. National Wildlife Refuge managers use this information to determine the amount of various habitat resource types needed to meet these energy requirements for the number of waterfowl that winter in the areas surrounding the specific National Wildlife Refuge. Many National Wildlife

Refuges do not have a large enough land base to meet these energy requirements with natural foods only and must rely on high energy cereal grains, such as corn, to supplement natural foods.

Concern 4: Commenters asserted that the U.S. Fish and Wildlife Service did not fully consider the impacts of GEC use and associated pesticide applications on wildlife, especially the fact that pesticide applications often correspond with key wildlife feeding and breeding times.

Response. The U.S. Fish and Wildlife Service included appropriate analysis of these issues in the PEA as required by NEPA ([National Environmental Policy Act](#)). Chapter IV (Environmental Consequences) of the Programmatic Environmental Assessment provides an in-depth assessment of the impacts of Alternatives 1 and 2 to the environment. Included are the impacts to the physical resources, biological resources, habitat, wildlife, and the socioeconomic resources. The cumulative impacts for each alternative are discussed and subsequently summarized in Table 1 of the Programmatic Environmental Assessment.

Section 7(a)(2) of the Endangered Species Act requires that Federal agencies, in consultation with the U.S. Fish and Wildlife 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 Service completed a Section 7 consultation, which concluded the proposed action would not likely adversely affect any threatened or endangered species, and would not adversely modify designated critical habitat. Please refer to Appendix E. Site specific analysis stepped down from this PEA will be conducted prior to implementation of actions based on this analysis, including where appropriate additional Section 7 consultation.

Departmental Policy 517 DM 1, Service Policy 569 FW 1, 601 FW 3, and current Regional Guidance for GECs (Appendix C) will be followed to ensure Best Management Practices, which are explicitly referred to in the Programmatic Environmental Assessment and Finding Of No Significant Impact, are applied. National Wildlife Refuge managers monitor annual cooperative farming activities to ensure compliance with all Departmental, Service, and Regional Policies. The Service refers the commenter to the National Academy of Sciences, Engineering, and Medicine (2016) report which represents the best available scientific and commercial information on the potential for impacts on GEC use on insect populations. The NASEM recently completed a comprehensive analysis on genetically engineered crops which contains helpful information on this issue ([Genetically Engineered Crops Experiences and Prospects](#)).

Concern 5: Commenters expressed doubt that the use of GECs could expand waterfowl populations over a natural forage strategy.

Response. Biologists within the U.S. Fish and Wildlife Service establish objectives for National Wildlife Refuges using bioenergetic models based on forage production from natural wetlands and areas managed for waterfowl, such as croplands. In several portions of the southeastern United States such as the Lower Mississippi Valley Joint Venture geography, biologists from the U.S. Fish and Wildlife Service and conservation partners have determined that significant energy deficits exist for waterfowl due to wetland loss and degradation across the landscape ([LMVJV MAV Waterfowl Stepdown State Summaries](#)). National Wildlife Refuge managers use this information to determine the amount of various habitat types needed to meet these energy requirements for the number of waterfowl that winter on the specific refuge. Many National Wildlife Refuges do not have a large enough land base to meet these energy requirements with

natural foods only and must rely on high energy cereal grains, such as corn, to supplement natural foods.

Impacts Analysis: Wildlife Resources – Threatened and Endangered Species

Concern 1: Commenters felt that the U.S. Fish and Wildlife Service improperly downplayed the potential harms to wildlife, including endangered and threatened species, on southeast national wildlife refuges stemming from the use of GECs, associated herbicide use, and related insecticide effects in the draft PEA.

Response. Section 7(a)(2) of the Endangered Species Act requires that Federal agencies, in consultation with the U.S. Fish and Wildlife Service 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 Service completed a Section 7 consultation, which concluded the proposed action would not likely adversely affect any threatened or endangered species, and would not adversely modify designated critical habitat. Please refer to Appendix E. Site specific analysis stepped down from this PEA will be conducted prior to implementation of actions based on this analysis, including where appropriate additional Section 7 consultation.

The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). The U.S. Fish and Wildlife Service will, however, review and consider the information submitted by the commenter and determine whether it warrants modifying the PEA or otherwise informs our decision making in this matter. In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

Concern 2: Commenters asserted that the U.S. Fish and Wildlife Service failed to consider the potential negative impacts of agricultural pesticides (2,4-D and dicamba) on threatened and endangered species on refuge lands in the southeastern region. Commenters specifically felt that the U.S. Fish and Wildlife Service improperly excluded three mammals (the endangered Indiana bat, threatened northern long-eared bat, and endangered red wolf—which the U.S. Fish and Wildlife Service previously identified as likely to be directly affected by the aerial spraying of 2,4-D)—from the analysis of the draft PEA.

Response. The stated purpose of the Programmatic Environmental Assessment is to evaluate the use of GECs on National Wildlife Refuges in the southeast in order to meet wildlife management objectives in accordance with National Wildlife Refuges purposes. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

The Service completed a Section 7 consultation, which concluded the proposed action would not likely adversely affect any threatened or endangered species, and would not adversely modify designated critical habitat., including Indiana bat, northern long-eared bat, and red wolf. Please refer to Appendix E. Site specific analysis stepped down from this PEA will be conducted prior to implementation of actions based on this analysis, including where appropriate additional Section 7 consultation.

Impacts Analysis: Wildlife Resources – Invasive Species

Concern 1: Commenters inquired whether the PEA could include the use of GECs as a strategy for grassland restoration to control invasive and exotic species.

Response. As stated in the PEA, the U.S. Fish and Wildlife Service uses agricultural practices to help manage invasive or undesirable species on National Wildlife Refuges (page 3). However, as stated in Chapter 1, the purpose of this PEA is to evaluate the use of GECs on National Wildlife Refuges in the southeast in order to meet wildlife management objectives and achieve the specific goals of a National Wildlife Refuge's Comprehensive Conservation Plan, Habitat Management Plan, and other national and international conservation initiatives (page 4). In addition, the PEA analyses the action with respect to National Wildlife Refuges, such as the Biological Integrity, Diversity, and Environmental Health Policy, Department of the Interior's Pesticide Use Policy, the Integrated Pest Management Policy, and other applicable policies. Although not the use analyzed in this PEA, genetically engineered crops can be part of an effective agricultural practice to control invasive species.

Impacts Analysis: Wildlife Resources – Insects (including pollinators)

Concern 1: Commenters felt that the U.S. Fish and Wildlife Service improperly dismissed glyphosate as a leading cause of declines in pollinator insect populations in the draft PEA.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). The U.S. Fish and Wildlife Service will, however, review and consider the information submitted by the commenter and determine whether it warrants modifying the PEA or otherwise informs our

decision making in this matter. In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex. The U.S. Fish and Wildlife Service will continue to consult with agricultural experts to determine to most appropriate approaches to crop management.

As noted on pages 43-44 in the PEA, pesticide use has increased on National Wildlife Refuges in the southeast following the switch to non-GECs in 2013. The Service refers the commenter to the National Academies of Sciences, Engineering, and Medicine (2016) report, which represents the best available scientific and commercial information on the potential for impacts on GEC use on plant biodiversity ([Genetically Engineered Crops Experiences and Prospects](#)).

Concern 2: Commenters expressed concern regarding the potential increased use of neonicotinoid pesticides resulting from GEC use on southeastern refuges, and the potential impacts of these pesticides on pollinators.

Response. The U.S. Fish and Wildlife Service specifically analyzed genetically engineered crops in this PEA, not the use of pesticides. When the U.S. Fish and Wildlife Service contemplates the use of pesticides on a National Wildlife Refuge, it follows and complies with all legal and policy requirements, including 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). In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

As noted on pages 43-44 in the PEA, pesticide use has increased on National Wildlife Refuges in the southeast following the switch to non-GECs in 2013. Regarding the relationship between use of GECs and trends in non-target insects such as monarch butterflies, the Service refers the commenter to the National Academies of Sciences, Engineering, and Medicine (2016) report, which represents the best available scientific and commercial information on the potential for impacts on GEC use on plant biodiversity ([Genetically Engineered Crops Experiences and Prospects](#)).

Concern 3: Commenters felt that the Service's argument regarding pesticide resistance outlined in Alternative 2 of the draft PEA is faulty, and should be revised by the U.S. Fish and Wildlife Service.

Response. The stated purpose of the PEA (page 2) is to evaluate the use of genetically engineered crops on National Wildlife Refuges in the southeast in order to meet wildlife

management objectives. In addition, the Service also relies on four tiers of analysis to ensure NEPA compliance:

- Pesticide specific analysis by the EPA;
- Pesticide specific analysis through the Service's 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 an EAS that documents the pesticide uses/treatments planned for a particular NWR or NWR complex.

The U.S. Fish and Wildlife Service consults with University extensions agents concerning Best Management Practices and Integrated Pest Management Strategies for the control of targeted pest species associated with crops. The U.S. Fish and Wildlife Service agrees there are a few insecticides that are not broad spectrum that could be used to control above ground caterpillars preying upon corn crops. The challenge with utilizing these insecticides, such as chlorantraniliprole, is knowing when and where to use them and restrictions with use around water.

Concern 4: Commenters expressed concern that the increased use of GECs on southeastern refuges will result in more pesticide applications, which will negatively impact pollinator species.

Response. Many National Wildlife Refuges in the southeast provide habitat for pollinators and other insects, including many butterfly species. National Wildlife Refuges follow Best Management Practices, including implementing buffers from flowing or standing water for pesticide applications. The U.S. Fish and Wildlife Service included appropriate analysis of these issues in the Programmatic Environmental Assessment as required by the National Environmental Policy Act (<https://www.doi.gov/nepa>). We refer the commenter to the National Academy of Sciences, Engineering, and Medicine (2016) report which represents the best available scientific and commercial information on the potential for impacts on GEC use on insect populations. The NASEM recently completed a comprehensive analysis on genetically engineered crops which contains helpful information on this issue ([Genetically Engineered Crops Experiences and Prospects](#)).

Concern 5: Commenters asserted that the U.S. Fish and Wildlife Service did not fully consider or incorporate research into the PEA demonstrating that herbicidal eradication of non-target plants from pesticide applications has led to the collapse of pollinator species.

Response. The U.S. Fish and Wildlife Service included appropriate analysis of these issues in the Programmatic Environmental Assessment as required by the National Environmental Policy Act (<https://www.doi.gov/nepa>). Chapter IV (Environmental Consequences) of the Programmatic Environmental Assessment provides an in-depth assessment of the impacts of Alternatives 1 and 2 to the environment. Included are the impacts to the physical resources, biological resources, habitat, wildlife, and the socioeconomic resources. The cumulative impacts for each alternative are discussed and subsequently summarized in Table 1 of the Programmatic Environmental Assessment. Section 7(a)(2) of the Endangered Species Act requires that Federal agencies, in consultation with the U.S. Fish and Wildlife Service and 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 Service completed a Section 7 consultation included as Appendix E. For those resources with none to minimal or minimal effects,

Departmental Policy 517 DM 1, Service Policy 569 FW 1, 601 FW 3, and current Regional Guidance for GECs (Appendix C) will be followed to ensure Best Management Practices, which are explicitly referred to in the Programmatic Environmental Assessment and Finding Of No Significant Impact, are applied. National Wildlife Refuge managers monitor annual cooperative farming activities to ensure compliance with all Departmental, Service, and Regional Policies. We refer the commenter to the National Academy of Sciences, Engineering, and Medicine (2016) report which represents the best available scientific and commercial information on the potential for impacts on GEC use on insect populations. The NASEM recently completed a comprehensive analysis on genetically engineered crops, which contains helpful information on this issue (<https://www.nap.edu/catalog/23395/genetically-engineered-crops-experiences-and-prospects>).

Impacts Analysis: Socioeconomic Resources

Concern 1: Commenters felt that the socioeconomic analysis in the draft PEA failed to properly consider and analyze the potential adverse socioeconomic effects of GEC use on southeast refuges, and how these effects may impact the objectives of the PEA.

Response. As indicated on Page 55 of the PEA, GECs can 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 National Wildlife Refuges where conditions often include later planting dates in bottomland settings, increased pest damage, increased weed pressure, reduced pesticide use, poor soil quality, and high soil moisture. This is supported by Fernandez et. al 2014 that found the adoption of GEC increases yields by mitigating yield losses from competition from weeds and insects. However, empirical evidence regarding the effect of herbicide tolerant (HT) crops on yields is mixed. Generally, stacked seeds (seeds with more than one GE trait) tend to have higher yields than conventional seeds or than seeds with only one GE trait. Planting Bt corn seed is associated with higher net returns when pest pressure is high. The extent to which HT adoption affects net returns is mixed and depends primarily on how much weed control costs are reduced and seed costs are increased (Fernandez-Cornejo, Jorge, Seth Wechsler, Mike Livingston, and Lorraine Mitchell. Genetically Engineered Crops in the United States, ERR-162 U.S. Department of Agriculture, Economic Research Service, February 2014. [U. S. Department of Agriculture Genetically Engineered Crops in the United States](#)).

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 National Wildlife Refuges is disproportionately important for successful agricultural production and providing increased high energy food production for waterfowl. The PEA states that GECs are likely a more economically viable option for cooperative farming partnerships, but it appropriately does not cover profitability of the practice to individual farmers. Profitability of farming operations of private farmers varies according to many factors and is outside the scope of this PEA. Additionally, agricultural practices are used to meet specific wildlife management objectives in certain areas of National Wildlife Refuges, thus, socioeconomic considerations such as trends in farm size on private lands are not relevant to this PEA.

Concern 2: Commenters expressed concern that the U.S. Fish and Wildlife Service did not fully consider the economic impact from non-GEC use on southeastern wildlife refuges in the draft PEA, including recreational hunting impacts due to reduced waterfowl populations, reduced

hunter populations, (including the decline in hunting license and sportsman tax revenue), and reduced conservation groups membership and fundraising.

Response. The stated purpose of the PEA is to evaluate the use of GECs on National Wildlife Refuges in the southeast in order to meet wildlife management objectives in accordance with National Wildlife Refuge purposes. The U.S. Fish and Wildlife Service shares the concern with the potential decline of waterfowl numbers and hunters in portions of the southeastern United States. However, a comprehensive analysis of trends in waterfowl populations and hunters is outside the scope of this PEA.

Concern 3: Commenters asserted that the U.S. Fish and Wildlife Service did not fully consider the economic impacts from non-GEC use on southeastern refuges in the draft PEA on farmers who had to resort to using lower-yielding non-GEC crops.

Response. The Service appreciates the commenter's input and experience with cooperative farming on refuges. Cooperative farming on refuges must comply with current Service policies including the Cooperative Agricultural Use policy (602 FW 2) and the Biological Integrity, Diversity, and Environmental Health Policy (601 FW 3). The BIDEH Policy requires that managers "use sound professional judgment when implementing this policy" and clearly denotes that "feasibility" relative to meeting National Wildlife Refuge purposes is a key consideration in implementing management practices.

Impacts Analysis: Environmental Justice and Human Health

Concern 1: Commenters requested that the U.S. Fish and Wildlife Service adequately assess the potential impacts on human health and safety associated with planting GECs on wildlife refuges in the southeast region.

Response. The potential effects of alternatives on human health are analyzed on pages 38-39 of the PEA. The Service refers the commenter to the National Academies of Sciences, Engineering, and Medicine (2016) report, which represents the best available scientific and commercial information on the potential for impacts on GEC use on plant biodiversity (<https://www.nap.edu/catalog/23395/genetically-engineered-crops-experiences-and-prospects>).

Concern 2: Commenters expressed concern that the U.S. Fish and Wildlife Service did not fully consider the potential impacts on human health from the use of GECs and associated pesticides in the PEA.

Response. The U.S. Fish and Wildlife Service included appropriate analysis of these issues in the Programmatic Environmental Assessment as required by the National Environmental Policy Act (<https://www.doi.gov/nepa>). The National Academies of Sciences, Engineering, and Medicine recently completed a comprehensive analysis on genetically engineered crops ([Genetically Engineered Crops Experiences and Prospects](#)).

Appendix G. Finding of No Significant Impact

INTRODUCTION

The Fish and Wildlife Service (Service) will use genetically engineered crops (GEC) for natural resource management on national wildlife refuges (NWR or refuge) in the southeastern United States. A Programmatic Environmental Assessment (PEA) has been prepared to inform the public of the possible environmental consequences of implementing the Preferred Alternative. A description of the alternatives, the rationale for selecting the preferred alternative, the environmental effects of the preferred alternative, the mitigation measures of the action, and a declaration concerning the factors determining the significance of effects, in compliance with the National Environmental Policy Act of 1969, are outlined below. The supporting information can be found in the Service's Final Programmatic Environmental Assessment for Use of Genetically Engineered Agricultural Crops for Natural Resource Management on National Wildlife Refuges in the southeastern United States.

ALTERNATIVES

This PEA analyzes the following alternatives for southeastern NWRs' use of GECs in agricultural practices as a natural resource management tool:

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

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

Each alternative is summarized 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 for natural resource management in agricultural practices to cultivate supplemental foods for wildlife, manage invasive species, and provide opportunities for wildlife dependent public recreation, such as wildlife observation. These non-GECs may include different seed varieties developed through years of selective and cross breeding to incorporate certain desired traits 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 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, as possible, especially with respect to maintaining conservation buffers.

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

Under this alternative, NWRs in the southeast could use GECs for natural resource management in agricultural practices to cultivate supplemental foods for wildlife, manage invasive species, and provide opportunities for wildlife dependent public recreation, such as

wildlife observation. Only U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) evaluated and deregulated or exempted 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 NWR purpose(s), Comprehensive Conservation Plan (CCP) or Habitat Management Plan (HMP) 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 crop rotation, conservation tillage, limited soil preparation, direct drill planting, nutrient management including conservation buffers and cover crops, integrated pest management, and other techniques.

Southeastern refuges would use a tiered analysis to determine whether a GEC could be used based on the following:

- 5) APHIS's specific NEPA analysis and de-regulation or exemption of the GEC;
- 6) The Region's programmatic NEPA analysis of GEC use;
- 7) 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); and,
- 8) Analysis of whether GEC use would meet with the essentialness requirement of the Biological Integrity, Diversity, and Environmental Health (BIDEH) Policy (601 FW 3).

SELECTION RATIONALE

Alternative 2 is selected for implementation because it most effectively allows the Service to meet wildlife management objectives and achieve the specific goals of a NWR's CCP, HMP, and other national and international conservation initiatives, including the North American Waterfowl Management Plan (NAWMP; USDOJ EC ENRM 2012). In addition, Alternative 2 meets policies governing these uses on NWRs such as the Service's Biological Integrity, Diversity, and Environmental Health Policy (601 FW 3, USFWS 2006a), 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. In addition, the Preferred Alternative:

- Ensures that the Service can consistently meet refuge goals and objectives while adhering to applicable laws and policies.
- Reduces the number and amount of pesticides used in refuge agricultural practices;
- Minimizes agricultural footprint required to meet refuge goals and objectives;
- Ensures refuges have minimized economic risks of implementing agricultural practices; and
- Minimizes physical, biological, socioeconomic, and cultural impacts while achieving refuge goals and objectives.

ENVIRONMENTAL EFFECTS

Implementation of the Service's management action is expected to result in environmental, social, and economic effects as outlined in the PEA. Integrating the use of GECs for natural

resource management on NWRs in the southeastern United States will result in consistently meeting wildlife objectives while adhering to applicable laws and policies; reducing the number and amount of pesticides used in refuge agriculture practices; minimizing agricultural footprint required to meet refuge goals and objectives; ensuring refuges have minimized economic risks of implementing agricultural practices; and minimizing physical, biological, socioeconomic, and cultural impacts while achieving refuge goals and objectives. These effects are summarized as follows:

1. Consistently meeting objectives for waterfowl and other wildlife is mandated in order to manage populations and maintain biological integrity, diversity, and environmental health (601 FW 3.14B). Use of GECs can increase yields over non-GEC varieties, especially in areas with pest problems or other production challenges. Because waterfowl management on NWRs is often conducted in low-lying areas and conditions for agriculture are often less optimal than on nearby private lands, the use of GECs is disproportionately important for successful agricultural production on many NWRs to consistently meet wildlife objectives.
2. The Service demonstrated the increase in the number of active ingredients and the pounds of pesticides per acre applied to agricultural crops on select NWRs after 2012 when GECs were prohibited for use within the southeastern U.S. The amount of pesticides applied on NWRs in the southeast has steadily increased since 2013. The total number of pesticides (active ingredients) and associated pounds of active ingredients on Wheeler, West Tennessee, Tennessee, and North Carolina Coastal NWR Complexes have increased from 39 pesticides (25,213 lbs.) in 2012 to 64 pesticides (43,413 lbs.) in 2019 (Figure 6 and 7). The number and associated pounds of restricted use pesticides increased from one (7.5 lbs.) in 2012 (GEC use) to seven (1,339 lbs.) in 2019 (non-GEC use). The U.S. Department of Agriculture has tracked the amount of pesticide use on 21 crop types since the 1960's. A summary of this research was published in 2014, which showed peaks in pesticide use were recorded before GECs became widely used across the country (Fernandez-Cornejo et al. 2014b).
3. Many NWRs do not have a large enough land base to meet wildlife energy requirements with natural foods only and must rely on high-energy cereal grains, such as corn, to supplement natural foods to meet wildlife objectives. As indicated in the final PEA on pages 52-59, the best available science indicates that GECs are safe for consumption by wildlife. Moreover, wildlife feed extensively on GECs on private lands throughout the United States, as GECs comprise most commercial farming acreages of major crops nationwide.
4. Federally listed species and critical habitat as itemized in Appendix E of the Final PEA are protected and are not likely to be adversely affected by the use of GECs.
5. Cooperative partnerships with private farmers utilizing GECs are the most economically efficient and sometimes the only economically viable means to implement agriculture on NWRs to meet wildlife objectives. Use of GEC varieties on NWRs is usually more economically viable than use of only non-GECs because it requires less variation in

equipment and agricultural practices as nearby private lands (i.e., consistent with industry standard practices), requires less NWR staff time for pest scouting and other activities, and requires less pesticide use, especially topically applied insecticides. Moreover, GECs are more economically viable also because of the ability to mitigate loss of yield from a variety of pest species (both insect and weeds) and poorer environmental conditions (wetter soils, later planting dates).

6. The additional staff time required to oversee cooperative farming partnerships increased substantially following the switch from GECs to non-GEC varieties after 2012. Given diverse and abundant demands on NWR staff time, increased time commitments associated with use of non-GEC varieties reduces the time available to accomplish other tasks and address other primary NWR purposes and priorities (e.g., public outreach, providing public recreation opportunities, threatened and endangered species conservation, etc.). Thus, use of only non-GEC varieties would likely result in less efficient use of staff time and a reduction in management activities for a wide variety of species.
7. Use of GECs is not expected to have any significant adverse effects on wetlands and floodplains, pursuant to Executive Orders 11990 and 11988, as actions will not result in development of buildings and/or structures within floodplain areas, nor will they result in irrevocable, long-term adverse impacts.

MITIGATION MEASURES

As described in the Final PEA (starting on page 8 and referenced throughout the document and in Appendix C), the Service will apply regionally consistent Best Management Practices (BMPs) and mitigation measures to reduce the likelihood of adverse impacts associated with the use of GECs. These BMPs includes integrated pest management, conservation tillage, conservation buffers, and crop type rotations and non-*Bt* refugia as well as other measures to detect and avoid resistance development. The Service uses the latest information regarding best management practices and integrated pest management strategies to address pest resistance and consultation with local university extension agents concerning best control options for pest species. The Service also meets with cooperative farmers on a yearly basis to determine crops to be planted and methods for addressing pest issues. Mitigation measures would be applied and considered before implementing the use of GECs.

In addition, considerable precautions and BMPs are utilized in all aspects of agricultural practices, including but not limited to pesticide use. Although pesticide use is beyond the scope of this Final PEA, the Service will use considerable caution if and when pesticides are used in conjunction with agricultural crops (both GEC and non-GEC). The Service only uses Environmental Protection Agency-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 for use on a NWR must first be approved under the Service's Pesticide Use Proposal (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 (and for restricted use pesticides, also the National 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 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 adversely affected. 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).

COORDINATION

The management action has been thoroughly coordinated with all interested and affected parties. Parties contacted include:

- Congressional representatives
- Southeastern States Coastal Zone Management Programs
- Southeastern States Clearing Houses or appropriate State Agencies
- Affected Tribes including:
 - Catawba Indian Nation, Chitimacha Tribe of Louisiana, Coushatta Tribe of Louisiana, Eastern Band of Cherokee, Jena Band of Choctaw, Miccosukee Tribe of Indians of Florida, Mississippi Band of Choctaw Indians, Poarch Band of Creek Indians, Seminole Indian Tribe of Florida Tunica-Biloxi Indian Tribe of Louisiana, Absentee Shawnee Tribe of Indians, Alabama- Coushatta Tribe of Texas, Alabama-Quassarte Tribal Town, Caddo National of Oklahoma, Cherokee Nation of Oklahoma, Chickahominy Tribe, Chickahominy Tribe, Eastern Division, Chickasaw Nation, Choctaw Nation of Oklahoma, Delaware Nation of Oklahoma, Delaware Tribe of Indians, Eastern Shawnee Tribe of Oklahoma, Kialegee Tribal Town, Miami Tribe of Oklahoma, Monacan Indian Nation, Muscogee (Creek) Nation, Nansmond Tribe, Osage Nation, Pamunkey Indian Tribe, Peoria Tribe of Indians of Oklahoma, Quapaw Tribe of Indians, Rappahannock Tribe, Seminole Nation of Oklahoma, Seneca-Cayuga Nation, Shawnee Tribe of Oklahoma, Stockbridge Munsee Community, Thlopthlocco Tribal town, Tuscarora Nation of New York, United Keetooway Band of Cherokee Indians of Oklahoma, Upper Mattaponi Tribe, Wichita & Affiliated Tribes (Wichita, Keechi, Waco and Tawakonia)
- State Media Outlets
 - On March 20, 2020, the Service distributed a notice of the availability of the draft Programmatic EA to over 300 media outlets in 10 southeastern states including; Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. A second notice was distributed on March 30, 2020. Recipients included newspapers, radio stations, and television stations. Two virtual public information sessions were held via ZOOM on April 6 and 7. A total of Approximately 60 individuals participated. In addition, the Service announced the availability of the draft Programmatic EA through the Service's web site and social media accounts.
- Local community officials

- Interested citizens

FINDINGS

It is my determination that the management action does not constitute a major federal action significantly affecting the quality of the human environment under the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969 (42 U.S.C. §§4321-4370h, as amended). As such, an environmental impact statement is not required. This determination is based on the following factors (40 C.F.R. 1508.27), as addressed in the Service's Draft Programmatic Environmental Assessment for Use of Genetically Engineered Agricultural Crops for Natural Resource Management on National Wildlife Refuges in the Southeastern United States:

1. Both beneficial and adverse effects have been considered and this action will not have a significant effect on the human environment. (Environmental Assessment, pages 38-68)
2. The actions will not have a significant effect on public health and safety. (Environmental Assessment, pages 38-68)
3. The project will not significantly affect any unique characteristics of the geographic area, such as proximity to historical or cultural resources, wild and scenic rivers, or ecologically critical areas. (Environmental Assessment, pages 38-47)
4. The effects on the quality of the human environment are not likely to be highly controversial. (Environmental Assessment, pages 38-68)
5. The actions do not involve highly uncertain, unique, or unknown environmental risks to the human environment. (Environmental Assessment, pages 38-68)
6. The actions will not establish a precedent for future actions with significant effects nor do they represent a decision in principle about a future consideration. (Environmental Assessment, pages 38-68)
7. There will be no cumulatively significant impacts on the environment. Cumulative impacts have been analyzed with consideration of other similar activities on adjacent lands, in past action, and in foreseeable future actions. (Environmental Assessment, pages 64-66)
8. The actions will not significantly affect any site listed in, or eligible for listing in, the National Register of Historic Places, nor will they cause loss or destruction of significant scientific, cultural, or historic resources. (Environmental Assessment, pages 38-68)
9. The actions are not likely to adversely affect threatened or endangered species, and are not likely to adversely modify designated critical habitat. (Environmental Assessment, pages 38-68, Appendix F)
10. The actions will not lead to a violation of federal, state, or local laws imposed for the protection of the environment. (Environmental Assessment, pages 38-68).

SUPPORTING REFERENCES

U.S. Fish and Wildlife Service. 2020. 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, Fish and Wildlife Service, South Atlantic-Gulf and Mississippi Basin Interior Region, Atlanta, Georgia.

DOCUMENT AVAILABILITY

The Draft Programmatic Environmental Assessment was made available for public review and comment from March 19, 2020 to April 19, 2020. The Service posted the draft PEA and other documents on <https://sites.google.com/site/fwsregion4gmcpeis/home>. The Service sent the news release to over 300 newspapers, radio stations, and TV news directors in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Tennessee and South Carolina on March 20, and again on March 30, 2020. The Service extended the public comment period on the draft PEA to April 19, 2020, which was transmitted on April 1, 2020. Two public webinar meetings were held. The final PEA will be uploaded the Service’s regional website and available for download.

DECISION

The Service has decided to utilize APHIS evaluated and deregulated or exempted GECs, as described in 7 CFR 340.6 for natural resource management on National Wildlife Refuges in the southeastern United States.

This action complies with the purposes of the refuges and the mission of the National Wildlife Refuge System.

The action is consistent with applicable laws and policies.

Regional Director

Date