Draft Environmental Assessment

Use of Specified GMCs with Associated Herbicides in Conjunction with the Cooperative Farming Program on the Sequoyah National Wildlife Refuge

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1.0 PURPOSE OF AND NEED FOR PROPOSED ACTION

1.1 Introduction

The United States Fish and Wildlife Service (Service), is proposing to continue the use of three genetically modified crops (GMCs) in conjunction with the cooperative farming program on the Sequoyah National Wildlife Refuge as described in Alternative A. The Refuge is in the process of developing a Comprehensive Conservation Plan (CCP) to determine overall management direction for the Refuge over the next 15 years. The CCP will address all aspects of Refuge management with close attention to habitat, wildlife, facilities, and public use. The CCP and its corresponding Environmental Assessment (EA) will evaluate the farming program as a whole, considering acreage and operations. Future decisions that could be revisited through adaptive management may include the types of crops farmed, converting to force account farming conducted solely by Refuge staff, implementation of no-till farming, and adapting the most current farming technologies for use on the croplands. Sequoyah NWR's Draft CCP is expected to be distributed for public review in summer 2011. Alternatively, this particular EA solely evaluates the use of chemicals and the aforementioned GMCs.

This Environmental Assessment (EA) is being prepared to evaluate the effects associated with this proposal and complies with the National Environmental Policy Act (NEPA) in accordance with Council on Environmental Quality regulations (40 CFR 1500-1509) and Department of the Interior (516 DM 8) and Service (550 FW 3) policies (see Section 1.7 for a list of additional regulations that this EA complies with). NEPA requires examination of the effects of proposed actions on the natural and human environment. In the following chapters, two alternatives are described and environmental consequences of each alternative are analyzed.

There is an abundance of literature available on the potential environmental risks and benefits produced from farming with genetically modified crops as compared to conventional farming. Different studies have produced varying results since the introduction of Roundup Ready® corn and soybeans along with Liberty Link® corn in the 1990s. The Refuge reviewed a variety of peer-reviewed journal articles and publications to determine the range of effects associated with implementation of each alternative. Many of the risks associated with the use of GMCs focus specifically on the use of crops that have been engineered to carry insecticide traits, such as *Bacillus thuringiensis* (Bt) corn. The literature used in this EA and analysis of environmental consequences specifically addresses the three herbicide-tolerant GMCs that are currently permitted on Sequoyah NWR. Appendix D summarizes each of the articles referenced within this document and provides a description of how and why the articles were used in the NEPA analysis. Where federally approved guidance and research existed (from the Service, U.S. Department of Agriculture, or U.S. Environmental Protection Agency), this information provided the basis for the analysis. In addition, the conclusions documented in the Environmental Consequences section of this document (Section 4.0) are believed to be supported by the available scientific literature (See Section 5.2 References and Appendix D).

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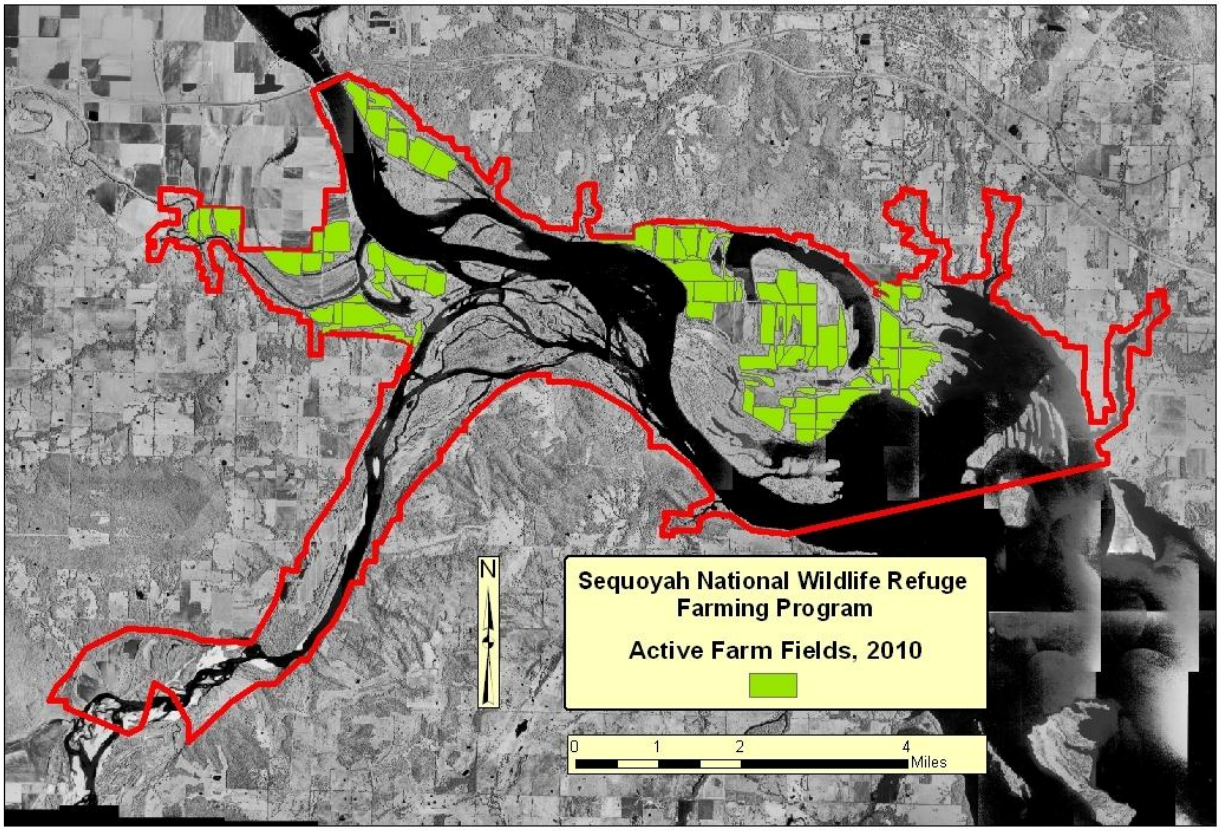
1.2 Location

Sequoyah NWR is located in east-central Oklahoma on the upper end of the Robert S. Kerr Reservoir in Sequoyah, Muskogee, and Haskell counties. The 20,800-acre Refuge is three miles south of the Vian exit on Interstate 40 (I-40) and approximately 150 miles east of Oklahoma City, Oklahoma. The Refuge lies at the confluence of the Canadian and Arkansas Rivers, in the gently rolling foothills of the Ozark Mountains. The Refuge is an overlay project with the U.S. Army Corp of Engineers (USACE), and approximately 6,500 acres of the Robert S. Kerr Reservoir overlaps Sequoyah NWR. The project area encompasses nearly 2,800 acres of croplands which are scattered throughout the Refuge (Map 1, below). Satellite imagery of these units is illustrated in the images below. A large portion of the existing croplands were in conventional crop production prior to Refuge establishment in 1970.



1.3 Background

In 1946, Congress approved funding for the U.S. Army Corps of Engineers to develop a multiple-purpose plan involving the integration of developments for navigation, flood control, hydroelectric power, and related features into a single Navigation Project. The Navigation Project included a navigation route from Catoosa, Oklahoma, to the Mississippi River and seven multiple-purpose reservoirs located in eastern Oklahoma. As construction ensued, sections along the Arkansas River known to support migrating waterfowl within the Central Flyway were negatively affected by river channelization activities and drainage of wetlands. Simultaneously, the U.S. Fish and Wildlife Service was seeking land acquisition approval for multiple areas in eastern Oklahoma to compensate for the loss of waterfowl and other wildlife habitat.

Upon completion of the Robert S. Kerr Reservoir project, the U.S. Army Corps of Engineers and the Department of the Interior established Sequoyah National Wildlife Refuge on December 11, 1970, by entering into a cooperative agreement for fish and wildlife management of the Sequoyah NWR on the northern part of the reservoir. Sequoyah NWR was established through Cooperative Agreement DACW56-3-71 between the U.S. Army Corps of Engineers and the Service "….for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon…," in accordance with the Fish and Wildlife Coordination Act (16 U.S.C. 664 et seq.). Waterfowl management is the main focus of the Refuge.

At the time of its establishment, Sequoyah NWR contained over 5,000 acres of cropland, much of which was surrounded by water. In order to produce food and provide habitat for waterfowl, the Refuge originally utilized 30 cooperative farmers to manage Refuge croplands. Cooperative farming is defined in 6 RM 4.3 as cropland management carried out by private citizens on refuge lands, under the terms of a "Cooperative Farming Agreement," in which the cooperator (private citizen) provides labor, equipment, and materials and the Government provides the land. The resulting crop is shared by the cooperator and the Government. The agricultural programs carried out on Sequoyah NWR at the time of acquisition were generally the growing of cotton, soybeans, alfalfa, and some peas, watermelon, or squash. Prior to acquisition, heavy grazing had also been practiced on most of the Refuge.

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In 1974, the Refuge developed a Croplands Management Plan to determine the most appropriate management of the historic croplands on the Refuge. Much of the area's original bottomland had been flooded and the bulk of the area's remaining croplands were on the Refuge. The Plan stated that productive cropland exceeded the amount needed for waterfowl and other objectives, and 2,000 acres of croplands were to be retired. The Refuge began reducing farming acreage along with reducing the number of cooperative farmers from 30 to 15-20 individuals while noting the local economy is quite dependant on the Refuge's farming program through the purchase of goods, services, and materials such as equipment and parts, seed, pesticides and other consumables such as fuel, lubricants and other petroleum products.

In 1994, Sequoyah NWR evaluated the status of their farming program and associated chemical weed control by developing an Environmental Assessment. At that time, the Refuge had reduced the number of cooperative farmers to 11 and intended to continue withdrawing land from farming until an appropriate acreage could be determined. The purpose of farming remained food production in ample quantities and quality to supplement and balance the diet of wild, native foods with grain crops for the maintenance needs of wintering migratory waterfowl and other resident wildlife. In order to meet those demands, the EA stated that retention of skilled cooperative farmers was critical and that those farmers were forced to rely on chemical weed control to carry out normal farming practices. The proposed action included implementation of Integrated Pest Management principles in combination with minimal chemical use.

Genetically modified crops were introduced into Sequoyah and Muskogee Counties in 1995. Within the following couple of years, farmers were believed to have transitioned completely from the conventional farming of corn and soybeans to the use of Roundup Ready ® soybeans and Roundup Ready ® corn (S. Sloan, pers. comm., October 2010). Recent figures from the USDA National Agricultural Statistic Service indicate that 10,600 acres of soybeans and 6,500 acres of corn were produced in Sequoyah County, and 15,300 acres of soybeans and 6,000 acres of corn were produced in Muskogee County. Roundup Ready crops account for about 90 percent of the soybeans and 70 percent of the corn grown in the United States (James, 2009). The District Extension Area Agronomist for Eastern Oklahoma indicated that a good portion of all the corn and soybeans grown in Sequoyah and Muskogee counties have the roundup ready gene and farmer adoption of those technologies closely fit the national averages (Chris Rice, pers. comm. March 17, 2011).

On the Refuge, the first use of herbicide tolerant GMCs is believed to be in 1997. This date was provided after discussions with local farmers that were cooperators at that time (S. Sloan, pers. comm., October 2010). Currently, the Refuge retains approximately 2,800 acres of cropland, down from over 5,000 acres in 1970. The majority of the croplands are farmed by six cooperative farmers through Annual Cooperative Farming Agreements. A small amount (25 acres) of farming has also been conducted by refuge personnel in the past. This type of farming is defined as force account farming, referring to any cropland management operation carried out by government employees. On those acres that are cooperatively farmed, cooperative farmers take approximately 75 percent of the crop and leave approximately 25 percent of the crop unharvested and available for waterfowl and other wildlife. Corn and soybeans are the most common crops grown in the cooperators' share. Crops grown for wildlife (Refuge share) include corn, winter wheat, and Japanese millet. The Refuge allows cooperators to use three herbicide-tolerant GMCs (Roundup Ready© Corn, Roundup Ready© Soybeans, and Liberty Link© Corn) along with accompanying chemicals (see Appendix B) in order to meet production needs and control undesirable weeds in the agricultural fields. As farming becomes increasingly more

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efficient, seed availability without biotechnology is being phased out as the demand for GMC seed outweigh non-GMC (conventional) seed. To date, the use of these GMCs has been deemed important in continuance of the Refuge's cooperative farming program by allowing cooperators to farm in a manner that is economically beneficial and still provide food sources and amounts needed for wildlife. Through the use of GMC's, the refuge has seen the beneficial aspects of increased yields with decreased labor inputs such as fewer herbicides needed, less mechanical disturbance and cultivation which reduces the overall fossil fuel consumption. As a result, the refuge has reduced farming acreages from approximately 5000 acres to 2754 acres further allowing the Refuge to restore the unneeded acreages back to native bottomland hardwoods.

1.4 Purpose of Action

The purpose of the proposed action is to continue to provide a food resource to effectively and efficiently meet the energetic needs of migratory waterfowl and other wildlife species for which the Refuge was established. The significantly reduced farming program has been determined an integral part of meeting the Refuge purpose because this management tool provides multiple food sources for migratory waterfowl and resident wildlife. The use of cooperative farmers employs the most efficient and cost effective means of producing small forage grains that would otherwise dedicate a full-time staff to force account farm. Not only does cooperative farming provide food sources but retards encroachment of woody and/or invasive plant species. Moist soil management has been implemented on farm fields that have shown decreased crop production or favor a moist soil community over agricultural crops. These fields will be rotated out of croplands into a moist soil management program where the two food resources will satisfy the diet and needs of migratory and resident waterfowl and wildlife. The purpose of this Environmental Assessment (EA) is to evaluate the effects of farming with specified GMCs and chemicals compared to conventional farming with chemicals and to determine if the use of GMC's is appropriate for fulfilling waterfowl and migratory bird conservation needs. Additionally, the purpose of the EA is to remain consistent with current laws, regulations, and policies (National Environmental Policy Act of 1969 and National Wildlife Refuge System Improvement Act of 1997).

1.5 Need for Action

The Service's Biological Integrity, Diversity, and Environmental Health Policy (601 FW 3) provides policy for maintaining and restoring, where appropriate, the biological integrity, diversity, and environmental health of the National Wildlife Refuge System. This policy states that the Service only utilizes GMCs when their use is deemed essential to accomplishing the purpose of the Refuge. Therefore, there is a need to thoroughly evaluate the use of these specific GMCs, with associated herbicides, and determine if their use, compared to non-GMC's (conventional) with associated chemicals, better meets the Refuge's wildlife management objectives while simultaneously supporting the purpose of the Refuge ("…for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon…"), the mission of the National Wildlife Refuge System, the Service's Biological Integrity policy, and other relevant laws, regulations, and policies.

1.6 Decision to be Made

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This EA is an evaluation of the environmental impacts of the alternatives and provides information to help the Service fully assess impacts of the proposal. Using the analysis in this EA, the Regional Director of the Southwest Region (Region 2 of the U.S. Fish and Wildlife Service) will decide which alternative to implement and whether there would be any significant effects associated with the selected alternative that would require the preparation of an environmental impact statement. If no significant impacts are identified, a Finding of No Significant Impact (FONSI) will be prepared.

1.7 Regulatory Compliance

National wildlife refuges are guided by the mission and goals of the National Wildlife Refuge System (NWRS), the purposes of an individual refuge, Service policy, and laws and international treaties. Relevant guidance includes the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, Refuge Recreation Act of 1962, and selected portions of the Code of Federal Regulations and Fish and Wildlife Service Manual.

The mission of the Refuge System 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" (National Wildlife Refuge System Improvement Act of 1997, Public Law 105-57).

The goals of the Refuge System are to:

- *Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered;*
- *Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges;*
- *Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts;*
- *Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation);* and
- *Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.*

The NWRS Improvement Act of 1997 provides guidelines and directives for the administration and management of all areas in the NWRS. It states that national wildlife refuges must be protected from incompatible or harmful human activities to ensure that Americans can enjoy Refuge System lands and waters. Before activities or uses are allowed on a national wildlife refuge, the uses must be found to be compatible. A compatible use "… will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes

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of the refuges." A draft compatibility determination for cooperative farming and associated herbicide tolerant GMC use on Sequoyah NWR has been completed and is also available for review.

The Sequoyah NWR is an overlay project of the U.S. Army Corps of Engineers (USACE) established on the 42,000 acre Robert S. Kerr Reservoir by Cooperative Agreement No. DACW56-3-71 on December 11, 1970. A General Plan formulated and approved through the Cooperative Agreement states that the land and water areas set aside for the refuge will be administered for the conservation and management of migratory birds and of other fish and wildlife.

This EA was prepared by the Service and represents compliance with applicable Federal statutes, regulations, Executive Orders, and other compliance documents, including the following:

- Administrative Procedures Act (5 U.S.C. 551-559, 701-706, and 801-808) as amended
- American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996)
- Antiquities Act of 1906 (16 U.S.C. 431-433
- Archaeological Resources Protection Act of 1979 (16 U.S.C. 470)
- Bald Eagle Protection Act (16 U.S.C. 668-668d) as amended
- Clean Air Act of 1972, as amended (42 U.S.C. 7401 *et seq.*)
- Clean Water Act of 1972, as amended (33 U.S.C. 1251 *et seq.*)
- Endangered Species Act of 1973, (ESA) as amended (16 U.S.C. 1531 *et seq.*)
- Executive Order 12898, Federal Action Alternatives to Address Environmental Justice in Minority Populations and Low Income Populations, 1994.
- Executive Order 13112, Invasive Species (issued in February 1999)
- Fish and Wildlife Coordination Act of 1958, as amended (16 U.S.C. 661 *et seq.*)
- Fish and Wildlife Improvement Act of 1978 (16 U.S.C. 7421)
- Floodplain Management (Executive Order 11988)
- Migratory Bird Treaty Act (16 U.S.C. 703-712 as amended
- National Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee) as amended
- National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq.*)
- Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 *et seq.*)
- National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 *et seq.*)
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 *et seq.*)
- Protection and Enhancement of the Cultural Environment (Executive Order 11593)
- Protection of Wetlands (Executive Order 11990)
- National Pollutant Discharge Elimination System, as amended (33 U.S.C. 1251 *et seq.*)
- Soil and Water Conservation Act of 1977 (16 U.S.C. 2001-2009) as amended

In preparation of this EA, the Refuge also reviewed and considered the Cropland Management policy in U.S. Fish and Wildlife Service Refuge Manual (6 RM 4). This policy provides definitions, objectives, preferred farming systems, and management guidance for farming while also discussing soil conservation, chemical use, and biodiversity. Where this EA outlines specific management, the Refuge relies on the definitions provided by the Cropland Management Refuge

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Manual policy (See Appendix A). In addition, the Refuge considered the Service's Policy on Biological Integrity, Diversity, and Environmental Health (601 FW 3), which states:

"We do not use genetically modified organisms in refuge management unless we determine their use is essential to accomplishing refuge purpose(s) and the Regional Chief or the Assistant Manager, California/Nevada Operations Office (CNO), National Wildlife Refuge System, approves the use."

Further, this EA reflects compliance with applicable State of Oklahoma and local regulations, statutes, policies, and standards for conserving the environment and environmental resources such as water and air quality, endangered plants and animals, and cultural resources. The Endangered Species Act Section 7 consultation on the Refuge farming program including GMC use was completed on May 5, 2009.

1.8 Scoping/Public Involvement and Issues Identified

Scoping was initiated on July 1, 2010. The Refuge distributed a news release to 44 local media outlets including 19 radio stations, 1 television news network, and the following news sources:

- Big Basin LLC
- Cherokee Phoenix
- Democrat-Journal
- Eastern Statesman
- Eastern Times Register
- Latimer County News-Tribune
- Muskogee Phoenix
- News-Sentinel
- Northeastern
- Poteau Daily News
- Sequoyah County Times
- Tahlequah Daily Press
- Times Record
- Tri-County Publications
- Van Buren Press Argus-Courier
- Vian Tenkiller News
- Viking Banner
- Washington County News Inc.
- McAlester News Capital and Democrat
- Field Notes
- Graphic
- Greenwood Democrat
- Haskell News
- Heavener Ledger

The Refuge simultaneously posted a public notice that established a 30-day scoping period with a scheduled culmination date of August 1, 2010. The public notice was posted at the Headquarters Office as well as the following locations in the local community: Finish Line Gas Station, Ace Hardware, Short Stop #2 Gas Station, C and C Auto, L and S Feed and Lube, and IGA Grocery. The Service determined that additional time was necessary to involve the many interested parties in the EA process, and the public scoping period was extended through August 31, 2010. Public notices were reposted to reflect this change.

The Service also developed a scoping letter explaining all of the farming programs on the national wildlife refuges in the Southwest Region. On July 29, 2010, this letter was distributed to 263 potentially interested parties including federal, state, and local agencies; nearby irrigation districts; soil and water conservation districts; cooperative extensions; volunteer groups; private landowners; local chambers of commerce; county commissioners; members of Congress; and U.S. Representatives. The letter solicited comments and included a brief description of all of the farming programs throughout the region, including the program on the Sequoyah NWR.

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During the scoping period, which lasted until August 31, 2010, the Service received twelve comments on farming. One letter was received in response to the regional scoping letter and considered during the development of the Sequoyah NWR Farming EA. The commenter recommended that all farming on national wildlife refuges should be conducted organically; no genetically modified crops should be used; focus should be on removal of invasive species such as Johnson grass, buffelgrass, salt cedar, etc.; and our first concern should be the health of wildlife. The remaining eleven comments were submitted by members of the local community.

Eleven response letters and emails with comments from the local community were considered as part of the analysis for Sequoyah NWR Farming EA. Of these comments, only one of the public comments specifically addressed the use of GMCs or chemical use. That comment, from the Oklahoma Farm Bureau, stated that the use of GMCs has decreased the amount of chemicals required on croplands, and that this use shows the Refuge's sensitivity to farmers' needs because the purchase of non-GMC seeds is nearly impossible. An additional comment from the U.S. Army Corps of Engineers (USACE) Eufaula Lake Office stated that the USACE supports the Best Management Practices implemented by the Refuge for the health of both the wildlife and the Refuge's visitors. The remaining ten comments that the Refuge received were determined to be outside the scope of this EA because they will be addressed in the CCP, which is currently in development. The focus of this EA is to evaluate the environmental impacts of cooperative farming use of GMCs and associated chemicals compared to conventional farming and associated chemicals without the use of GMCs.

In an effort to exhibit transparency in Refuge actions, it is still important to summarize the concerns and issues raised by the public even though the Service has determined that these comments are outside the scope of this particular EA. Most of the individuals who commented on the farming program requested that the Refuge continue its current farming program management and expressed concern over the planting of hardwood trees in previous farm fields at Webbers Falls in particular. Some members of the public stated that these tree plantings have contributed to declining opportunities for waterfowl observation and hunting as fewer birds utilize Refuge lands. Specifically, some individuals suggested that farming practices should return to the Webber Falls Unit of the Refuge in which some areas were recently restored to native bottomland hardwoods habitat. Other members of the public commented on the influence of the Refuge farming program on the local economy due to investments in equipment, fuel, seed, and maintenance, as well as crop depredation occurring on nearby private lands. In addition, comments included concern over food production for all Americans and especially for local families dependent on the long-standing tradition of cooperative farming. The Oklahoma Department of Wildlife Conservation requested that the Refuge continue crop production as part of their integrated habitat management practices. As mentioned previously, the CCP for Sequoyah NWR will evaluate other aspects of Refuge management including the farming program. Therefore, the comments that were received will be considered in the development of the CCP and its corresponding EA.

Internal scoping of refuge and regional office staff was conducted throughout June, July, and August of 2010. The main internal scoping meeting with the Regional Office was held on July 21, 2010, to identify issues, concerns, and management opportunities. A phone conference between Regional Planning Division staff and Refuge staff was held on August 3, 2010. Regional Planning staff also visited the Refuge to discuss issues, alternatives, and develop the draft document October 4-8, 2010, and the team held multiple conference calls with the Regional

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Office over that timeframe. Based on internal and external scoping, the following issues were identified and considered in the development of the alternatives in Chapter 2 of this EA:

Use of Genetically Modified Crops

In accordance with the FWS Biological Integrity Policy, the use of genetically modified crops (GMCs) is allowed on national wildlife refuges if their use is deemed essential to meet the purpose of the refuge. The use of GMCs on Sequoyah NWR was approved in 2006 by the Regional Chief, Region 2, of the National Wildlife Refuge System in accordance with the Biological Integrity Policy. The Refuge currently allows the use of three herbicide-tolerant GMCs (Roundup Ready© Corn, Roundup Ready© Soybeans, and Liberty Link© Corn) by their cooperators, and approximately 80-90 percent of Refuge croplands are planted in the aforementioned herbicide-tolerant GMCs. One member of the public has stated that no GMCs should be used on any refuge whereas the Oklahoma Farm Bureau "is pleased to see the Refuge allows the use of GMO crops". To address this issue, this EA considers two alternatives: cooperative farming with specified GMCs and chemicals and conventional farming with chemicals (without GMC use).

Use of Chemicals to Control Pests and/or Invasive Species/Undesirable Weeds

Chemicals are routinely used on refuges to assist with the management of invasive species and undesirable weeds as part of Integrated Pest Management. There is concern that chemicals used as part of farming programs could adversely impact the physical, biological, or human environment. One commenter recommends that all farming on refuges should be done organically. The Oklahoma Farm Bureau commented that the purchase of non-GMC seed can be nearly impossible and the use of genetically modified corn and soybeans has cut back on the amount of chemicals required. Refuges only allow the use of chemicals that have been approved through the Pesticide Use Proposal (PUP) process. There are specific pesticides approved for use on Sequoyah NWR's farming units in order to treat undesirable weeds and maintain crop yields. These chemicals and their approval process are described in Appendix B. A Contaminant Assessment Process (CAP) Report for Sequoyah NWR was published in 2002. This Report identified potential problems with pesticide-related contamination on the Refuge although no specific contamination or habitat degradation was documented. The Service recognizes there are risks associated with pesticide use; however, measures incorporated in the best management practices and integrated pest management strategies are used to minimize the potential for harmful effects. These measures will apply to all alternatives.

Management Consideration/Alternatives

It is important to determine the management scheme that will best meet the biological needs of wildlife on a particular refuge. Therefore, the Refuge will evaluate whether current management meets the Refuge's management goals and objectives as well as the Refuge purpose. The refuge will consider an appropriate range of alternatives including reducing and/or eliminating the farming program if other management tools will more effectively meet the purpose of the Refuge. As mentioned before, the consideration of acreages, operations, and different management opportunities will be addressed in the CCP.

Water Rights

Water is often described as the "lifeblood" of the Refuge System, but it is also the lifeblood of agriculture, industry, energy production, and municipalities. This resource is vital to supporting management actions occurring on Refuge lands. The Refuge has water rights to 1040-acre feet

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from the Arkansas River. According to Refuge records (1970 – 2003), yearly average precipitation is 43.82 inches. The Refuge usually receives ample rainfall each year, which supports agricultural development on the Refuge; therefore, water rights are currently not an issue on Sequoyah NWR. While this EA will not evaluate the impact of management decisions on water rights, it will, however, assess the relationship between farming activities and water quality and quantity.

2.0 ALTERNATIVES

Alternatives are different approaches designed to meet the purpose and need for the proposed action. NEPA requires federal agencies to consider a reasonable range of alternatives that meet the purpose and need for the proposed action. Based on the issues, concerns, and opportunities heard during the scoping process, the following alternatives were identified. Two management scenarios that could meet the purpose and need of the proposed action were identified and analyzed in detail in this EA. The alternatives solely evaluate the use of the aforementioned GMCs and chemicals. Three additional scenarios/alternatives were also considered but were found to be infeasible (do not meet the stated purpose and need); therefore, they were eliminated from detailed analysis for the reasons listed in Section 2.5.

The CCP and its corresponding Environmental Assessment (EA) will further evaluate alternatives to the farming program as a whole, including the number of acres and locations farmed.

2.1 Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)

Under this alternative, the Refuge would continue to utilize both force account and cooperative farming to manage approximately 2,800 acres of historic croplands. Farming would continue to target the production of quality foods in ample amounts to maintain a large population of migratory waterfowl that use the area in migration and wintering periods with many other wildlife species benefiting from the same crops.

Cooperators would be allowed to continue to carry out farming operations on 2,754 acres, or 13%, of the Refuge. Currently, six cooperative farmers provide this service for Sequoyah NWR. These farmers would continue to use their own equipment and fuel to prepare the ground, plant the fields, apply chemicals, and harvest an agreed-upon percentage of the crop. To compensate for the use of Refuge lands, cooperators are required to leave a portion (typically 25%) of the crop unharvested in the field as food for waterfowl and other wildlife. The Refuge provides cooperators with guidance on best management practices in an effort to ensure that farming operations are conducted in a safe and productive manner. The planting, growing, and harvesting season is generally from February 15 through October 31 each year.

Annual Cooperative Farming Agreements would continue to specify crop types, Refuge share for wildlife, cooperator share, and location where the cooperator may farm. See Appendix C for an example of a typical Cooperative Farming Agreement. The Refuge typically prefers that the cooperators provide winter wheat, corn, or Japanese millet for the Refuge share, but the Refuge specifies a range of acceptable crops for Refuge share in the agreement. Winter wheat and rye

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are planted as a source of green-browse during the fall and winter months for wintering and resident waterfowl and other migratory birds.

Under the No Action Alternative, the Refuge would continue to allow the use of three genetically modified crops (GMCs) and associated chemicals on the farming acreage due to the unavoidable necessity of weed control in agricultural activities and practices. The GMCs used on the Refuge are herbicide-tolerant and directly correlated with herbicide use. Specifically, cooperators are allowed to use Roundup Ready ® Corn, Roundup Ready ® Soybeans, and Liberty Link ® Corn. Roundup Ready ® (glyphosate-tolerant) corn and soybeans have been genetically modified through insertion of a gene that allows the plant to tolerate applications of glyphosate. When applied according to label instructions, glyphosate will kill all actively growing plants, except for those that have been genetically modified to tolerate that herbicide. Liberty Link ® (glufosinate-tolerant) corn has been genetically modified in the same manner, which allows the plant to tolerate applications of glufosinate ammonium. Proposals submitted to the Refuge Manager for future use of GMCs under newly established cooperative agreements would be evaluated on a case-by-case basis to ensure the Refuge's consistency with the biological integrity, diversity, and environmental health policy. The Refuge has reviewed the non-regulated list of Genetically Modified Crop (GMC) Seeds and associated environmental assessments (EAs) written by the United States Department of Agriculture's Animal and Plant Health Inspection Service Bio-Technology Division (APHIS). Under the current No Action Alternative, the Refuge would continue to use the three genetically modified crops (GMCs), Roundup Ready ® Corn, Roundup Ready ® Soybeans, and Liberty Link ® Corn, which have been granted a non-regulated status. The Refuge believes that the detailed and extensive analysis used by APHIS in granting non-regulated status to the specified GMCs in this EA is relevant and appropriate for the farming program on Sequoyah NWR.

Treatment of undesirable weeds has been an ongoing battle throughout the Refuge's cooperative farming program since its establishment in 1970. To control plant and animal pests, the Refuge would continue to require that cooperators implement Integrated Pest Management (IPM) strategies, including crop rotation, tillage, no-till, fallowing, hand and mechanical removal, biological controls and certain chemical pesticides. By employing cooperative farmers, they are tasked with the responsibility of undesirable weed control efforts in all farm fields, in the most effective and efficient means possible. This allows the refuge to redirect existing staff and resources to other wildlife, habitat and conservation priorities. Treatments are focused on the prevention of seed production, stressing perennial root systems, and minimizing inadvertent spread through chemical and mechanical operations. The goal is to reduce plant pest species by 80 percent with each treatment leading to the elimination and control of these pests, thus decreasing the amount of chemical used as weed pressures are eliminated. Pesticides may be applied when field scouting indicates competition will reduce targeted/desired crop yields. Mechanical control will be used when feasible. The Refuge would continue to crop scout and only use pesticides when and if necessary and only as prescribed.

Under the No Action Alternative, all farming and chemical use would continue to be conducted in such a way as to minimize impact on non-farmed areas of land or water. All agriculture chemicals would continue to be used sparingly under scrutiny of Refuge staff and must be approved by the Refuge Manager and through the Pesticide Use Proposal (PUP) process prior to application. Appendix B describes the PUP process and lists the pesticides that are currently used in conjunction with farming on the Sequoyah NWR. The Refuge rarely has a need to use insecticides. One insecticide (Tracer Naturalyte Insect Control) was approved through the PUP

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process; however, conditions at present have not warranted its use. The Refuge implements best management practices when chemical use is required, and these conservation measures are outlined in Section 2.3 "Conservation Measures Common to Both Alternatives".

Adaptive Management

Under this alternative, the Refuge would continue to implement adaptive management, which includes periodic review and evaluation of the farming program and management practices. As cooperative farming ceases on Refuge croplands due to attrition or a cooperative farmer quitting the program, the land will be evaluated to determine if farming is the most desirable use from a waterfowl conservation standpoint.

If croplands are not deemed to be the best use of those tracts, consideration would be given to conversion to either moist soil units or bottomland hardwood forests. When such grain and forage production is deemed no longer useful or is overshadowed by other methods, farming on those tracts would be phased out as rapidly as practical.

If farming is determined to be the best use of the existing cropland acreages, the Refuge will re-assess the type of cropland management that will most benefit waterfowl. Decisions at that point may include continuing or discontinuing the use of specified GMCs, converting to force account farming conducted solely by Refuge staff, which could include implementing no-till farming and adapting the most current farming technologies for use on the cropland. In addition, the Refuge would modify the Integrated Pest Management Plan that would provide the fullest possible range of alternative control strategies to encourage lower chemical input from farming activities. The Refuge will use the IPM Plan in concert with habitat monitoring to assess progress and effectiveness of different control and eradication techniques and to identify additional problem species and areas.

Assumptions

The Refuge believes that the use of herbicide-tolerant soybeans and corn has resulted in an overall decrease in the amount and varieties of pesticides (active ingredient) applied to the farm fields since their original use in the late-1990s. A review of the best scientific information available supports this conclusion, at least in the short-term (Benbrook 2001, Brookes and Barfoot 2006, Ervin et al. 2000, and Phipps and Park 2002). The use of these GMCs allows the farmers to achieve a highly effective weed control system with fewer inputs on the land while simultaneously minimizing labor requirements. Some contradictory scientific literature related to the relationship between the use of Roundup Ready ® soybeans and corn and the amount of herbicides used state that the transition to more intensive use of glyphosate and, presumably, glufosinate has led to more glyphosate- or glufosinate-tolerant weeds that require heavier doses to kill (Benbrook 2001; Villar and Freese 2008). Although the amount of active ingredient has decreased, the pounds of pesticides per acre for GMC crops are marginally higher than conventional crops (Benbrooke 2001). While some weed-resistance has occurred at Sequoyah NWR, the Refuge requires the farmers to cyclically cease the use of glyphosate or glufosinate to further reduce this risk and associated increase in glyphosate and glufosinate treatments.

The Refuge also believes that the use of such technology has led to adoption of conservation tillage practices Three cooperative farmers have indicated that the switch to GMC farming has allowed them to implement no-till farming. This assumption is also based on a literature review,

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noting this conclusion from scientific articles and literature reviews (Carpenter and Gianessi 1999, Ervin et al. 2000, Phipps and Park 2002).

Summary

The Refuge believes that the current cooperative farming program (Alternative A) is an important and effective means of helping the Refuge meet its goals. The acreage farmed by cooperators greatly reduces the budgetary and staffing requirements that would be needed if Refuge personnel were responsible for farming all croplands. As cooperative farmers harvest their portion of crops this leaves only stubble in the fields creating open areas that otherwise would not exist in agricultural areas. This cropland habitat on the Refuge benefits wildlife by providing and maintaining open areas for feeding and resting and retarding encroachment by woody and/or invasive plant species. Additionally, photography and wildlife viewing opportunities are enhanced as birds and other wildlife species congregate on agricultural lands.

Alternatively, the Refuge does recognize certain risks associated with the adoption of GMC farming. Specifically, these risks include an increased tolerance in weeds to glyphosate and glufosinate with the possibility of resistance in the use of these two particular chemicals. In an effort to minimize the build up of glyphosate and glufosinate in the soil and possible weed resistance, cooperators are required to rotate their crops and use an herbicide with a different mode of action every third year. In addition, the use of GMCs could result in gene transfer to wild relatives; however, the specific GMCs used on the Refuge (corn and soybeans) do not have wild relatives.

2.2 Alternative B— Cooperative Farming with Conventional Crops Only (No GMC Use Permitted)

Alternative B would involve the same administrative management and acres in production as Alternative A, but the Refuge would implement GMC-free conventional farming with chemicals. Conventional farming typically involves a full complement of tillage practices (e.g., plow, disk, plant, cultivate) with dependence on synthetic pesticides and fertilizers in order to continuously produce one or two crops (6 RM 4.3 E). These activities are more labor intensive than Alternative A and require an increase in ground disturbing activities. Although the Refuge would discontinue use of GMCs under this alternative, cooperators would be allowed to use Integrated Pest Management, including pesticides, to assist in undesirable weed and insect control.

Regulations regarding chemical use would remain the same as under Alternative A. All agricultural chemicals would continue to go through the Pesticide Use Proposal process prior to application and only be used when crop scouting indicates pests have reached threshold limits, with guidance from Refuge staff.

Adaptive Management

The Refuge would continue to implement adaptive management, which would include periodic review and evaluation of the farming program and management practices. As Refuge croplands are given up through attrition or when a cooperative farmer chooses to quit the program, the land will be evaluated to determine if farming is the most desirable use of the land from a waterfowl conservation standpoint.

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If croplands are not deemed to be the best use of those tracts, consideration would be given to conversion to either moist soil units or bottomland hardwood forests. When such grain and forage production is deemed no longer useful or is overshadowed by other methods, farming on those tracts would be phased out as rapidly as practical. If cropland management is determined to be the best use of those parcels of land, the Refuge will then determine whether or not to convert the parcel to force account farming conducted solely by Refuge staff, implementation of no-till farming, and the potential to adapt the most current farming technologies for use on the croplands. This is the same as Alternative A, except that GMCs will not be used or considered.

Summary

Discontinuing the use of GMCs would cause challenges for the Refuge's cooperative farmers and possibly the future of the farming program. Farmers would face increased financial obligation in the operation and purchase of seed, various pesticides, and additional fuel. Conservation tillage practices would be replaced by traditional soil disturbing practices to rid any weeds that were not affected by the use of a selective, post-emergent herbicide. Various selective, broadleaf and grass killing herbicides, per crop, would replace a glyphosate/glufosinate product. Market research for a new variety of a non-GMO product would have to be initiated as seed availability without biotechnology is being phased out as the demand for GMC seed outweigh non-GMC seed. Additional trips in the field may be necessary since many herbicides are non-compatible tank mix partners which could require mechanical soil incorporation. Mechanical cultivation in row crops would have to be integrated with herbicide applications. In addition, less certainty in effective pest control methods would likely lead to increased multiple pesticide usage, which would likely include harsher chemicals than glyphosate. This could hinder the Refuge's ability to control undesirable plant species and meet waterfowl conservation management objectives. Alternatively, this use of a wider variety of chemicals may reduce the risk of weed resistance associated with GMC use. Conventional farming also eliminates the risk of hybridization with wild relatives for any crop, and the effects of conventional farming methods are much better understood than environmental consequences of GMC farming.

2.3 Conservation Measures Common to Both Alternatives

The approved PUPs include measures to minimize environmental impacts through the following best management practices:

- Application at wind speeds less than 10 mph (but not inversion conditions)
- Application must be in accordance with chemical label
- Calibrate application equipment
- Field scouting/monitoring before pesticide application
- Use pesticide application buffers around sensitive areas
- Implement vegetative buffers
    - The Refuge currently has 150-foot vegetated buffers (50-foot buffers for glyphosate pesticides) around all permanent wetlands, lakes, ponds, and rivers for non-glyphosate pesticides. Drift issues can also be minimized by using drift control agents and applying droplets that are > 150 microns in size.
    - Must have a 100-foot buffer around all permanent wetlands, lakes, ponds, and rivers during aerial application. All label precautions/recommendations to avoid drift, environmental hazards, and water contamination will be strictly followed.

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Applicator must follow Aerial Spray Drift Management section (pg. 4) stated within label.

- Use lowest effective application rate.
- Drift control agents must be compatible with label. Certain products will not be applied if rainfall is forecasted within 48 hours.
- The importance of drift management practices and wetland buffer zones will be conveyed to the cooperator due to the toxicity of this product towards aquatic organisms.
- For Quadris Flowable & Tracer Naturalyte: Impacts to all (if any) sensitive areas will be prevented by the following means: 1) A 300 foot buffer from water and any adjacent endangered or threatened species will be used provided soils are not characterized as gravel, sand or sandy loam; 2) Chemical applications will not be made during windy conditions or when rain is expected within 4 hours; 3) Chemical applications will be made only according to product label; 4) Buffer zones will be established between treatment areas and adjacent croplands and wetlands to avoid contamination by drift or runoff; 5) All pesticide applications will be done by State-certified applicators; 6) This product will not be applied when weather conditions favor drift from the target area (wind >7 mph); 7) Avoid any application within 24 hours of previously heavy rainfall or within 24 hours of predicted rainfall; 8) Avoid spraying when air temperatures exceed 85 degrees Fahrenheit and implement all additional precautions or recommendations in any applicable supplemental label or county bulletin.

In addition, numerous special conditions are specified in the Annual Cooperative Farming Agreements including soil testing and monitoring. If soil fertility were to decline, the cooperators would be required to improve the condition at their own expense.

2.4 Comparison of Alternatives

Issue	Alternative A Cooperative Farming with Specified GMC Use Permitted (Proposed Action)	Alternative B Cooperative Farming with Conventional Crops Only (No GMC Use Permitted)
Use of Genetically Modified Crops	Roundup Ready ® Corn, Roundup Ready ® Soybeans, and Liberty Link ® Corn would continue to be utilized on farm fields with re-evaluation of farming and the use of chemicals including GMCs when current cooperative farmers leave the program due to attrition.	No GMCs would be utilized.

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Use of Chemicals to Control Pests and/or Invasive Species	Only chemicals approved through the Pesticide Use Proposal process would be utilized. See Appendix B for the complete list.	Same as Alternative A except application rates and treatment areas would vary from current management. It is likely that a wider variety and harsher chemicals than glyphosate would be needed.
Management Considerations	Cooperative farming would occur as described in Alternative A (Section 2.1). Currently 2,754 acres are cooperative farmed and an additional 25 acres are farmed by Refuge staff. Through adaptive management, the amount of acreage in farming would be evaluated based on management needs and could be reduced as farmers retire or through attrition.	Same as Alternative A if cooperators are able to continue farming with increased costs (fuel, equipment, manpower, chemicals) of converting back to conventional farming.
Water Rights	Use of allocated water rights would not change.	Same as Alternative A.

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2.5 Alternatives Considered But Dismissed From Detailed Analysis

The Refuge considered implementing biological (organic) farming as defined in the Refuge Manual (6 RM 4) but determined that this alternative would not be feasible. To be in accordance with the Refuge Manual, this action would require that the Refuge replace conventional means of pest control with legume-based crop rotation. These crops do not meet the needs of migratory waterfowl in the same manner as corn and small grains. In addition, the Refuge does not have adequate staff, funding, or the expertise to pursue force account farming. Therefore, this alternative will not meet the purpose and need of the EA and was dismissed from further consideration.

The Refuge considered converting their farm program to farming without GMCs and without chemicals but determined this action not to be feasible. This alternative would be labor intensive and expensive as mechanical treatments to control undesirable plant species would have to be increased. The Refuge is surrounded by privately owned agricultural land where chemical pest control is prevalent. If the Refuge eliminated chemical use, it is likely that undesirable weeds and invasive species could spread on the Refuge and to adjacent private lands. The quality of the farming program would likely decrease as yields decrease; consequently, less food would be produced for wildlife. Therefore, the Refuge would not meet their waterfowl conservation management objectives.

The Refuge considered phasing out the use of GMCs when cooperative agreements expire and/or cooperative farmers leave the program through attrition. This approach was determined not to be a valid alternative, since it is basically the same as Alternative B in the long-term.

3.0 AFFECTED ENVIRONMENT

This section provides a description of the affected resources determined to be applicable to the range of alternatives. Strategically situated at the confluence of the Canadian and Arkansas Rivers, the Refuge is a valuable sanctuary containing rich river bottomland forests with numerous ponds and sloughs that provide food and cover for migratory and resident wildlife species. The Refuge supports a variety of wetland and upland vegetation within the 20,800 acres managed for resident and migratory fish and wildlife species. The resources described below are those that could be directly or indirectly impacted by the alternatives discussed in this document.

3.1 Physical Environment

3.1.1 Air Quality

Under the Clean Air Act (42 USC 7401-7671q, as amended in 1990), the Service has a responsibility to protect air quality and related values from the adverse effects of air pollution and to comply with federal, state, and local air pollution control laws and regulations. The project area has excellent air quality, due to the rural land uses in most of the surrounding area.

3.1.2 Soils

The soils of the Refuge consist predominantly of sandy loams and silty loams (Coushatta silt loam) that are typical of the river alluvial deposits in the area. These soils can be agriculturally

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productive and provide excellent woodland habitat if flood events and inundation periods are not extensive in length (USFWS 1995).

3.1.3 Water Quality and Quantity

The Refuge is located in the Robert S. Kerr Reservoir watershed. This watershed encompasses approximately 1,795 square miles in Oklahoma and Arkansas and extends across ten counties. The watershed includes 2,507 total river miles including 755.3 perennial river miles and 473 lakes with 49,382 total watershed acres. The Canadian and Arkansas Rivers converge and flow through the middle of the Refuge, creating a very productive floodplain. The flow of both rivers is controlled by the USACE. The Refuge contains 6 creeks, 2 lakes, 33 wetlands, and 5 seasonal semi-permanent ponds.

While the water quality of most streams, ponds, and lakes on the Refuge is adequate for wildlife, the overall water quality of the Robert S. Kerr watershed is ranked by the U.S. Environmental Protection Agency as five on a scale of six with one being pristine water quality. A five ranking indicates a watershed having more serious problems with low vulnerability to future impact changes (EPA 2000). Approximately 50 percent of the streams monitored in the watershed were rated as Category I (watershed needing restoration) and approximately 50 percent were rated as Category II (watersheds needing preventive action to sustain water quality).

3.2 Biological Environment

3.2.1 Habitat

Sequoyah NWR is a mosaic of woodlands, grasslands, wetlands, sand bars, and croplands scattered by rivers, creeks, lakes, and ponds. Very little bottomland hardwood forests remain in Oklahoma due to waterway alterations, making the 6,300 acres of late-, mid-, and early-successional forests found on the Refuge vital for wildlife use. There are approximately 200 acres of grasslands in relatively small plots scattered throughout the Refuge and 6,260 acres of wetlands that include marshes, ponds, wood sloughs, and moist soil units. In addition, 900 acres of sandbars are located on the Refuge, primarily in river habitat on the western portions of Sequoyah NWR. The project area would occur solely within the approximately 2,800 acres of cropland that exist on the Refuge.

3.2.2 Wildlife

The Refuge supports a diversity of wildlife species of eastern Oklahoma, including game and nongame species, reptiles, amphibians, and invertebrates, which are important contributors to the overall biodiversity on the Refuge. The Refuge is located within the easternmost section of the Central Flyway, bordering the Mississippi Flyway. Due to its convenient yet unique locality, birds from both flyways utilize the Refuge, thus providing a crucial stopover and wintering ground for many species. Waterfowl censuses on the Refuge are conducted weekly from October to March. On average, up to 7,000 mallards, 3,000 green-winged teal, 100 northern pintails, several hundred Canada geese, and 10,000 snow geese are known to utilize winter feed on Refuge land. The northern waterfowl migration usually begins in mid-February leaving a small

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population of breeding mallards, a solid population of wood ducks, a few hundred snow and Canada geese, several northern shovelers, and many migrating shorebirds to utilize the Refuge.

The Refuge has documented 272 species of birds, 46 species of mammals, 94 species of reptiles and amphibians, and 73 species of fish. Management of many of these species remains a collaborative effort with the ODWC. The Refuge's rich mixture of bottomland hardwood forests, open lakes and wetland habitats also support other rare and declining migratory birds, particularly neotropical songbirds and federally listed species such as the interior least tern.

3.2.3 Threatened and Endangered Species and Other Special Status Species

Two endangered species occur on the Refuge – the American burying beetle and the interior least tern. The American burying beetle plays an important role in breaking down decaying matter and recycling it back into the ecosystem as they bury themselves under the soil to overwinter. The cause for the decline of this species is not clearly understood, but it could be a direct result of habitat fragmentation, habitat loss, carcass limitation, pesticides, disease, light pollution, or a combination of these factors. The interior least tern is listed as endangered by both the Service and the State of Oklahoma because the species' population decreased by more than 80 percent between the 1940s and the 1970s. In the interior United States, including Oklahoma, river channelization, irrigation diversions, and the construction of dams contributed to the destruction of much of the tern's sandbar nesting habitat. There are no candidate species presently occurring on the Refuge, but the following species of concern are known to occur on the Refuge or the Refuge contains potential habitat: alligator snapping turtle, bald eagle, Bell's vireo, common barn owl, golden eagle, loggerhead shrike, and Swainson's hawk.

3.3 Human Environment

3.3.1 Socioeconomic Resources

The Refuge is located approximately 3 miles from the city of Vian, Oklahoma, with a population of 1,438. Several other small cities are also within thirty to ninety miles away. The predominate land uses in the vicinity of the refuge are agriculture (irrigated and non-irrigated) and hay production. The Sallisaw Chamber of Commerce lists the Refuge as one of the area's main attractions. The Refuge averages about 75,000 visitors per year. The Refuge is open to public use activities such as hunting, fishing, wildlife observation, and wildlife photography. Sequoyah NWR is made up of a number of public use areas and access points. These areas consist of 28 parking lots, three fully developed boat ramps with courtesy docks, six other less developed to primitive boat ramps, five fishing/observation decks, two photography/observation platforms, and two hiking trails. The Refuge also plays a role in the local economy as Refuge employees typically live in the community, own property and support local businesses through routine purchases.

The Refuge's cooperative farming program plays a large role in the local economy. Cooperative farming has been used for more than 40 years to meet the goals of the Refuge while employing members of the local community. The cooperative farming program yields an annual return to the cooperators as well.

3.3.2 Visitor Services/Public Use

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The Sequoyah NWR provides opportunities for wildlife-dependent recreation including hunting, fishing, wildlife observation, photography, environmental education, and interpretation. Approximately 60 percent of the Refuge's farm fields are within public use areas that provide opportunities for these activities. Specifically, the Refuge allows hunting of small game, deer, and waterfowl within farm fields open to the public including one accessible hunting blind for waterfowl. The Refuge's six-mile auto tour route and other public roads access the majority of the farm fields, which are used extensively for wildlife observation, photography, and interpretative opportunities.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter analyzes and discusses the potential environmental effects or consequences that can reasonably expected by the implementation of the alternatives described in Chapter 2.0 of this EA. An analysis of the effects of management actions has been conducted on the physical environment (air quality, water quality, and soils); biological environment (vegetation, wildlife, and threatened and endangered species); and human environment (socioeconomic features, public use/visitor services). It has been determined that the current management and its alternatives will not have impacts on climate, geology, mineral resources, cultural resources, and visual/aesthetic resources; therefore, there will be no further discussion of these resources in the analysis. Potential impacts to all other resources are addressed below.

The direct, indirect, and cumulative impacts of each alternative are considered in the Environmental Assessment.

- **Direct effects** are the impacts that would be caused by the alternative at the same time and place as the action.
- **Indirect effects** are impacts that occur later in time or distance from the triggering action.
- **Cumulative effects** are incremental impacts resulting from other past, present, and reasonably foreseeable future actions, including those taken by federal and non-federal agencies, as well as undertaken by private individuals. Cumulative impacts may result from singularly minor but collectively significant actions taking place over a period of time.

The Refuge also considered various types of impacts during the Environmental Assessment. These include beneficial and adverse impacts.

- **Beneficial impacts** are those resulting from management actions that maintain or enhance the quality and/or quantity of identified refuge resources or recreational opportunities.
- **Adverse impacts** are those resulting from management actions that degrade the quality and/or quantity of identified refuge resources and recreational opportunities.

The Environmental Assessment also evaluates the reasonably expected duration of each impacts, whether short-term or long-term.

- **Short-term impacts** affect identified refuge resources or recreational opportunities and occur during implementation of the project but last no longer.
- **Long-term impacts** affect identified refuge resources or recreation opportunities and occur during implementation of the management action and are expected to persist in the 1-5 years following implementation.

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The Refuge considered the intensity of impact when evaluating the alternatives presented in the Environmental Assessment.

- **Negligible impacts** result from management actions that cannot be reasonably expected to affect identified refuge resources or recreational opportunities at the identified scale.
- **Minimal impacts** result from a specified management action that can be reasonably expected to have the least detectable effect on identified refuge resources at the identified scale when compared to the other analyzed alternatives.
- **Minor impacts** result from a specified management action that can be reasonably expected to have detectable though limited effect on identified refuge resources or recreation opportunities at the identified scale.
- **Moderate impacts** result from a specified management action that can be reasonably expected to have apparent and detectable effects on identified refuge resources or recreation opportunities at the identified scale.
- **Major impacts** result from a specified management action that can be reasonably expected to have readily apparent and substantial effects on identified refuge resources and recreation opportunities at the identified scale.

Scale of impact is an additional consideration evaluated in this EA. Geographic scale can refer to effects at the site-specific level, local level, or Refuge-wide.

- **Site-specific** effects are those impacts that occur solely within the project area croplands.
- **Local** effects are those impacts that can be reasonably expected to have detectable effects within and immediately surrounding the project area croplands.
- **Refuge-wide** effects are those impacts that can be reasonably expected to have noticeable effects across the entire Refuge landscape.

As stated in the Introduction, there is an abundance of conflicting literature available on the potential environmental risks and benefits produced from farming with genetically modified crops as compared to conventional farming. Different studies have produced varying results since the introduction of Roundup Ready® corn and soybeans along with Liberty Link ® corn in the 1990s. The Refuge reviewed a variety of peer-reviewed journal articles and publications to determine the range of effects associated with implementation of each alternative. **Much of the available scientific literature takes a broad approach at assessing GMC use and refers specifically to crops that have been engineered to carry insecticidal traits or stacked varieties that carry both herbicide-tolerant and insect-tolerant traits. Sequoyah NWR does not allow the use of these particular crops, and the literature on insecticide trait and stacked crops, therefore, does not apply.** The Refuge attempted to focus their literature review on GMC herbicide-tolerant crops (corn and soybeans) that are currently allowed on the Refuge. Where federally approved guidance and research existed (from the Service, U.S. Department of Agriculture, or U.S. Environmental Protection Agency), this information provided the basis for the analysis. GMCs are regulated by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS). APHIS evaluates each GMC through extensive scientific evaluation and regulatory process before granting a regulated or non-regulated status to meet the agency's compliance responsibilities under the National Environmental Policy Act (NEPA). APHIS thoroughly analyzes each GMC. Upon completion of an EA for each GMC, each EA includes a detailed, nationwide analysis of the consequences of continued regulation of a particular GMC. Typically, the analysis includes nationwide effects on agricultural production with and without deregulation, impacts on insect control practices, and the potential impact on

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non-target organisms, including beneficial organisms and threatened or endangered species. Also included is an analysis of potential impacts on birds and mammals and arthropods, as appropriate for each proposed deregulation petition. Any proposed move to non-regulation is described in an EA posted on APHIS's website. In addition, the Environmental Protection Agency (EPA) also evaluates any pesticides associated with the use of GMCs for general environmental affects, while the Food and Drug Administration evaluates the potential impact on food safety. The Refuge has reviewed the Environmental Assessments of APHIS to meet its obligations under NEPA for the continued use of non-regulated GMCs (Roundup Ready ® Corn, Roundup Ready ® Soybeans, and Liberty Link ® Corn) on refuge farm lands in the Southwest Region. The Refuge believes that the detailed and extensive analysis used by APHIS in granting non-regulated status to the specified GMCs in this EA is relevant and appropriate for the farming program on Sequoyah NWR.

These conclusions were then supported by the best scientific information available. Furthermore, research with oppositional conclusions was also presented to balance the analysis. Appendix D presents a summary of each article that was reviewed and a brief description of why and how it was used in the NEPA analysis.

4.1 Physical Environment

4.1.1 Impacts on Air Quality

<u>Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)</u>
Current farming operations would continue to result in direct negative effects on air quality due to emissions and dust produced by the use of agricultural machinery and equipment. Studies suggest, however, that the use of certain GMCs may facilitate a change from energy-intensive cultivation methods to reduced- or no-till cultivation (Towery et al. 2010). Three current cooperative farmers at Sequoyah NWR have stated that the transition to GMC use has allowed them to practice no-till farming. Additionally, this conversion to conservation tillage may have a marked effect on tractor fuel consumption, contributing to an overall reduction in the amount of emissions resulting from farming operations (Brookes and Barfoot 2006; Hails 2002).

Spraying of chemical pesticides on crops is likely to result in chemical drift that could indirectly degrade air quality. To minimize the likelihood of spray drift, the Refuge uses best management practices including only permitting the use of such chemicals when wind speeds are below 10 miles per hour. In addition, the Refuge promotes the use of drift control agents. Experience shows that all negative impacts to air quality associated with the current management would be minor, short-term, and local, only affecting Refuge lands in close proximity to operational farm fields.

<u>Alternative B – Cooperative Farming with Conventional Crops Only (No Use of GMCs Permitted)</u>
Alternative B would result in the same general negative impacts to air quality as Alternative A with slightly higher intensity and frequency. To control undesirable weeds and condition soils for planting, conventional farming would require a greater amount of ground disturbance (e.g., tilling) than the GMC farming described in the current management, thus increasing the overall use of farm machinery. Therefore, equipment emissions are expected to be slightly higher than

described in Alternative A. In addition, conventional farming would likely require farmers to increase their overall use of herbicides to effectively control undesirable weeds in agricultural fields. This increased pesticides use associated with Alternative B would inevitably result in an increase in chemical drift of varying toxicity levels as well, which could result in slightly more intense direct effects to air quality. The Refuge would continue to implement best management practices and integrated pest management strategies to minimize the potential for harmful effects when using chemicals. Therefore, these short-term adverse impacts to air quality would likely be moderate and local in scale.

4.1.2 Impacts on Soils

<u>Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)</u>
Current farming management would continue to result in direct adverse impacts to soils due to ground disturbance. GMC use could result in "at least two consequences [that] could potentially occur from reported alterations of soil ecosystems – decrease of plant decomposition rates and of carbon and nitrogen levels, which could affect soil fertility" and low community diversity (Wolfenbarger and Phifer 2000). The literature shows, however, that the use of herbicide-resistant GMCs results in reduced-tillage or no-tillage cultivation, and three farmers at Sequoyah have stated that this has occurred in their operation. This type of management would minimize the amount of erosion occurring in the project areas while simultaneously assisting soil conservation and providing additional soil carbon sequestration (Brookes and Barfoot 2006; Towery et al. 2010; Hails 2002; Wolfenbarger and Phifer 2000). Also, reduced-tillage allows for an increase in crop residue left on the soil surface combined with an increase in the size of soil aggregates, which can limit the potential for soil erosion (Towery et al. 2010). Overall, the effects to soils resulting from ground-disturbing activities (e.g., plowing, tilling) under the current management would remain minor and site-specific although long-term.

Current farming management would result in direct adverse impacts to soils resulting from the use of pesticides. The GMCs used on the Refuge are specifically modified to tolerate chemical treatments of glyphosate and glufosinate, and both chemicals have the potential to have direct adverse impact on soils. Glyphosate adheres strongly to soil, however, rendering it immobile in soil, where it is readily degraded by soil microbes (U.S. EPA 1993; Towery et al. 2010). Whereas the EPA explicitly states "residues [of glyphosate] are expected to be immobile in soils (1993)," one report suggests that "glyphosate can alter the community of soil microorganisms, interfering with the plant's absorption of important nutrients (Villar and Freese 2008)." Overall, based on past experience, glyphosate is expected to result in immediately occurring site-specific minor impacts that are confined to only the treatment area. Glufosinate, however, is highly mobile in soil and has been known to leach 6-24 inches underground (U.S. EPA 2008); therefore, it is likely that glufosinate would result in some adverse impacts to soil chemistry at and adjacent to the project area.

Such chemical pesticides have been used as part of the invasive plant control occurring on Sequoyah NWR since the 1970s, and Cooperative Farming Agreements require the cooperators to periodically sample soil conditions in an effort to monitor the long-term soil conditions in cultivated fields. These agreements specifically state, "A decline in soil fertility will require the cooperator to improve the condition at the cooperator's expense." This management minimizes

the chance for any long-term adverse impacts to soils. Therefore, it is likely that the use of chemicals associated with implementation of the current farming program will continue to result in moderate adverse effects in the short-term occurring at the local scale.

Alternative B – No Use of GMCs; Cooperative Farming with Conventional Crops
Alternative B would likely result in more impacts to soils than Alternative A. This alternative is more labor-intensive than the current management due to land preparation, cultivation, and undesirable weed control needs. Conventional farming would require an increase of pre-plant tilling and post-emergence cultivation over the No Action Alternative, risking increased soil erosion and reducing soil organic matter (Towery et al. 2010). Alternative B would also likely result in an increase in the types and amounts of chemical herbicides used to treat weeds, but the same soil monitoring program would be implemented under Alternative B as that of Alternative A. Increased chemical use in the short-term may cause slightly higher intensities of adverse impacts to soils, but this is expected to be reduced in the long-term as effective weed control methods are determined. These impacts would occur immediately and persist in the long-term while remaining moderate and at the local scale.

4.1.3 Impacts on Water Quality and Quantity

Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)
Current farming practices have the potential to cause direct negative effects to water resources due to ground-disturbance. Cultivation techniques and other ground-disturbing activities (e.g., plowing, tilling) associated with the current farming management would cause some level of soil erosion; as soil particles are moved by wind or rain and potentially reach Refuge waterbodies, this could increase sedimentation of those waterbodies . Experience shows not only that the likelihood for this management to cause adverse impacts to water quality is low, but also that these negative effects related to ground-disturbing farming practices would be minor, short-term, and local in scale.

The use of herbicides (specifically glyphosate and glufosinate) associated with current farming practices would likely result in chemical runoff that could negatively affect water quality. The Refuge would continue to implement best management practices to minimize this potential. Specific effects associated with the chemical application required of the three herbicide-tolerant GMCs utilized under the current management are described below.

As described in Alternative A, the current management entails the use of Roundup Ready® Corn and Roundup Ready® Soybeans, both of which are genetically engineered to tolerate glyphosate application. According to the Environmental Protection Agency (1993), glyphosate is not likely to travel to groundwater or surface water with runoff due to the chemical's ability to adsorb (molecular attraction) to soil particles. This herbicide, however, may reach surface waters through erosion as it bonds so tightly to soil. This could cause adverse impacts to water quality, but glyphosate degrades quickly and noticeable effects to water quality are highly unlikely (EPA 1993). Furthermore, the Refuge states in the special conditions of their Annual Cooperative Farming Agreements that the cooperators provide a 50-foot vegetative buffer from waterbodies to prevent this from occurring. Due to the Refuge's control measures and the EPA's current literature, the Refuge expects that glyphosate use on the Refuge will result in negligible effects to water quality.

The third GMC allowed on the Refuge is Liberty Link ® Corn, which is genetically modified to tolerate treatments of glufosinate. This chemical is highly mobile in soil and can travel vertically below the surface to a maximum depth of 24 inches. According to the existing PUPs, glufosinate is only approved for use in areas where the depth to groundwater is at least five feet. Therefore, it is highly unlikely that glufosinate could potentially contaminate groundwater. Through erosion, the herbicide may reach surface waters, however, where it is highly miscible as it combines with water to create a homogenous substance rather than biodegrade (U.S. EPA 2008). To minimize the potential for this to occur, the Refuge implements best management practices that include only applying the herbicide when wind speeds are below 10 miles per hour and utilizing pesticide application buffers around sensitive areas and 150-foot vegetative buffers along treatment sites. Glufosinate, therefore, is expected to cause minor long-term adverse impacts at the local scale.

Based on the above-mentioned research and experience, Alternative A would collectively result in minor long-term adverse impacts to water quality at the local scale.

No impacts to water quantity are expected since there are no irrigation systems for farming on the Refuge.

<u>Alternative B – No Use of GMCs; Cooperative Farming with Conventional Crops</u>
Alternative B would likely result in similar adverse impacts to water quality as those described in the current management though with noticeably higher intensity as GMC use is discontinued. This increase stems from the anticipated need to increase both tillage activities and chemical applications when GMCs are no longer utilized on the Refuge. The cooperators would have to rely on a wider variety of chemicals of differing toxicities in order to effectively control pests, and this increased chemical use increases the potential for degradation of waterbodies. Overall, Alternative B could result in increased sedimentation and chemical pollution in the long-term over the current management. Effects on water quantity would be the same as Alternative A.

4.2 Biological Environment

4.2.1 Impacts on Habitat

<u>Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)</u>
Crops produced by the current farming management would result in the continuance of direct beneficial impacts to habitat on the Refuge. These benefits of the current farming program are the result of providing vital food and cover for waterfowl during the wintering season. Creating viable habitat for migratory waterfowl is directly tied to the purpose of the Refuge. Herbicide use under the current management could negatively impact surrounding habitat by affecting non-target plants in a variety of habitats, but the cooperators are required to provide 50-150 foot vegetative buffer zones around their cropland acreage in an effort to minimize this impact. Cooperators are also required to implement integrated pest management strategies and best management practices as specified in PUP approval forms. Collectively, continued crop production is expected to result in minor long-term beneficial impacts at the site-specific scale.

Alternatively, the use of specified GMCs under the current management entails some risk of negative effects to habitat. Studies warn of the unknown risk of hybridization with wild relatives

of the herbicide-tolerant plants and the resultant potential to create genetic mutations that enhance an organism's ability to become an invasive species (Hails 2002). If GM corn or soybeans were to hybridize with related wild species, transgenes that have been inserted into the GMCs may be transmitted along with the natural genes. The traits of the GM crops may be adopted by the next generation of resultant hybrids, persisting indefinitely in the wild. If these traits offer a competitive advantage such as herbicide resistance, the hybrids can become weedy or invasive (Wolfenbarger and Phifer 2000). On the Refuge, however, neither crop (Roundup Ready® Soybeans, Roundup Ready© Corn, or Liberty Link® Corn) poses a serious risk because corn and soybeans have no wild or weedy relatives with which they can easily interbreed within the United States. In addition, soybeans are self-pollinating, so the risk of transgenic pollen moving to nearby weeds is small.

An additional concern associated with GMC use is the "epidemic of herbicide-resistant weeds" that has developed as GMCs have facilitated heavier use of glyphosate and glufosinate, which weeds have grown tolerant of over time (Villar and Freese 2008). Specifically, in 1999, farmers began noticing that weeds could no longer be controlled with the normal dose of glyphosate and increased their glyphosate use in the short-term (Villar and Freese 2008). An additional study notes that herbicide use on Roundup Ready ® acreage is gradually rising as a result of weed shifts, late-season weed escapes leading to a buildup in weed seed banks, and the loss of susceptibility to glyphosate in some weed species (Benbrook 2001). The risk of weed-resistance is a serious concern, but the Refuge has implemented measures to ensure that this does not occur. The Refuge requires cooperators to alternate crops seasonally using herbicides with different modes of action so that farmers break the continuous cycle of applying glyphosate or glufosinate.

<u>Alternative B – No Use of GMCs; Cooperative Farming with Conventional Crops</u>
This alternative would result in the same benefits to habitat as Alternative A, without the risk of hybridization of herbicide-tolerant seeds with wild relatives. This action, however, would result in increased moderate long-term adverse impacts resulting from both the spread of undesirable weeds/invasive species and the necessary increase in amounts, types, and applications of pesticides used on the Refuge. As GMC use is discontinued under Alternative B, it is expected that invasive species/undesirable weeds would spread rapidly, thereby degrading habitat quality. If cooperators are expected to control weed infestations as stated in their Annual Cooperative Farming Agreements, increased chemical treatments other than glyphosate or glufosinate would be necessary. Either way, it is expected that this change in management would result in moderate short-term adverse impacts until treatment levels are effective in controlling invasive species. When efficient weed control is achieved, the intensity of these impacts would decrease. A benefit of this transition, however, is that the likelihood of weed-resistance would decrease without the intensive use of glyphosate and glufosinate. In addition, these chemical treatments may inadvertently effect beneficial or native organisms as effective pest control mechanisms are determined over time through adaptive management.

4.2.2 Impacts on Wildlife

<u>Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)</u>
Experience has shown that, in both the short- and long-term, the current management produces moderate beneficial impacts for migratory and resident wildlife utilizing the Refuge. Current management has allowed for the production of high quality carbohydrate rich foods and in

quantities sufficient enough to sustain healthy body conditions of peak populations of waterfowl, including numerous species of ducks and geese, during wintering months. Other wildlife populations that benefit from the production of agricultural foods are deer and turkey. This program has evolved over the past 40 years, consistently providing benefits to migratory waterfowl and resident wildlife. It has been established that these three approved herbicide-tolerant GMCs benefit the Refuge by contributing to the efficient production of supplemental grain at a yield necessary to meet specific Refuge and flyway objectives and aides in conducting Refuge farming activities in the best economic, environmental, and social means possible. Alternatively, the effect of consuming genetically modified seed is not yet well understood by the scientific community.

The Refuge requires cooperators to implement Integrated Pest Management techniques to control plant and animal pests; these tactics include a combination of crop rotation, hand and mechanical removal, biological controls, and approved pesticides. These management activities reduce the need to over utilize chemical treatments. Herbicides do, however, have the potential to cause the only adverse impacts associated with the current management. Based on current data, the U.S. EPA (1993) has determined that the effects of glyphosate on birds, mammals, fish and invertebrates are minimal. Glyphosate is no more than slightly toxic to birds and mammals, moderately toxic to amphibians, and practically nontoxic to fish, aquatic invertebrates and honeybees (U.S. EPA 1993; Giesy et al. 2000). Additionally, a risk assessment completed in 2000 found that there was no observed probability of population- or community-level effects occurring in nontarget organism populations after the use of Roundup (Giesy et al. 2000). Also, glufosinate is considered practically non-toxic to birds, mammals, and insects, slightly non-toxic to slightly toxic to fish, and moderately toxic to invertebrates (U.S. EPA 2008). Using best management practices when implementing herbicidal treatments helps minimize any negative impacts associated with spraying. Therefore, chemical use is expected to result in negligible effects to wildlife.

<u>Alternative B – Cooperative Farming with Conventional Crops Only (No GMC Use Permitted)</u>
Alternative B would continue to meet the current objectives of providing food and cover for the same species as Alternative A. When compared to the current management, however, Alternative B has the potential to result in an increased intensity of short- and long-term adverse impacts at the Refuge scale resulting from an increase in the use of chemicals of varying toxicities after GMC use is eliminated. As described in Alternative A, best management practices would continue to be implemented. All of the various chemicals may have different effects on wildlife. Furthermore, increased tilling activities would cause direct adverse impacts as a result of increased disturbance to resident and migratory wildlife that occupy the project area.

4.2.3 Impacts on Threatened and Endangered Species and Special Status Species

<u>Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)</u>
Listed species that occur within the Refuge include the Interior least tern and American burying beetle. The Refuge's PUPs show that, through Section 7 consultation, the pesticides used for farming will either have no effect or will be not likely to adversely affect threatened and endangered species. In addition, the Refuge has undergone Section 7 consultation with Ecological Services to determine the likelihood of the specified GMC use occurring on the

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Refuge to affect threatened and endangered species on the Refuge. The result of that consultation process was a "not likely to adversely affect" determination (2009).

Additionally, research shows that the likelihood of negative effects to listed species associated with glyphosate and glufosinate use is low. The U.S. EPA (1993) does not expect that most endangered terrestrial or aquatic organisms will be negatively affected by the registered uses of glyphosate. The U.S. EPA is in the process of performing a risk assessment that will determine the potential effects of glufosinate on threatened and endangered species, as outlined in the work plan for the Glufosinate Registration Review (2008). In the past, however, this herbicidal treatment method on the Refuge has not resulted in any adverse impacts to such species.

Alternative B – Cooperative Farming with Conventional Crops Only (No GMC Use Permitted)
Alternative B would likely result in the same effects as Alternative A.

4.3 Human Environment

4.3.1 Impacts on Socioeconomic Resources

Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)
Continued implementation of the current farming program would result in major long-term beneficial impacts to socioeconomics due to high yields resultant from GMC use. GMC technology has had a very positive impact on farm income derived from a combination of enhanced productivity and efficiency gains (Brookes and Barfoot 2006). Higher yields also typically result from the ability to efficiently control weeds with fewer applications, to utilize narrow row spacing, and to protect crops from crop injury resulting from application of herbicides (Carpenter and Gianessi 1999). Additional literature states that GMCs "increase yields, make pest control simpler and more effective, and facilitate the adoption of no-till or conservation tillage" which is less labor-intensive for the farmers (Tower and Werblow 2010). Some reports, alternatively, argue that GMC yields have, at best, been equal to that of their conventional counterparts (Villar and Freese 2008). The current management provides additional economic benefits to the Refuge because all of the farming operations are funded by and performed by the cooperative farmers. This saves the Refuge from taking on the burden of devoting staff time and funding to the production of crops necessary to meet wildlife management objectives.

Alternative B – Cooperative Farming with Conventional Crops Only (No GMC Use Permitted)
Alternative B requires that the cooperative farmers devote increased finances and time to the program as a result of additional labor-intensive ground preparation needs, equipment use, and application of a wider variety and possibly harsher herbicides. Discontinuing the use of GMCs and conversion to conventional farming methods would be a challenge to implement because of drastic immediate increased costs to the cooperative farmers as a result of additional labor-intensive ground preparation, equipment use, cost of non-GMC seed (limited availability) and application of herbicides. "High-quality conventional corn and soybean seeds are also becoming much more difficult to find (Center for Food Safety 2005, cited in Villar and Freese 2008). This change in management may drive the Refuge's cooperators out of business as they are less likely to compete with those on periphery lands who have unrestricted use of GMCs. If this alternative is implemented and the cooperative farmers are financially unable to no longer farm on the

refuge, this would have major long-term adverse impacts to these individuals and their families, the Refuge's cooperative farming program, and the local community.

4.3.2 Impacts on Visitor Services/Public Use Opportunities

Alternative A – Current Management – Cooperative Farming with Specified GMC Use Permitted (Proposed Action)
Alternative A would continue to provide existing public use opportunities.

Alternative B – Cooperative Farming with Conventional Crops Only (No GMC Use Permitted)
The impact would be the same as Alternative A unless cooperative farmers choose to resign as a result of the change in management. As lands lay fallow and natural regeneration occurs over time, public use opportunities would be negatively impacted as agricultural production areas are used extensively for observation and hunting of migratory waterfowl and resident wildlife. Without the production and availability of small grains, the Refuge would see a decline in migratory waterbird stop over and wintering grounds use.

4.4 Assessment of Cumulative Impacts:

A cumulative impact is defined as an impact on the environment that results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future action regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Cumulative impacts are the overall, net effects on a resource that arise from multiple actions. Impacts can "accumulate" spatially, when different actions affect different areas of the same resource. They can also accumulate over the course of time, from actions in the past, the present, and the future. Occasionally, different actions counterbalance one another, partially cancelling out each other's effects on a resource. However, more typically, multiple effects add up, with each additional action contributing an incremental impact on the resource.

The land surrounding the Refuge is owned by the U.S. Army Corps of Engineers, Oklahoma Department of Wildlife Conservation, and private landowners. While some non-Refuge acreage consists of intact woodland habitats, the predominant land use practices include agricultural (i.e., corn, soybeans, winter wheat) and hay production. Most of the private woodland acreage is heavily fragmented and remains only where farming practices are not suitable for various reasons. Agriculture is the largest single economic component for each of the three counties where the Refuge is located, but the majority of the economic base is nonfarm/agriculture (grazing).

According to the 2007 Agricultural Census, there are 35,087,269 acres of farmland in the state of Oklahoma (USDA Economic Research Service 2007). Farming on federal, state, and privately owned lands in Oklahoma with the use of GMCs and chemicals has occurred in the past and will continue into the future. Although the USDA has not published statistics on the use of genetically modified soybeans and corn in the state of Oklahoma, such research does exist across the United States that illustrates the larger national trend in adopting such varieties. Across the United States, 86 percent of all corn planted in 2010 was modified through biotechnology (insect resistant, herbicide tolerant, or stacked) and 23 percent was specifically herbicide tolerant

(USDA NASS S 2010). Meanwhile, 93 percent of all soybeans planted in the United States in 2010 were herbicide tolerant (USDA NASS 2010).

Ultimately, conventional seeds are becoming increasingly hard to find as genetically modified varieties are more readily adopted. Roundup Ready ® crops and newfound glyphosate-resistant weeds "has driven a more than 15-fold increase in the use of glyphosate on major field crops from 1994 to 2005 (Villar and Freese 2008)"; although this transition may mean a decrease in the overall amount of pesticide active ingredients applied annually. Overall, "the increased rates of glyphosate and large quantities of other herbicides [used] to kill resistant weeds" may result in cumulative impacts across the larger landscape. There is approximately 135 million acres (54.6 million hectares) of GMCs grown in the United States (Villar and Freese 2008). The amount grown on Sequoyah NWR (2754 acres currently), therefore, is merely 0.00002 percent of the amount cultivated in the nation. Ultimately, the contribution that Sequoyah has to the national adoption of GMCs is insignificant based on this statistic. Furthermore, since GMCs are used so extensively on the land surrounding the Refuge, any use or non-use on the Refuge is insignificant in the larger context.

There is the potential for farming practices associated with the two alternatives described in this EA to add to known contaminant sources on the Refuge. Alternative B is likely to have greater impacts than Alternative A; however, the best management practices identified in the current management (and carried into other alternatives) are intended to minimize those impacts and the Refuge does not believe they will reach a level of significance.

The Refuge is not aware of any past, present or future planned actions that would result in a significant cumulative impact when added to the Refuge's proposed action.

4.5 Environmental Justice:

Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority and Low-Income Populations; February 11, 1994) was designed to focus the attention of Federal Agencies on the environmental and human health conditions of minority and low-income populations, with the goal of achieving environmental protection for all communities. The order directed federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high and adverse human health and environmental effects of their programs, policies, and activities on minority and low-income populations. The order is intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority and low income communities with access to public information and opportunities for participation in matters related to human health and the environment.

None of the alternatives described in this EA will disproportionately place any adverse environmental, economic, social or health impacts on minority and low income populations. Implementation of the proposed action is anticipated to benefit the environment and people in the surrounding communities.

4.6 Indian Trust Assets:

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The proposed action and its alternatives would involve farming operations occurring on previously disturbed lands, and none of these alternatives involves the breaking of new ground. Therefore, no impacts to Indian Trust Assets are anticipated to result from the use or non-use of GMCs and/or chemicals.

4.7 Unavoidable Adverse Effects

None of the alternatives would result in any unavoidable adverse impacts to Refuge resources. Farming operations may result in some short-term disturbance to migratory and resident wildlife, but these impacts are expected to be negligible.

4.8 Irreversible and Irretrievable Commitment of Resources:

Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that this use could have on future generations. Irreversible effects primarily result from the use or destruction of specific resources that cannot be replaced within a reasonable time frame, such as energy or minerals. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action, such as extinction of a threatened or endangered species or the disturbance of a cultural resource.

None of the alternatives would result in a large commitment of nonrenewable resources. Project implementation would require the irretrievable commitment of fossil fuels (diesel and gasoline), oils, and lubricants used by heavy equipment and vehicles. Since each of the alternatives requires that farming continue to occur on the same amount of acreage, no unavoidable harm or harassment to wildlife is expected. The Service would implement best management practices to minimize potential negative impacts.

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4.9 Table 1 – Summary of Environmental Effects by Alternative

Environmental Resource	**Alternative A Cooperative Farming with Specified GMC Use Permitted (Proposed Action)**	**Alternative B Cooperative Farming with Conventional Crops Only (No Use of GMCs Permitted)**
Impacts to Air Quality	Minor, short-term, local negative effects	Moderate, short- and long-term, and local negative impacts
Impacts to Soils	Minor, long-term, site-specific negative effects related to ground disturbance; moderate, short-term, local adverse impacts related to chemical use	Moderate, long-term, local negative effects
Impacts to Water Quality and Quantity	Minor, short-term, local negative effects related to ground disturbance; minor, long-term, local effects (at most) related to chemical use; minor, short-term, Refuge-wide negative effects to water quantity	Similar adverse impacts to water quality as Alternative A with noticeably higher intensity over the long-term; effects on water quantity would be the same as Alternative A
Impacts on Habitat	Direct beneficial impacts that would remain minor, long-term, and site-specific	Moderate short- and long-term adverse impacts resulting from an increase in invasive species/undesirable weeds and chemical treatments
Impacts of Wildlife	Moderate local beneficial impacts in both the short- and long-term	Same as Alternative A, plus some minor short- and long-term adverse impacts at the Refuge scale related to increased pesticide use

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Impacts on Threatened and Endangered Species	Not likely to adversely affect threatened and endangered species	Same as Alternative A
Impacts on Socioeconomic Resources	Moderate, long-term, beneficial impacts for the farmers, the community, and the Refuge	Moderate, long-term, adverse impacts to individual farmers and the community
Impacts on Visitor Services	No effect on visitor service opportunities	Same as Alternative A, unless farmers choose to resign by the change in management which would result in negative impacts to wildlife observation and hunting

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5.0 CONSULTATION, COORDINATION AND DOCUMENT PREPARATION

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5.2 References

Benbrook, C. 2001. Do GM crops mean less pesticide use? Pesticide Outlook. The Royal Society of Chemistry: 204-207.

Brookes, G., and P. Barfoot. 2006. Global impact of biotech crops: Socio-economic and environmental effects in the first ten years of commercial use. AgBioForum 9(3): 139-151.

C. James, Global status of commercialized biotech/GM crops: 2009 (ISAAA Brief No. 41, International Service for the Acquisition of Agri-Biotech Applications, Ithaca, NY, 2009).

Carpenter, J. and L. Gianessi. 1999. Herbicide tolerant soybeans: Why growers are adopting Roundup Ready varieties. AgBioForum 2(2): 65-72.

Ervin, D.E., S.S. Batie, R.Welsh, C.L. Carpentier, J.I. Fern, N.J. Richman, and M.A. Schulz. 2000. Transgenic Crops: An Environmental Assessment. Henry A. Wallace Center for Agricultural and Environmental Policy at Winrock International: Arlington, VA. 81pp.

Giesy, J.P., S. Dobson, and K.R. Solomon. 2000. Ecotoxicological risk assessment for Roundup® herbicide. Review of Contamination and Toxicology 167: 35-120.

Hails, R.S. 2002. Assessing the risks associated with new agricultural practices. Nature 418: 685-688.

Phipps, R.H., and J.R. Park. 2002. Environmental benefits of genetically modified crops: Global and European perspectives on their ability to reduce pesticide use. Journal of Animal and Feed Sciences11: 1-18.

Relyea, R.A. 2005. The lethal impact of roundup on aquatic and terrestrial amphibians. Ecological Applications 15(4): 1118-1124.

Sisson, F. 2000. A cultural resources overview and assessment for Sequoyah National Wildlife Refuge, Oklahoma. Unpublished Report. U.S. Fish and Wildlife Service. Albuquerque, NM. On file at Sequoyah NWR Vian, OK.

Towery, D., and S. Werblow. 2010. Facilitating conservation farming practices and enhancing environmental sustainability with agricultural biotechnology. Conservation Technology Information Center: West Lafayette, IN. 25pp.

U.S. Department of Agriculture. 2008. National Organic Program Background Information. Agricultural Marketing Service: Washington, D.C. 2 pp.

U.S. Department of Agriculture. 2010. National Agricultural Statistics Survey. Agricultural Statistics Board: Washington, D.C. 41 pp. Available at: http://www.ers.usda.gov/Data/biotechcrops/ExtentofAdoptionTable3.htm [November 17, 2010].

DRAFT

U.S. Department of Agriculture. 2010. Oklahoma Fact Sheet. Economic Research Survey: Washington, D.C. Available at: http://www.ers.usda.gov/StateFacts/OK.HTM [November 17, 2010].

U.S. Environmental Protection Agency. 1993. Re-registration Eligibility Decision: Glyphosate. U.S. Environmental Protection Agency: Washington, D.C. Available online at: http://www.epa.gov/oppsrrd1/REDs/old_reds/glyphosate.pdf [August 18, 2010].

U.S. Environmental Protection Agency. 2000. Watershed Profile, Robert S. Kerr Reservoir. Available online at: http://epa.gov/surf3/hucs/1111010/ [December 12, 2000].

U.S. Environmental Protection Agency. 2008. Glufosinate Summary Document Re-registration Review: Initial Docket. U.S. Environmental Protection Agency: Washington, D.C. 71pp.

U.S. Fish and Wildlife Service. 1985. Refuge Manual: Habitat Management. 6 RM 4.3.

Wolfenbarger, L.L., and P.R. Phifer. 2000. The ecological risks and benefits of genetically engineered plants. Science 290: 2088-2093.

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Appendix A
DEFINITION OF TERMS

Cropland Management (6 RM 4.3)

Croplands are any lands on which mechanical soil disturbances and artificial introduction of seed or other plant parts are periodically used to (1)produce stands of annual plants for use primarily as food by wildlife, domestic animals, or man, or (2)produce and maintain stands of non-native, herbaceous, perennial forage or green browse for such uses.

Cooperative farming defines cropland management carried out by a private citizen on refuge lands, under the terms of a "Cooperative Farming Agreement," in which the cooperator (private citizen) provides labor, equipment, and materials and the Government provides land, equipment, and/or materials and the resulting crop is shared by the cooperator and the Government.

Force account refers to any cropland management operation carried out by government employees.

Conventional farming is the most commonly practiced commercial farming system characterized by the following:

1. A full complement of tillage practices (e.g., plow, disc, plant, cultivate)
2. Dependence on synthetic pesticides and commercial fertilizers
3. Continuous production of one or two crops

Biological (organic) farming is a crop production system that relies predominantly on natural soil and ecosystem processes rather than synthetic chemicals. Biological farming has four identifying characteristics or goals:

1. Elimination of insecticides
2. Elimination of inorganic nitrogen fertilizers
3. Reduction in the use of herbicides with a long term goal of elimination
4. Use of crop rotations including legumes as the primary means of fulfilling the functions of pest control and fertilization.

Where appropriate, biological farming may utilize biological pest control, imported manure and other organic wastes, ocean-based fertilizers, mineral-bearing rock, and natural soil conditioners.

No-till farming is a crop production system in which seed is planted directly into standing crop residues with no seedbed preparation. Similar terms include zero-till and slot planting. In contrast to biological farming, all reduced-till systems rely heavily on synthetic chemicals.

Invasive Species is one that is non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Undesirable Weed is any plant that poses a major threat to agriculture and/or natural ecosystems within the United States.

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Appendix B
PROCESS FOR PESTICIDE USE ON NATIONAL WILDLIFE REFUGES

What is a pesticide?
According to Service policy (7 RM 14), a pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest or which is intended for use as a plant growth regulator, defoliant, or desiccant.

Why does the Service Use Pesticides?
The Service uses pesticides as one tool in an integrated pest management approach in managing pest species that interfere with resource management objectives. Most of the pesticides the Service uses are on National Wildlife Refuges for the management of non-native invasive species, such as Canada thistle, Johnson grass, and phragmites. These species out compete the native species, which is detrimental for native ecosystems. Pesticides play a role in resource management, but they must be used wisely along with other measures to manage and/or eliminate pest species.

What are Pesticide Use Proposals?
A Pesticide Use Proposal (PUP) is information required by the U.S. Fish and Wildlife Service (Service) before application of a pesticide on Service property. It is a protective measure to ensure the proper use of pesticides on Service lands. The forms asks for a variety of information including where the pesticide will be applied, what pesticide will be used, what species will be managed with the pesticide, and whether or not there are any endangered species in the pesticide application area.

What Pesticides have been approved for use in the Farming Program at Sequoyah NWR?
The following pesticides used in association with farming practices have been approved through the PUP process to treat invasive species and maintain crop yields in 2010, 2011, and 2012:

- Accent
- Amine 4 2,4-D Weed Killer
- Banvel (Micro Flo)
- Basagran
- Callisto
- Canopy
- Classic
- Cobra
- Dual Magnum
- Envive
- Flexstar
- Flexstar GT
- Gly Star Plus
- Glyphosate T&O
- Grandslam 4XS
- Ignite 280 SL
- Impact
- Makaze
- Mirage Plus
- Poast Plus
- Prefix
- Prowl H2O
- Pursuit
- Quadris Flowable
- Reflex
- Resource
- Rifle
- Roundup Original
- Salvo
- Select 2 EC
- Status
- Stealth
- Stout
- Tracer Naturalyte Insect Control
- Ultra Blazer
- Valor SX

A large amount of PUP's are entered into the database prior to the growing season and are approved for use on the refuge in case the need arises to use them. However, only a small portion of the PUP's approved for use are normally used during any given year. Pesticide use reports are submitted by each cooperative farmer to accurately track and document the use and amount of chemicals used for that particular year.

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What pesticides are actually used?

2008
Banvel (Micro Flo), Accent, Accent Gold WDG, Classic, Gly Star Plus, Grandslam 4XS, Makaze, and Round- UP Original.

2009
Rodeo, Banvel (Micro Flo), Classic, Salvo, Rifle, Gly Star Plus, Grandslam 4XS, Makaze, Mirage Plus, and Round-Up Original.

What measures are taken to minimize potential environmental impacts?

The approved PUPs include measures to minimize environmental impacts through the following best management practices:

- Application at wind speeds less than 10 mph (but not inversion conditions)
- Application must be in accordance with chemical label
- Calibrate application equipment
- Field scouting/monitoring before pesticide application
- Use pesticide application buffers around sensitive areas
- Implement vegetative buffers
  - The Refuge currently has 150-foot vegetated buffers (50-foot buffers for glyphosate pesticides) around all permanent wetlands, lakes, ponds, and rivers for non-glyphosate pesticides. Drift issues can also be minimized by using drift control agents and applying droplets that are > 150 microns in size.
  - Must have a 100-foot buffer around all permanent wetlands, lakes, ponds, and rivers during aerial application. All label precautions/recommendations to avoid drift, environmental hazards, and water contamination will be strictly followed. Applicator must follow Aerial Spray Drift Management section (pg. 4) stated within label.
- Use lowest effective application rate.
- Drift control agents must be compatible with label. Certain products will not be applied if rainfall is forecasted within 48 hours.
- The importance of drift management practices and wetland buffer zones will be conveyed to the cooperator due to the toxicity of this product towards aquatic organisms.
- For Quadris Flowable & Tracer Naturalyte: Impacts to all (if any) sensitive areas will be prevented by the following means: 1) A 300 foot buffer from water and any adjacent endangered or threatened species will be used provided soils are not characterized as gravel, sand or sandy loam; 2) Chemical applications will not be made during windy conditions or when rain is expected within 4 hours; 3) Chemical applications will be made only according to product label; 4) Buffer zones will be established between treatment areas and adjacent croplands and wetlands to avoid contamination by drift or runoff; 5) All pesticide applications will be done by State-certified applicators; 6) This product will not be applied when weather conditions favor drift from the target area (wind >7 mph); 7) Avoid any application within 24 hours of previously heavy rainfall or within 24 hours of predicted rainfall; 8) Avoid spraying when air temperatures exceed 85 degrees Fahrenheit and implement all additional precautions or recommendations in any applicable supplemental label or county bulletin.

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Please see http://www.fws.gov/contaminants/index.cfm for more information on pesticides and the Service's Environmental Contaminants Program.

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Appendix C

EXAMPLE OF TYPICAL COOPERATIVE FARMING AGREEMENT

Cooperator's name Farmer Joe	**Address** P.O. Box 10,000 Vian, OK, 74962
Period of Use: From: January 1, 2009 To: December 31, 2009	**Refuge Name and State where located:** Sequoyah National Wildlife Refuge, Oklahoma

The U.S. Fish and Wildlife Service (Service), for and in consideration of the mutual benefits arising hereunder, grants to the Cooperator named above, privileges of using lands of the National Wildlife Refuge System indicated above, for the cultivation, production, and/or harvesting of agricultural crops, on a share basis as specified below:

Farm unit	Field	Cooperators Crop or crop group	acres	Cooperator's share In (acres)	(10%) Government's share of approved standing grain. (crop=acreage)	(15%) Government's share of wheat or equivalent winter green browse.
T	1a	Millet	4	---	Millet = 4 ac	---
T	1b	Corn	62	58 ac	Corn = 4 ac	---
		Soybeans	6.5	6.5 ac	---	
T	2a	Soybeans	44.2	44.2 ac	---	---
T	2b	Soybeans	9.4	9.4 ac	---	---
T	3	Corn	24.9	20.6 ac	Corn = 4.3 ac	---
T	4a	Soybeans	10.6	7.6 ac	Millet = 3 ac	---
T	4b	Corn	34.6	30.3 ac	Corn = 4.3 ac	---
T	4c	Soybeans	32.7	32.7 ac	---	---
T	5a	Fallow Wheat	20	---	Millet = 2 ac	18 ac
T	5b	Soybeans	17.5	17.5 ac	---	---
T	5c	Soybeans	7.4	7.4 ac	---	---
T	6	Soybeans	19.2	16.2 ac	Millet = 3 ac	---
T	7a	Soybeans	13.7	7.7	Millet = 6 ac	---
T	7b	Fallow Wheat	10.6	---	---	10.6 ac
T	7c	Corn	33.3	29.3	Corn = 4 ac	---
T	7d	Soybeans	4.2	4.2 ac	---	---
T	7e	Soybeans	11.6	11.6 ac	---	---
T	8c	Soybeans	32	25 ac	Millet = 7 ac	---
T	8b	Soybeans	32	32 ac	---	---
T	8a	Corn	60.1	53.1 ac	Corn = 7 ac	13.4 ac
T	9	Fallow Wheat	26.4	---	---	26.4 ac
T	10	Fallow Wheat	17.5	---	Millet = 5 ac	12.5 ac
T						
		TOTAL ACRES	534.4 ac	413.3 ac	53.6 ac	67.5 ac +13.4 ac

1. The Cooperator agrees that agricultural crops of the type and acreages specified above must be planted, cultivated, and harvested during the first year of operation. If this agreement is for more than one year, the type of crop, acreage, and distribution may be altered or modified annually, following the first year of operation, by mutual consent of both parties. Changes in the agreement must be made prior to

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planting season by an addendum. Any attachments to this agreement are legal and binding, and will be treated as part of this contract.

2. These privileges are granted by the U.S. Fish and Wildlife Service, and accepted by the undersigned, subject to the terms, covenants, obligations, and reservations contained herein. This agreement does not imply or establish a use precedent. Future use of this area will be based upon the most satisfactory use of the land for wildlife benefits, cooperator performance, habitat management needs and administrative needs.

3. To control plant and animal pests, Integrated Pest Management (IPM) techniques shall be used including, not limited to crop rotation, hand and mechanical removal, biological controls and certain chemical pesticides. The Cooperator will be responsible for the application of approved herbicides, as mutually agreed with the Refuge Manager and will assume the costs. The Cooperator shall employ conventional farming methods including the proper, timely, and adequate application of fertilizers, and soil amendments to assure a good crop, and will assume the costs thereof. Soil tests should be taken to monitor the long-term conditions of cultivated fields. A decline in soil fertility will require the cooperator to improve the condition at the cooperator's expense. Fertilizer receipts for the refuge share of crops will be kept and turned in to the program coordinator. Less nitrogen may be required when mungbeans or similar type crops are planted as a green manure soil builder.

4. No pesticides/herbicides may be applied without prior written approval of the Refuge Manager. Use of any pesticide, herbicide or insecticide without prior written approval of the Refuge Manager may result in termination of this contract. Cooperators are required to notify the refuge prior to pesticide application, specifying the date, area and chemical to be applied. Random samples of pesticides may be taken in the field when the cooperator is applying. Approved post-emergence pesticides will not be used unless crop scouting indicates pest density is at, or beyond, the economic threshold level. A crop scouting report with recommendations will be delivered to and approved by the Refuge Manager prior to the application of any pesticides.

   Only glyphosate-based pesticides (Roundup, Rodeo, Accord SP, etc.) shall be applied from 50-150 feet of permanent water. The cooperator must keep a detailed record of all chemical use and return the chemical use form to the refuge by October 31.

   The Cooperator will be notified when the PUP(S) is/are approved as submitted or if modifications are required. A copy of the approved PUP as well as the product label and MSDS can be provided to the Cooperator upon request. Those documents should be available at the treatment site during treatment activities.

   There are no insecticides approved for the Cooperator's use. The use of insecticide on Refuge lands is generally not permitted. There may be an exception for use of a particular insecticide, depending on type, rate, and method of application, if there is clear justification that insect infestations are substantially affecting crop yields. In that case a Pesticide Use Permit would have to be written and approved through the Regional Office. Any aerial pesticide applications and restricted use pesticides will need Washington D.C. approval. Application will be in accordance with State and Federal pesticide laws and U.S. Fish and Wildlife Service policy.

5. All General Conditions (attached) and the Special Conditions that follow are applicable for this Agreement.

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6. Special Conditions:

- The Government's share of crops shall be left un-harvested and equal twenty-five percent of the total farm acreage. Ten percent left in approved standing grain (preferably no soybeans), and fifteen percent left in green winter browse.
- No pre-emergent herbicides/pesticides.
- Post-emergence herbicides/pesticides will be applied per label.
- Only soybeans, mungbeans, purple hull peas, corn, milo, millet and wheat will be approved crops for cultivation. No other crops may be cultivated without the permission of the refuge manager.
- Spring tillage may begin on February 15th for corn, and March 15 for soybeans, any exceptions should be approved by the refuge manager.
- Wheat should be planted by September 20th.
- Wheat acreages should not be disturbed during the active grassland bird nesting period (April 1st to July 1st). Wheat should be tilled under by August 1st, unless acreage is rotated into alternative crop or subject to no till program.
- Wheat should be seeded at a minimum rate of 1.5 bushels per acre. A minimum of 11 sprouted plants per row foot is required.
- Japanese millet should be planted sometime between the last week of July to the first week of August.
- Japanese millet shall be maintained via adequate application of fertilizers, and soil amendments to assure a good crop and by post emergent application of pesticides if crop scouting indicates pest density is at, or beyond, the economic threshold level.
- Post harvest corn stubble may be brush-hogged, sprayed or wicked with roundup. Tillage of post harvest corn stubble should be approved by the refuge manager.
- Field edges may be mowed up to a distance of 20 feet from the cultivated edge. Areas between the field and the main refuge tour road may be mowed from the field edge to the road edge unless that distance is greater than 25 feet. All mowing may begin on March 15th, and should be kept up to discourage bird nesting. If weeds/grasses reach a height of 5 inches or greater, then mowing should not occur until July 1st. All brush and tree trimming should be approved by the refuge manager.
- Drainage alteration and any other earth-moving projects should be specifically approved by the refuge manager.
- The cooperator will keep the refuge clean and will remove all equipment, materials and trash upon completion of their use.
- Fires are not permitted. The cooperator should not burn crop residue without permission of the Refuge Manager.
- All refuge gates should be kept closed and locked with refuge locks.
- Cooperator is not responsible for weather events that the refuge manager determines may reasonably interfere with the completion of the terms of this contract.

(Cooperator's signature) (Issuing officer's signature and title)

_____ _____

(Date) _____ (Date) _____

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Appendix D
LITERATURE USED IN THE NEPA ANALYSIS

Benbrook, C. 2001. Do GM crops mean less pesticide use? Pesticide Outlook. The Royal Society of Chemistry: 204-207.

SUMMARY:
In this "Viewpoint" article, Charles Benbrook of the Northwest Science and Environmental Policy Center states his opinion on whether or not genetically modified crops minimize the use of pesticides. Citing four years of USDA soybean herbicide use data from 1997 to 2001, Benbrook presents four conclusions: (1) slightly more pounds of herbicides are applied on the average acre of RR soybeans compared to the average acre planted to conventional soybean varieties, (2) fewer herbicide active ingredients are applied on the average acre of RR soybeans relative to the average conventional acre, (3) average per acre pounds of herbicide applied on RR soybeans exceeds by 2- to 10-fold herbicide use on the approximate 30% of soybean acres where farmers depend largely on low-dose imidazolinone and sulfonylurea herbicides, and (4) herbicide use on RR soybean acres is gradually rising as a result of weed shifts, late-season weed escapes leading to a buildup in weed seedbanks, and the loss of susceptibility to glyphosate in some weed species. Overall, Benbrook states, "herbicide-tolerant varieties have modestly reduced the average number of active ingredients applied per acre but have modestly increased the average pounds applied per acre."

USE:
Although this article does not present clear methodologies and appeared in the "Viewpoint" section (implying that it is an opinion-based piece), it still presented summaries of previous studies. Summarizing the available USDA literature on herbicide use in conjunction with soybeans, the author presents some contradictory evidence when compared to the other articles reviewed in this document. Therefore, this literature was used in the NEPA analysis to present the alternative view on the effect of GMCs on pesticide use.

Brookes, G., and P. Barfoot. 2006. Global impact of biotech crops: Socio-economic and environmental effects in the first ten years of commercial use. AgBioForum 9(3): 139-151.

SUMMARY:
This article presents the results of a study researching the global economic and environmental impacts of genetically modified crops since their commercial introduction in 1996. First, the authors reviewed existing literature from "as many years of relevant comparable data as possible" and used the findings to estimate the farm income impact between 1996 and 2006. The results state "GM technology has had a very positive impact on farm income derived from a combination of enhanced productivity and efficiency gains" and "the largest gains in farm income have arisen in the soybean sector." Second, the authors present an analysis of environmental impacts from changes in herbicide use by comparing both pesticide active ingredient used and specific pesticides used through an indicator known as the Environmental Impact Quotient (EIQ). The results state "GM crops have contributed to a significant reduction in the global environmental impact of production agriculture" and complement that statement by presenting a 4.1% reduction in the volume of herbicides used on GM herbicide tolerant soybeans. In addition, the results state "in the maize sector, pesticide use decreased by 43 million kg and the environmental impact decreased due to a combination of reduced insecticide use (4.6%) and a switch to more environmental-benign herbicides (4%)." Third, the authors estimate the impact on greenhouse gas emissions by assessing the reduction in fuel use due to

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less frequent herbicide applications, the shift to reduced- or no-till systems, and the likewise decrease in plowing that increases the amount of organic carbon stored in the soil. According to the authors, "the additional soil carbon sequestration gains resulting from reduced tillage with GM crops accounted for a reduction in 8.05 kg of carbon dioxide emissions in 2005."

USE:
This article was reviewed and cited throughout the impact analysis for Sequoyah's farming program. Although the article approaches environmental and economic effects resulting from the adoption of GM seed varieties from a broad global perspective, some of their conclusions do apply to the site-specific level. For example, experience has shown that the use of GM crops on the Refuge allow the farmers to reduce fuel consumption by treating acreage in fewer applications and using reduced-tillage. Therefore, where other sources or experience could supplement the data presented in this article, the authors were cited.

Carpenter, J. and L. Gianessi. 1999. Herbicide tolerant soybeans: Why growers are adopting Roundup Ready varieties. AgBioForum 2(2): 65-72.

SUMMARY:
In this article, the authors give a brief overview of the adoption of GM seeds, focusing on RR soybeans due to its widespread adoption by growers. The article discusses the shift of weed control practices from mechanical and cultural means prior to the 1960s to herbicides thereafter. The development of herbicides influenced production practices in soybeans particularly according to the authors. The article states that the primary reason for the rapid adoption of RR soybeans is "the simplicity of the weed control program, which allows growers to use on product to control a wide range of both broadleaf and grass weeds without sustaining crop injury, instead of using several herbicides to achieve adequate weed control." The authors also state that the availability of post emergence herbicides has facilitated the adoption of conservation tillage practices and the more efficient use of space through narrow row spacing that assists weed control as canopy closure is quicker. Conventional herbicide programs are also cited in the article as more expensive than their GM counterparts, adding to the incentive to convert to the GM system. In addition, the authors present data on variation in yields between GM crops and conventional crops, illustrating the variety of conclusions on the matter.

USE:
This information was used for consideration in the assessment of impacts of Sequoyah's farming program on socioeconomics only. This article assesses the reasoning behind farmers' quick adoption of GM crops from a historical and social context, thus providing some good information for that portion of the NEPA document. Therefore, the summary statements were used in support of conclusions shown through experience.

Ervin, D.E., S.S. Batie, R.Welsh, C.L. Carpentier, J.I. Fern, N.J. Richman, and M.A. Schulz. 2000. Transgenic Crops: An Environmental Assessment. Henry A. Wallace Center for Agricultural and Environmental Policy at Winrock International: Arlington, VA. 81pp.

SUMMARY:
This report uses available scientific literature to discuss what we know now about the environmental effect of GM crops, the regulatory regimens on such crops in the United States and the European Union, and recommendations for governmental policies and actions intended to ensure that continued use of GM crops is ultimately beneficial to the environment. In reviewing this document for use in Sequoyah's Farming EA, I focused primarily on the

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"Environmental Risks and Benefits" section. The article presents USDA's Economic Research Service conclusions that, "on the whole, the introduction of transgenic crops has reduced farmers' use of pesticides nationwide (USDA ERS, 1999a, 1999b)." These statistics, however, include consideration of Bt varieties that are known to definitively reduce insecticide use. The article does state, however, "the increased use of herbicide-tolerant soybeans in the U.S. in 1997 led to an increase in the use of… glyphosate" while simultaneously resulting in "decreases in the use of other herbicides resulting in a net decrease in the total pounds of herbicides applied to soybeans." Furthermore, the replacement of other varieties of herbicides with glyphosate is expected to be beneficial because "glyphosate can be 3 to 16 times less toxic than the herbicides it has replaced, and 1.6 to 1.9 times less likely to persist in the environment (Heimlich et al. 2000)."

Other benefits and risks of GMCs that are discussed in the report include the potential for soil conservation due to reduced tillage and gene transfer from GMCs to wild plants. An additional risk associated with GMCs is that "herbicide-tolerant crops and wild, weedy relatives could interbreed, making the latter more resistant to herbicides." The ultimate conclusion of the report is that future research is necessary to develop a better understanding of the effects, both positive and negative, of using genetically modified crops.

USE:
This article was not cited throughout Sequoyah's Farming EA because it does not present scientific research with methodologies and conclusions. It was, however, used as evidence supporting that the use of Roundup Ready Soybeans in particular on Sequoyah have likely led to decreased pesticide use. It was also used as a starting ground for researching USDA Economic Research Service data.

Giesy, J.P., S. Dobson, and K.R. Solomon. 2000. Ecotoxicological risk assessment for Roundup® herbicide. Review of Contamination and Toxicology 167: 35-120.

SUMMARY:
This study and assessment was prepared to "expand the available ecotoxicology data and apply current ecological risk assessment methodologies to the evaluation of potential acute and chronic effects of Roundup." The report goes into great detail on the methodologies used to prepare the risk assessment, including an evaluation of currently available peer-reviewed scientific and proprietary literature. To test the toxicity of Roundup, the assessment looked at the effect of the herbicide on fish, amphibians, and aquatic invertebrates, which are all non-target species that could be affected as a result of direct toxic effects of the chemical. The report compares effects from glyphosate with those from commercial Roundup, which is mixed with a surfactant such as polyethoxylated tallowamine. Ultimately, the report uses a hazard quotient to draw conclusions about the toxicity of Roundup. Based on the results, "no acute or chronic hazard quotients greater than 1 were observed for aquatic, soil, or terrestrial organisms" for Roundup use in agriculture. Hazard quotients between 0 and 1 indicate that "it can be concluded with great certainty that there is essentially no probability of population- or community-level effects occurring in nontarget organism populations."

USE:
This information was used to support the findings related to glyphosate use in the environmental consequences section of Sequoyah's Farming EA. Because the report relies heavily on data presented by the Environmental Protection Agency, which is also used as the primary source on glyphosate throughout Chapter 4 of the EA, and describes lengthy methodologies that are sound

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with conclusive results, it was found to be a great resource for determining environmental effects of this particular herbicide.

Hails, R.S. 2002. Assessing the risks associated with new agricultural practices. Nature 418: 685-688.

SUMMARY:
This article focuses on how we assess the potential impacts of using genetically modified herbicide tolerant crops. When discussing effects related to this new biotechnology, the author uses other peer-reviewed scientific studies to defend his conclusions. For example, the author cites an article by Phipps and Park from 2002 that states "fewer herbicide or pesticide treatments will also mean reduced consumption of fossil fuels driving agricultural machinery and a significant reduction in atmospheric carbon dioxide emissions." The article also discusses other routes to achieving agricultural goals, such as cutting pesticide use by enhancing beneficial insects and birds or using pheromone traps to interfere with mate-finding. The article reads as an assessment on producing food while minimizing environmental impact rather than a true study on the effects of using herbicide tolerant crops.

USE:
This article was used to support other findings throughout the Environmental Consequences portion of Sequoyah's EA. The data presented in the EA from Hails' article is only used to describe, "what could happen" as opposed to assumptions about "what will happen," and the information is typically used only when other available scientific literature also supports similar claims.

Phipps, R.H., and J.R. Park. 2002. Environmental benefits of genetically modified crops: Global and European perspectives on their ability to reduce pesticide use. Journal of Animal and Feed Sciences 11: 1-18.

SUMMARY:
This article was written under the premise that the published data on the use of genetically modified crops, though controversial, should document both the risks and benefits of the crops. The authors begin by discussing concerns over pesticide use on human health and the environment, setting the stage to assess the need for new technologies. The underlying assumption is that as habitat and available land decreases due to development, "there is a need to increase crop yield, improve nutritional quality of food and reduce crop losses" to meet agricultural demands. Many individuals believe that genetically modified crops are one part of the solution to this global issue, and the authors, therefore, focus their paper on the effect of GMCs on pesticide use globally. The document specifically assesses pesticide use associated with herbicide tolerant soybeans and maize, as well as other crops. Overall, the article reports data on herbicide tolerant soybeans from four sources, three of which state that pesticide use has declined and one of which states that the effect has been negligible. In evaluating herbicide tolerant maize, one report is cited that states "the use of herbicide tolerant maize has on average reduced herbicide use by 30 percent." The article also states that "the most valuable contribution to environmental benefits of GM soybeans may be that they encourage farmers to use conservation tillage techniques."

USE:
The article does not go further than studying the effects of herbicide tolerant seeds on pesticide use. Therefore, no environmental effects resulting from that transition are evaluated. This

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article was only used as a reference to support the notion that the use of herbicide tolerant soybeans and corn on Sequoyah NWR likely has reduced the amount of pesticides used on Refuge croplands.

Towery, D., and S. Werblow. 2010. Facilitating conservation farming practices and enhancing environmental sustainability with agricultural biotechnology. Conservation Technology Information Center: West Lafayette, IN. 25pp.

SUMMARY:
This report was prepared by CTIC, a national non-profit organization that promotes and provides information "on comprehensive conservation and sustainable agricultural systems that are beneficial for soil, water, air, and wildlife resources and are productive and profitable for agriculture." The report declares biotechnology and genetically modified crops in specific as one of the potential solutions to sustainably solving the global food crisis. The authors argue that steady improvements in crop yields are vital to providing food for our world's growing populations, and GMCs have the ability to do this while also benefiting air, water, and soils. The report supports this conclusion by evaluating the social, economic, and environmental benefits of GMCs. The article goes into detail on how GMCs "increase[e] yields, mak[e] pest control simpler and more effective, and [facilitate] the adoption of no-till or conservation tillage." These benefits lend a hand to reduced potential for erosion, increased organic matter in soils, fewer trips across the croplands thereby reducing fuel consumption and emissions, conservation of water consumption by increased infiltration, and less labor-intesnive and costly practices required of farmers. The authors even argue that conservation tillage associated with GMCs is good for wildlife by decreasing disturbance to the layers of soil where insects thrive, providing sustenance for many bird species. In addition to discussing these benefits, the authors also support the conclusion that GMCs have reduced pesticide use.

USE:
This article was cited in Sequoyah's Farming EA because it presents a holistic view of the benefits of GMCs and herbicide-tolerant corn and soybeans in particular. However, the article does not discuss the issues associated with GMC use although it does mention weed resistance as one potential problem. Therefore, other articles were evaluated to determine the potential risks.

U.S. Environmental Protection Agency. 1993. Re-registration Eligibility Decision: Glyphosate. U.S. Environmental Protection Agency: Washington, D.C. Available online at: http://www.epa.gov/oppsrrd1/REDs/old_reds/glyphosate.pdf [August 18, 2010].

SUMMARY:
The EPA requires that all pesticides sold or distributed in the United States be registered for use based on scientific studies illustrating that their use will not pose unreasonable risks to people or the environment. This document is a re-evaluation of this registration process for glyphosate, one of the most widely used pesticides by volume. The Re-registration Eligibility Decision (RED) profiles the use of glyphosate along with a human health assessment. In the document, the EPA states "the nature of glyphosate residue in plants and animals is adequately understood." The EPA presents an environmental assessment of glyphosate, citing the environmental fate, ecological effects, and ecological effects risk assessment for use of the herbicide. The EPA explicitly states "glyphosate adsorbs strongly to soil and is not expected to move vertically below the six inch soil layer; residues are expected to be immobile in soils." The EPA also states that glyphosate is "not likely to move to groundwater due to its strong adsorptive characteristics." The ecological effects portion of the report also states "glyphosate is no more than slightly toxic

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to birds and is practically non-toxic to fish, aquatic invertebrates, and honeybees." Ultimately, the full RED presents an analysis of the existing scientific literature on effects of glyphosate use on humans and animals, and supports their decision to regulate its use and labeling in the way it exists today.

USE:
This document was used to illustrate evidence on the potential effects of using glyphosate on Sequoyah NWR. The crops used on the Refuge are genetically altered to tolerate treatments of this particular chemical; therefore, the current status of the farming program is reliant on glyphosate use. This official documentation provides the regulations for use across the United States, as approved by the EPA. Because this information is presented by the EPA as scientific evidence, it is assumed that the RED presents an unbiased and holistic overview of the environmental effects of glyphosate. Therefore, the planning team found it appropriate to cite this document as the main source on potential effects of glyphosate use in Sequoyah's Farming EA.

U.S. Environmental Protection Agency. 2008. Glufosinate Summary Document Re-registration Review: Initial Docket. U.S. Environmental Protection Agency: Washington, D.C. 71pp.

SUMMARY:
Similarly to the RED analyzed for glyphosate, this document presents the preliminary EPA registration review work plan and rationale on glufosinate use. This document includes a preliminary work plan for registration review development, a fact sheet on glufosinate, an ecological risk assessment problem formulation, and a human health effects scoping document. The initial docket includes data from previous risk assessments to support hypotheses on glufosinate use and to illustrate data gaps where more research is needed. The docket presents data on test species evaluated for assessing potential ecological effects of glufosinate-ammonium and the associated Acute Toxicity Classification. According to the EPA, glufosinate is practically non-toxic to birds, mammals, and insects; slightly non-toxic to freshwater fish; slightly toxic to estuarine/marine fish; and moderately toxic to freshwater invertebrates and estuarine/marine invertebrates. Other data presented in the docket includes similar information on effects to soils, surface water, and groundwater. These conclusions will be further analyzed in the re-registration review, which has yet to be published or is currently unavailable.

USE:
The information that the EPA presents in this docket is included in the analysis for glufosinate use on Sequoyah NWR. As stated above, the EPA presents this data as scientific evidence supporting their conclusions, and the Refuge assumes their review presents an unbiased and holistic overview of the best available data on environmental effects due to glufosinate use. Therefore, the planning team cited this document as the main source on potential effects of glufosinate use in Sequoyah's Farming EA.

Villar, J.L., and B. Freese. 2008. Who benefits from GM crops? The rise in pesticide use. Agriculture and Food 112.

SUMMARY:
This report was prepared by Friends of the Earth International, "the world's largest grassroots environmental network" that campaigns on social and environmental needs and promotes sustainability. The purpose of the article is to present a fact-based assessment of GMCs and to

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clear up common misconceptions about such use. The authors begin by describing the current trend of adopting herbicide-tolerant GMC use in soybeans, corn, cotton, and canola specifically. The authors describe that pesticides used in conjunction with GMCs have increased, replacing the use of a wider variety of herbicides; this transition has facilitated increased natural herbicide-resistance in weed species. Therefore, increased rates of glyphosate are often used to kill these more resistant weed species. This is counter to much of the literature that presents the perspective that GMC use has contributed to a decrease in pesticide use, which the authors believe to be true in the brief timeframe immediately following herbicide-tolerant crop use. The authors also present evidence that GMCs, at best, produce equal yields to their conventional counterparts. The report provides evidence illustrating the increase in "market power" granted to seed suppliers including Monsanto and DuPont-Pioneer, who control a concerning amount of world's commercial seed supply. A detailed analysis on various types of genetically modified cotton was provided but was determined to be out of the scope of the NEPA analysis presented in the EA. The authors provide an additional look at crops in Europe, where the public has consistently opposed genetically modified food and "no new GMCs have been approved for cultivation… since 1998."

USE:
This broad-spectrum report was used to present information on the risks associated with GMC use at Sequoyah NWR. Much of the available literature promotes GMC adoption, whereas this thorough report describes the other side of the story. The information presented in this document relies on scientific literature to describe many of the aspects and issues associated with GMC use. Therefore, the report was used in the NEPA analysis to show potential effects resulting from GMC use.

Wolfenbarger, L.L., and P.R. Phifer. 2000. The ecological risks and benefits of genetically engineered plants. Science 290: 2088-2093.

SUMMARY:
This article appeared in *Science* in 2000 to illustrate the conclusion that the available literature on environmental risks and benefits associated with GMC use is lacking. The authors reviewed the existing empirical, published information, primarily from academic, peer-reviewed journals, on potential effects of genetically engineered crops as well as similar fish, trees, and microbes. Although the authors did find minimal literature discussing the risk of increased invasiveness of weed species, the article highlights the fact that no published studies have examined whether introgression of transgenes or its potential ecological consequences have occurred in natural populations though some experience suggests negative effects are possible. Also, the authors discuss direct nontarget effects on beneficial and native organisms, focusing on those resulting from the use of Bacillus thuringiensis (Bt) crops. However, the authors do state "at least two consequences could potentially occur from reported alterations of soil ecosystems – decrease of plant decomposition rates and of carbon and nitrogen levels, which could affect soil fertility" and lower community diversity. Other indirect effects are explored in the article, including the depletion of pests that other species may depend upon for survival or reproduction and the risk of bioaccumulation. Another major risk associated with GMCs is the creation of viruses with new biological characteristics that could arise in transgenic viral-resistant plants. Benefits of GMC use are also discussed in the article, including reduced environmental impacts from pesticide use, soil conservation through conservation tillage practices, increased yields, and phytoremediation or in situ remediation of polluted soils, sediments, surface waters, and aquifers. The authors list six main conclusions, most importantly including "neither the risks nor the benefits of genetically engineered organisms are certain or universal" and "evaluation of potential

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environmental benefits, still in its infancy, will allow risk managers and decision-makers to balance these against the extent and irreversibility of any ecological change."

USE:
Because data discussing the risks associated with the use of GMCs is limited, this article was used when discussing such adverse effects that may occur due to the use of herbicide-tolerant GMCs at Sequoyah NWR. The EA intends to present what environmental consequences are likely to result from the use of GMCs or the lack thereof, and the planning team sought to illustrate a balanced view of these effects. This article provided a good basis, citing other scientific literature articles, for elaborating on the potential risks associated with GMC use on the Refuge.

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