DRAFT Environmental Assessment of Row Crop Program at Crab Orchard National Wildlife Refuge

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Crab Orchard National Wildlife Refuge

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Proposed Action

In the current, human-modified landscape, the remaining habitat resources on Crab Orchard National Wildlife Refuge must be actively managed to sustain population levels of many wildlife species. To attain the management objectives of a National Wildlife Refuge, the United States Fish and Wildlife Service (Service) must efficiently and effectively use a variety of management tools, sometimes including agriculture. The Service is proposing to make changes to the current row crop program at Crab Orchard National Wildlife Refuge (refuge) in order to address several challenges associated with the current program.

Over time, refuge staff has recognized issues with the sustainability of the current agricultural program and compliance with the Service's Biological Integrity, Diversity, and Environmental Health policy (*see* https://www.fws.gov/policy/601fw3.html). Issues include proliferation of invasive and undesirable species, consistently low crop yields for wildlife food sources, and increased use of potentially harmful pesticides. To improve the Service's ability to fulfill the agricultural purpose of Crab Orchard National Wildlife Refuge, and to meet wildlife management objectives, the Service is evaluating the use of genetically modified crops in the refuge agricultural program. While an agricultural Environmental Assessment was completed in 2018 (USFWS 2018), consideration of additional management alternatives related to the use of genetically modified crops was not considered at that time. The use of genetically modified crops on national wildlife refuges in the Midwest region had been suspended in 2012. Following the national phase out of genetically modified crops in 2014, the Service did not analyze the potential effects of using only conventional row cropping systems on the refuge. In the decade since the phase out was enacted, the refuge has experienced significant challenges with maintaining its agricultural program at Crab Orchard National Wildlife Refuge. Therefore, this Draft Environmental Assessment was prepared to analyze those effects and the potential alternatives for the row crop program over the next 1-5 years. The Service is committed to future planning efforts that will incorporate additional analyses, consider public input, and use the expertise of our partners. This will help determine the best long-term solution to fulfilling the agricultural purposes of the refuge.

Background

National Wildlife Refuges have historically provided foraging habitat and sanctuary for the millions of waterfowl that migrate through and winter in North America. Some refuges use agriculture as a resource management tool to produce high-energy food sources for meeting waterfowl and other wildlife objectives, to control invasive species, and maintain maximum early-succession natural vegetation communities. Row crop agriculture is used on less than ten percent (10%) of the lands of Crab Orchard National Wildlife Refuge to support these objectives. The refuge does not have the staff capacity to produce row crops, thus, community cooperators have been a more effective way to meet the refuge's agricultural purpose.

Prior to substantial clearing and drainage in the late nineteenth and early twentieth centuries, large, unbroken expanses of bottomland hardwood, freshwater emergent, and coastal wetlands were available for use by waterfowl and other wildlife (Dahl 1990, 2011; Schummer et al. 2012). In the last 100 years, wetland loss, habitat fragmentation, introduction of exotic plant and animal species, and disruption of natural hydrological and fire processes have drastically reduced habitat availability and quality for wildlife. In the current human-modified landscape, remaining habitat must be actively managed to sustain desired wildlife population levels based on numeric objectives in science-based, partner-driven plans. Management actions at Crab Orchard refuge include moist soil and water level management, prescribed burning, mowing, invasive species control, planting grassland and forest species, and agriculture. Before anthropogenic modification, entire systems were more resilient in the face of natural disturbances such as fire, drought, flooding, and severe storms. Wildlife must now depend on a disproportionately smaller proportion of refuges and other conservation lands to provide habitat resources in a matrix of unsuitable land uses. Many wildlife species have adapted to the loss of natural food sources by feeding on cultivated grains (Baldassarre and Bolen 1984, Delnicki and Reinecke 1986, Combs and Fredrickson 1996), but waste grain has declined substantially in harvested fields on private lands due to the changing and increasingly efficient agricultural practices (Manley et al. 2004, Foster et al. 2010). Since at least the 1930s, natural resource managers have used agriculture as a method to supplement natural foods for wildlife on conservation lands, but this practice is currently used primarily where native food sources may be difficult to restore or provide.

A Draft Environmental Assessment has been prepared to evaluate two alternatives concerning the management of the row crop program to meet the legislated conservation and agriculture purposes of the refuge. This Draft Environmental Assessment examines the environmental consequences that each management alternative could have on the human environment. This includes cultural and natural resources, as well as social and economic considerations, as required by the National Environmental Policy Act of 1969 in accordance with Council on Environmental Quality regulations (40 CFR 1500-1509) and Department of the Interior (43 CFR 46; 516 DM 8) and United States Fish and Wildlife Service (550 FW 3) regulations and policies.

National Wildlife Refuges are guided by the mission and goals of the National Wildlife Refuge System (Refuge System), 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. For this Draft Environmental Assessment, emphasis is placed on the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 Section 4(a)(4)(B) that states the following:

"*In administering the System, the Secretary shall . . . ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans . . . .*"

The mission of the Refuge System, as outlined by the National Wildlife Refuge System Administration Act (Administration Act), as amended by the National Wildlife Refuge System Improvement Act (16 U.S.C. 668dd et seq.), 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".

Additionally, the Administration Act mandates the Secretary of the Interior in administering the Refuge System (16 U.S.C. 668dd (a) (4)) to:

- Provide for the conservation of fish, wildlife, and plants, and their habitats within the National Wildlife Refuge System;
- Ensure that the biological integrity, diversity, and environmental health of the refuges are maintained for the benefit of present and future generations of Americans;
- Ensure that the mission of the Refuge System described in 16 U.S.C. 668dd (a) (2) and the purposes of each refuge are carried out;
- Ensure effective coordination, interaction, and cooperation with owners of land adjoining refuges and the fish and wildlife agency of the states in which the units of the Refuge System are located;
- Assist in the maintenance of adequate water quantity and water quality to fulfill the mission of the Refuge System and the purposes of each refuge;
- Recognize compatible wildlife-dependent recreational uses as the priority public uses of the National Wildlife Refuge System through which the American public can develop an appreciation for fish and wildlife;
- Ensure that opportunities are provided within the Refuge System for compatible wildlife-dependent recreational uses; and
- Monitor the status and trends of fish, wildlife, and plants in each refuge.

Crab Orchard National Wildlife Refuge was established on August 5, 1947, by Public Law 80-361. This Act of Congress transferred 22,575 acres from the Department of War (Illinois Ordnance Plant) and 21,425 acres from the Soil Conservation Service (Crab Orchard Creek Project) to the Secretary of the Interior. This directive stipulated the lands transferred would be administered by the Secretary of the Interior through the Fish and Wildlife Service "for the conservation of wildlife, and for the development of the agricultural, recreational, industrial, and related purposes specified in this Act."

The Refuge began farm management in 1948 with 35 cooperative and 18 cash farmers. The original focus of the farm program was to reclaim farmland that was fallow during ordnance plant operations, improve soil fertility and farm practices, establish pastureland, and use crops to establish a wintering flock of Canada Geese (*Branta canadensis*). In 2007, the Crab Orchard National Wildlife Refuge Comprehensive Conservation Plan (CCP, USFWS 2007) established specific goals, objectives, and strategies to guide management for all refuge purposes. Currently, the refuge maintains an agriculture program consisting of approximately 3,899 acres of row crops with seven cooperators, 304 acres of hay fields with five cooperators, and 1,049 acres of fescue and warm season grazing pastures with eight cooperators (Table 2).

The Midwest Region of the Service completed an Environmental Assessment in 2011 on the use of row crop farming and genetically modified and glyphosate tolerant corn and soybeans on National Wildlife Refuges and Wetland Management Districts within the Region, including Crab Orchard National Wildlife Refuge. The selected alternative was to "[c]ontinue farming for multiple objectives, glyphosate tolerant corn and soybeans allowed for habitat restoration only." The region subsequently issued guidance to field stations that aligned with the Finding of No

Significant Impact. Interest in the use of genetically modified crops on National Wildlife Refuges resulted in litigation between 2012 and 2015, during which time the Service, including Crab Orchard National Wildlife Refuge, phased out use of genetically modified crops as part of its agriculture programs.

Since the issuance of the 2007 refuge Comprehensive Conservation Plan, the staff documented a drastic decline in wintering goose numbers, decreased agriculture acreage, reduced field productivity, and failing infrastructure, which signaled a need to re-evaluate refuge agricultural goals. This culminated in the 2018 Crab Orchard National Wildlife Refuge Agriculture Program Environmental Assessment and Finding of No Significant Impact that selected Alternative C (USFWS 2018). Under Alternative C, the refuge would pursue strategic abandonment and/or deconstruction of agricultural infrastructure (e.g., roads and fences) where feasible to decrease annual maintenance costs. Additionally, the 2018 Environmental Assessment indicated there may be administrative need to remove certain crop fields, pastures, and/or hay units from production for a variety of reasons, e.g., unexploded ordnance, access issues, or if funding or maintenance needs outweighed the refuge's capacity to maintain certain units. Furthermore, the Environmental Assessment noted the location and methodology of some agricultural practices could change over time to address invasive species, soil health, field access issues, restore degraded sites, or address other unforeseen issues. The 2018 Environmental Assessment did not, however, evaluate the alternative of allowing GMCs to achieve refuge agricultural goals because they were not used at that time due to policy restrictions.

That same year, in 2018 the Service Director issued a memorandum allowing for refuges to consider the use of certain pesticides and GMCs on a case-by-case basis.

"Realizing that farming practices will continue into the foreseeable future with the [National Wildlife Refuge System] NWRS to adaptively fulfill the energetic needs as identified, we must ensure that we are appropriately making use of farm practice innovations as we actively manage farmed areas... There may be situations... where use of GMO crop seeds is essential to best fulfill the purposes of the Refuge and the needs of birds and other wildlife... The NWRS will now determine the appropriateness of the use of those crops on a case-by-case basis..." (G. Sheehan, personal communication, August 2, 2018).

The Service issued additional national guidance in 2020 from the Chief of the National Wildlife Refuge System. The guidance memo provides direction to evaluate, in a consistent and objective manner, the Service's agricultural practices on national wildlife refuges, including GMC seed and pesticide uses. The guidance directs refuges to use an evaluation questionnaire for the use of GMC seeds and states that the National Wildlife Refuge System practice is to use GMC seeds only if they are determined to be "essential to fulfill the purposes of the Refuge and to meet habitat and/or wildlife management objective(s)." This questionnaire is used to document an analysis of the proposed use of GMC seeds and ensure compliance with all laws, including NEPA and the National Wildlife Refuge System Administration Act (16 U.S.C. 668dd(a)(4)(B)), regulations, and policies. Use of GMC seeds must then be approved by the Regional Refuge Chief.

This current Draft Environmental Assessment evaluates the Crab Orchard National Wildlife Refuge row crop program with the potential for adding GMCs to meet immediate needs that will assist with current program goals and objectives until more comprehensive and inclusive planning takes place. Any subsequent bid cycles beyond the pending 2023 bid cycle would be subject to the new guidance developed from the future planning process. The revised comprehensive plan would provide a longer-term vision, along with goals and objectives, for fulfilling agricultural purposes on the refuge into the future. Through annual compliance checks, annual evaluations, long-term trends, and cooperator input of the row crop program, serious issues with the sustainability of the refuge agricultural program have been recognized for which a new comprehensive evaluation is needed. These issues include significantly reduced crop yields, expansion of multimodal herbicide resistant weeds in refuge crop fields, and a 333% increase in approved pesticide application since the phase out of GMCs on refuges took effect. In addition, there has been a recent increase in requests from cooperators to use pesticides with greater potential for ecological harm and ground and surface water contamination, as well as increased use of tillage to address these challenges. All pesticides used on National Wildlife Refuges undergo rigorous review for approval by refuge, regional, and national pesticide coordinators through the Service's Integrated Pest Management (IPM) program. Moreover, the Pesticide Use Proposal (PUP) system database contains detailed information for assessing and approving the potential use of a pesticide. Nonetheless, these issues have raised concern for the long-term sustainability of the row crop program. A more in-depth evaluation of the entire refuge agricultural program will be initiated prior to the subsequent bid cycle. This current Environmental Assessment is intended to address immediate needs for the upcoming 2023 bid cycle to ensure the refuge habitat management objectives and agriculture purpose is met, as well as providing opportunities for cooperators to produce viable crops.

Purpose and Need for the Action

The purpose of this proposed action is to evaluate alternatives not considered during the 2018 Crab Orchard National Wildlife Refuge Agriculture Program Environmental Assessment. As part of this assessment, the refuge is evaluating the option of incorporating genetically modified crops into the current program and selecting an alternative that will provide the greatest potential for meeting refuge purposes, goals and objectives until a more complete evaluation and planning effort is done prior to the subsequent bid cycle to provide a longer-term vision for the agriculture program. Each alternative is evaluated on environmental impacts (biological and socioeconomic), in accordance with NEPA and maintaining compliance with the National Wildlife Refuge Administration Act, the refuge's purposes, and the mission of the National Wildlife Refuge System.

The refuge was established in 1947 by an Act of Congress (Public Law 80-361) "for the conservation of wildlife and for the development of agriculture, recreational, industrial, and related purposes…" To attain the refuge's agricultural, habitat and wildlife management goals and objectives as outlined in the refuge's CCP, the Service must efficiently and effectively use a variety of management tools within a changing landscape while protecting biological integrity, diversity, and environmental health. Some agricultural practices have also been demonstrated to be effective and cost-efficient management tools to set back vegetative succession, prepare areas for native plantings, control invasive species, and promote food production that benefits migratory birds and other wildlife.

The refuge has historically used agriculture to provide food and habitat for ducks, geese, and other waterbirds during migration and wintering periods as well as for other wildlife species. At present, the refuge uses a cooperative agriculture program (Table 2) to meet its general agriculture purpose that provides economic opportunities for area farmers. Row cropping has been used with Integrated Pest Management to manage invasive or undesirable species, maintain and maximize early-succession natural vegetation communities, and satisfy other wildlife and/or habitat objectives. Over the last decade, the refuge has experienced declining crop yields, increased requests for pesticide application, and other challenges. As such, the refuge is evaluating the use of GMCs as a potential interim tool to maintain a viable agriculture program as part of the refuge's legislated purposes. The refuge is exploring alternatives to reduce the number and amount of pesticides used in agricultural practices, minimize the potential for ecological harm, and reduce potential for impacts to surface and subsurface waters. Additionally, the alternatives are being explored to ensure the refuge has an economically feasible method of implementing agricultural practices that include the ability to retain and recruit cooperative farmers.

This Environmental Assessment will evaluate the use of conventional row cropping and the use of GMCs on Crab Orchard National Wildlife Refuge to meet refuge purposes and achieve the specific goals of the existing Comprehensive Conservation Plan, the Habitat Management Plan, and other national and international conservation initiatives, including the North American Waterfowl Management Plan (USDOI EC ENRM 2012). The goal is to address current issues that are not allowing the refuge to meet its objectives in existing plans. A more comprehensive refuge planning effort initiated before the next cooperator bid cycle will further address the long-term sustainability of an agriculture program that contributes to the wildlife conservation purposes of the refuge and is consistent with the Service's biological integrity, diversity, and environmental health policy.

Decision Framework

Based on this Environmental Assessment, the Service will select an alternative for the best approach for meeting the goals and objectives on Crab Orchard National Wildlife Refuge or determine if the selected alternative is a major federal action that would significantly affect the quality of the human environment thus requiring preparation of an Environmental Impact Statement in accordance with NEPA.

Current refuge management practices will be reviewed and compared to a preferred alternative. In accordance with NEPA, each alternative was evaluated based on associated environmental consequences, including biological, physical, social, and economic impacts, as well as on the effectiveness of the alternative to support the mission of the National Wildlife Refuge System and the purposes for which Crab Orchard National Wildlife Refuge was established.

Description of Alternatives

Alternative A-Use only conventional farming practices as part of the Refuge's integrated pest management approach. (No Action Alternative)

This alternative would continue the status quo as described in the 2018 Crab Orchard National Wildlife Refuge Agriculture Program Environmental Assessment and Finding of No Significant Impact that selected Alternative C (USFWS 2018). Please see the 2018 Environmental Assessment for a detailed description. The document can be accessed through the following link, https://ecos.fws.gov/ServCat/DownloadFile/204848. Under this scenario, the refuge would not allow for the use of GMCs in its agricultural program and only conventional crops would continue to be farmed.

Alternative B –Use of Genetically Modified Crops as part of the Refuge's Integrated Pest Management Approach.

This alternative would utilize GMCs within the refuge's IPM approach and allow their use in crop rotations. GMCs are crop plants that have been modified using genetic engineering. The genetic modifications introduce new genetic traits to the plant that do not occur naturally in the plant species. Some plants are genetically engineered to withstand certain pesticide applications, environmental stressors (such as drought), or to resist certain pests or diseases, such as insects, molds, or mildews. Although not limited to these, examples of the types of GMCs proposed for use at the refuge include corn and soybeans that are glyphosate, glufosinate, and/or 2,4-D tolerant varieties.

This alternative would allow current agricultural and wildlife management objectives to be met by adapting, annually, to dynamic weed populations. The use of GMCs would provide additional options to manage herbicide resistant weed populations. Cooperators would have special conditions such that different GMCs would be required in successive years that utilize different chemical modes of action in the effort to reduce the prevalence of resistant weeds and reduce the likelihood of additional species becoming herbicide resistant. Conventional row crops could be incorporated within rotations to increase the diversity of chemical modes of action of herbicides for the same reasons outlined above.

Under this alternative, the refuge and cooperators would annually evaluate each row crop field and develop planting plans that best meet the IPM approach. The practice of idling fields would be judiciously used and possibly eliminated. Instead, small grain crops may be utilized every three to five years to provide additional diversity in the rotations and to utilize the inherent weed suppression capacity through allelopathic influences of crops such as wheat and rye. Other crops may be utilized to provide ground cover for weed suppression, such as brown top millet; these crops may be retained as the "refuge share" or may be harvested as cash crops, or some combination.

Alternatives Considered, but Dismissed from Further Consideration and Evaluation

Discontinue All Row Cropping on the Refuge

This alternative was included in initial analyses; however, it will not be analyzed further at this time. The row crop program maintains approximately 3,899 acres and the refuge has limited funding and staffing capacity to convert these acres to native habitat or hayable grasslands, making this alternative problematic without significant adjustments to established objectives and related priorities. A large-scale change from row cropping would take time and planning, especially in partnership with agricultural cooperators. Abrupt changes such as discontinuing row cropping would not be consistent with obligations to cooperators and would need a larger inclusive process. Without a plan for near term habitat restoration the areas would likely become infested with problematic invasive species resulting in more complex and expensive restoration work. This alternative would be difficult to implement immediately while still meeting the refuge's legislated agriculture purpose as well as objectives in the refuge's Comprehensive Conservation Plan. Such objectives include using crops to provide migrating and wintering food sources for ducks, geese, and other waterbirds. Crop foods also meet current objectives for other wildlife species and provide hunting and wildlife viewing opportunities. Therefore, this alternative was dismissed from further consideration at this time.

Allow Cooperators to Plant Genetically Modified Crops at their Discretion

This alternative was included in initial analyses; however, it will not be analyzed further considering the issues regarding multimodal herbicide resistant plants and the need to adhere to IPM policies. If cooperators are allowed to plant GMCs at their discretion, there is a higher likelihood that diversity of chemicals and chemical modes of action may be dramatically reduced. This can translate into continued persistence or development of additional herbicide resistant weed issues. An effective IPM approach relies on a diversified suite of tools used to provide food security, agricultural sustainability, and protection of the environment. Genetically modified crops are a tool that can be used to complement a diversified IPM program but should not be used as the sole mechanism and would not support agricultural program sustainability over an extended period time (Anderson et. al 2019). Therefore, this alternative was dismissed from further consideration.

Use only Organic Agriculture with Non-GMCs

Organic agriculture is a crop production system that relies predominantly on natural soil and ecosystem processes without the use of synthetic chemicals. This type of agriculture often utilizes biological pest control, imported manure and other organic wastes, ocean-based fertilizers, mineral-bearing rock, and natural soil conditioners. The Service eliminated this alternative from the current analysis because it would not be achievable within the next one to five years. However, it will be considered in the future evaluation of the refuge's agriculture program. The following reasons make a shorter-term conversion to organic agriculture difficult:

- Producers in the counties surrounding the refuge generally lack sufficient resources to utilize organic farming on the scale required within the next 5 years to attain the agricultural and wildlife goals and objectives established by the current CCP and associated Habitat Management Plan and Farm Plan for Crab Orchard National Wildlife Refuge.

- An inadequate number of organic farmers operate in reasonable proximity to the refuge at this time to make organic farming a reasonable alternative. A review of United States Department of Agriculture's 2019 data for this refuge shows organic farms sparsely located in southern Illinois (Figure 1).

Use only Non-Genetically Modified Cereal (Small Grain) Crops

Cereal small grain crops, such as millet, provide less energy density for waterfowl than corn, rice, and milo. For example, millet provides 5,203 duck energy days per acre compared to 28,591 duck energy days per acre for corn, 23,833 duck energy days per acre for rice, and 18,046 duck energy days per acre for milo (Reinecke and Kaminski 2006). Additionally, local grain elevators will not accept small grain crops with the exception of wheat. Milo is also often difficult for cooperators to exchange in the local area. Consequently, the Service eliminated this alternative from further analysis.

Affected Environment and Environmental Consequences of the Action

This section discusses the affected environment and the potential effects of the actions proposed in the alternatives. The effects of implementing Alternative A and Alternative B are organized in categories for each affected resource where the effects and impacts are more than negligible. The effects and impacts of the proposed action considered here are changes to the human environment, whether adverse or beneficial, that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives. This Environmental Assessment includes the written analyses of the environmental consequences on a resource only when the impacts on that resource could be more than negligible and therefore considered an "affected resource." Any resources that will not be more than negligibly impacted by the action have been dismissed from further analyses.

Crab Orchard National Wildlife Refuge is in southern Illinois in Williamson, Union, and Jackson counties, west of Marion and south of Herrin, on the northern edge of the Ozark foothills (Figure 1). The refuge is one of the largest refuges in the Service's Midwest Region. Established in 1947 for wildlife, agriculture, recreation, and industry, the 45,446-acre refuge includes 3,899 acres of row crop fields. The refuge landscape also includes hardwood and pine forests, open oak woodlands, savanna, other croplands, grasslands, wetlands, rolling hills, and rugged terrain with slopes of 24 percent. The 4,050-acre Crab Orchard Wilderness, the first wilderness area designated in the State of Illinois, lies within the refuge.

Crab Orchard National Wildlife Refuge is unique in the National Wildlife Refuge System in having an industrial agriculture program that generates $40 million annually to the local economy. The refuge is also the only National Wildlife Refuge to have resident youth camps, such as those operated by Girl Scouts, Boy Scouts, and religious organizations. The refuge hosts an estimated 1.2 million visitors annually, and its recreation programs contribute over $29 million to the local tourism economy. Public use opportunities at the refuge include an auto tour route, hiking trails, hunting, fishing, wildlife observation and photography, environmental education and interpretation, boating, swimming, camping, and picnicking. The refuge provides safe and equitable public use programs and facilities so that visitors have a wholesome, enjoyable recreational experience and gain an appreciation for fish and wildlife resources, natural and cultural history, outdoor ethics, and environmental awareness.

The proposed action is located on multiple units in the northern half of the refuge (Figure 4 in Appendix A). Detailed information regarding the affected environment is provided in Chapter 3 of the refuge's CCP (USFWS 2007), which can be found at the following link: https://ecos.fws.gov/ServCat/DownloadFile/214353. This Environmental Assessment includes the written analyses of only "affected resources." Any resources that will not be more than negligibly impacted by maintaining the status quo or allowing GMCs within an IPM approach have been dismissed from further analyses. Therefore, the following resources either do not exist within the project area, are not affected, or are only negligibly affected by the proposed action and are not analyzed further in this environmental assessment:

<u>Wilderness Act</u>

Congress designated the Crab Orchard Wilderness as a unit of the National Wilderness Preservation System in 1976. The 4,050-acre wilderness was the first in the State of Illinois. The Crab Orchard Wilderness is located at the extreme southern end of the refuge bordering the shores of Little Grassy and Devil's Kitchen Lakes. This wilderness area is over two miles from the nearest row crop field and will not be affected by either alternative.

<u>Unexploded Ordnance (UXO)</u>

All alternatives would adhere to the Refuge's Environmental Land Use Control Plans (USFWS 2008) and all future amendments. Several row crop units overlap the land use control plan (Figure 6 and Table 4), although, affected fields have already been removed from production or will be in 2023. The plan reduces exposure to contamination by limiting land or resource use and modifies or guides human behavior where hazardous substances prevent unlimited use and unrestricted exposure (EPA 2012). Protective measures will be followed to limit risk and promote safety on the refuge. About half of Crab Orchard National Wildlife Refuge exists on the former Illinois Ordnance Plant used during World War II. Munitions ranging from primers and land mines to 500-pound bombs were manufactured here by the millions. Some portions of the refuge were used to destroy munitions after World War II, and this resulted in some unexploded ordnance being left behind creating a potential safety issue. Additional restrictions on agricultural use may occur as land use control plans are further developed, modified, or as new information is acquired. Restrictions on areas contaminated with unexploded ordnance will be the same across all alternatives.

<u>Cultural Resources</u>

The consequences of the planned management on cultural resources are the same across all alternatives. Since most of the agricultural activities have resulted in ongoing ground disturbance, any additional effects to cultural or historic resources are likely to be minor or non-existent. Any management actions with the potential to affect cultural resources require review by the Fish and Wildlife Service Regional Historic Preservation Officer in consultation with the State Historic Preservation Office as mandated by Section 106 of the National Historic Preservation Act. Areas considered in this review have been previously farmed and disturbed, reducing the likelihood that impacts to cultural resources could occur. For any ground disturbing activities, clearance will be obtained from the Regional Historic Preservation Officer to confirm negligible to no impacts on cultural resources.

Environmental Justice and Human Health

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

The Animal and Plant Health Inspection Service (APHIS) considers the impacts of certain GMCs on minorities and low-income populations prior to deregulation. In addition, the Environmental Protection Agency (EPA) and United States Department of Agriculture's Economic Research Service monitor the use of genetically modified crop products to determine impacts of agricultural practices on human health. The results of this monitoring will provide further safety and efficiency guidance over time as real-world data are collected on the effects of a particular genetically modified crop on minority and low-income populations and the environment.

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

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

Affected Environment

Description of Relevant General Features of the Affected Environment

A thorough background description of the affected environment is provided in the 2018 Crab Orchard National Wildlife Refuge Agriculture Program Environmental Assessment (USFWS 2018; https://ecos.fws.gov/ServCat/DownloadFile/204848), and the 2007 CCP and accompanying Environmental Impact Statement (USFWS 2007; https://ecos.fws.gov/ServCat/DownloadFile/44166).

Natural Resources

Soils

Description of Relevant Environmental Trends and Planned Actions

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

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

Environmental Consequences

Impacts on Affected Resource

Alternative A: Use only non-genetically modified crops on the Refuge. (No Action Alternative)

Non-GMCs use often leads to the implementation of more conventional farming practices, such as increased conventional tillage, that have a greater impact on soil quality, structure and function (Benbrook, 2012). Conventional tillage practices cause soil erosion, soil compaction, reduction in soil bacteria, and reduction in crop residue (Towery and Werblow 2010). Crop residue is needed to minimize soil erosion, which can make land less productive and contaminate water. Despite the Service's incorporation of best management practices (e.g., cover crops, crop rotations) in its cooperative farming partnerships to reduce soil erosion and control pests, the refuge has reported increased occurrences of pests and weeds, particularly since the Service's switch to only non-GMCs in 2013 (Wood and Skaggs, personal communication). Since the switch, the refuge has had to increase the amount and types of pesticides applied to control increases in pests and weeds (Figures 2 and 3). This increase in pesticide applications has necessitated more frequent trips over fields on heavy machinery, which has worsened soil compaction.

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

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

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

The use of GMCs increases no-till and conservation tillage methods that reduce erosion and runoff; preserve soil organic matter, beneficial biota, and nutrients; improve water-retention capacity; and require less time and labor to prepare a field for planting relative to using non-GMCs (Roger-Estrade et al. 2010, He et al. 2011, Sharma and Abrol 2012, Van Eerd et al. 2014). No-till and conservation tillage also may increase soil organic matter and plant residues. Herbicide application may provide soils with plant matter from dead weeds, and the new organic matter would be beneficial to omnivores in the soil, such as bacteria and nematodes, which would consume the organic matter as food (Zhao et al. 2013). Enhanced organic matter hinders pesticide movement and facilitates pesticide degradation (Locke and Zablotowicz 2004). The use of GMCs as part of a holistic IPM system would allow the refuge to increase no-till and conservation tillage, decrease the amounts and types of pesticides, decrease the compaction of soils, decrease soil disturbance and erosion, increase soil organic matter, increase crop residue, increase cover crop use and rotation, and decrease crop pests and weeds.

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

Climate Change

Description of Relevant Environmental Trends and Planned Actions

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

Environmental Consequences

Impacts on Affected Resource

Alternative A: Use only non-genetically modified crops on the Refuge. (No Action Alternative)

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

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

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

Water Quality

Description of Relevant Environmental Trends and Planned Actions

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

Environmental Consequences

Impacts on Affected Resource

Alternative A: Use only non-genetically modified crops on the Refuge. (No Action Alternative)

Using non-GMCs on refuges has increased the application of conventional tillage in order to control weeds and prepare soil for planting (Wood and Skaggs personal communication). The trend of increased conventional tillage should be expected, which is in direct conflict with the CCP’s goals and objectives for water quality and agriculture (FWS 2007). Conventional tillage has the potential to increase sediment input into streams and surface runoff and increase the amplitude of stream hydrographs (Towery and Werblow 2010) and can result in decreased water quality.

The use of only non-GMCs on refuges has also caused an increase in the amount, types and applications of pesticides of some less environmentally benign chemicals that could directly affect water resources. Pesticides typically used with conventional crops generally have more potential to move off site, leach into groundwater, and take much longer to break down to inert substances (Brookes and Barfoot 2010, Cerdeira and Duke 2006, COBFLES 2010, Ferry and Gatehouse 2008). Increased buffers will likely need to be instituted to protect water quality resulting in increased acreage that cannot be chemically treated thus reducing overall row crop acreage.

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

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

The trend of increased conventional tillage should be expected to reverse, consistent with the CCP's Agriculture and Water Quality Goals/Objectives (USFWS 2007). However, occasional tillage is a necessary component of an IPM approach and may be used periodically. A decreased potential exists under this alternative for increased sediment inputs into streams, lakes, ponds, and surface runoff contributing to reduced stream hydrography. Increased buffers will not likely be needed to protect water quality. Thus, a decrease is expected in acreage that cannot be chemically treated for weed species, also decreasing the variety and abundance of weeds adjacent to crop fields resulting in no expected reductions in overall row crop acreage.

Herbicide tolerant and insect resistant crops have facilitated a shift to the use of no-till and conservation tillage (Fernandez-Cornejo and Caswell 2006, Carpenter 2011). The benefits of no-till and conservation tillage on water quality are well documented: reduces sediment input into streams; decreases surface runoff; reduces use of agricultural chemicals and fertilizer; decreases irrigation water use; and reduces the amplitude of stream hydrographs (Towery and Werblow 2010, Shipitalo and Owens 2011). Conservation tillage and no-till systems in which herbicide-tolerant crops are substituted for non-GMCs varieties could help increase water quality consistent with the goals and objectives outlined in the refuge's CCP (FWS 2007).

As with soil effects, most of the work on water quality has focused on direct and indirect effects of herbicide-tolerant and insect-resistant crops and the resulting changes in pesticide use. There is evidence that suggests adoption of herbicide-tolerant crops can minimize environmental impacts through reduced herbicide use and increased use of no-till and conservation tillage practices. Significant reductions in insecticide use have occurred because of the introduction of insect-resistant corn and soybeans (Fernandez-Cornejo and Caswell 2006, National Research Council 2010), which results in reduced chemical inputs into water bodies. Herbicide resistant crops generally make weed control more effective and may provide an incentive of lower cost of production to growers (National Research Council 2010, Fernandez-Cornejo et al. 2012).

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

Air Quality

Description of Relevant Environmental Trends and Planned Actions

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

Environmental Consequences

Impacts on Affected Resource

Alternative A: Use only non-genetically modified crops on the Refuge. (No Action Alternative)

The primary sources that affect air quality from crop production include soil particulates from tillage and wind erosion, exhaust from farming equipment, and spraying of pesticides (Madden et al. 2009). By generating a greater amount of suspended particulates (dust), conventional tillage also potentially contributes to higher rates of soil wind erosion, thus decreasing air quality (Towery and Werblow 2010). Although this impact is variable and affected by factors such as soil moisture and specific tillage regime employed, this observation demonstrates the role no-till and conservation tillage plays in reducing particulate matter. Increased tillage is expected under this alternative and will result in a greater amount of exhaust from farming equipment, reductions in carbon sequestration, degradation of the biotic and abiotic soil systems, and higher rates of suspended dust particulates, thus affecting air quality and contributing to factors implicated in climate change. Tillage also increases the likelihood of higher rates of soil wind erosion, also negatively affecting air quality.

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

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

Across much of the refuge, multi-herbicide-resistant plant species, including Palmer amaranth (*Amaranthus palmeri*), has forced cooperators to include or intensify tillage (Wood and Skaggs, personal communication). This can indirectly affect air quality as particulate matter can increase with more aggressive tillage practices. More aggressive tillage practices also require the use of more fossil fuels than do no-till and conservation tillage methods.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

Decreased tillage expected under this alternative will result in a lesser amount of exhaust from farming equipment, increased carbon sequestration, and reduced degradation of the biotic and abiotic soil systems, as they remain intact from no-till and low tillage operations. Lower rates of suspended dust particulates are expected from reducing tillage, thus positively affecting air quality and reducing contributing factors implicated in climate change. Reductions in tillage are likely to decrease rates of soil wind erosion, also positively affecting air quality.

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

Use of pesticides and potential environmental impacts through drift and volatilization are expected to decrease on the refuge with the use of GMCs. Prior to the phase out of GMCs use on refuges, the amount and types of pesticides use were much lower than those utilized in a non-GMCs system (Figures 2 and 3). The environmental label restrictions and the Service's and refuge's best management practices decrease the occurrences of drift or volatilization for both GMCs and non-GMCs; however, in most cases, non-GMCs require the use of chemicals that are more toxic in greater quantities (USFWS PUPS Database).

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

Habitat

Description of Relevant Environmental Trends and Planned Actions

Agricultural practices can potentially affect natural habitat resources and acreage on refuge and, thus, affect the availability of food resources to wildlife species. Initially, the intended beneficiaries of agricultural practices on Crab Orchard National Wildlife Refuge were migrating Canada Geese (Branta canadensis). Now, it is widely recognized that supplementary, planted foods can be valuable for a wide variety of waterfowl and other game and nongame species (Donalty et al. 2003) depending on the availability of native foods in the area. The refuge also uses agricultural practices in a wide variety of natural resource management activities, such as restoring native grasslands, managing moist-soil wetlands, and invasive species control.

The refuge was historically and still is an important area for waterfowl during the migratory season. The opening statement from the Service in the original proposal for the refuge revealed the justification and intent for the refuge's establishment, "because of its strategic location in the heart of the Mississippi flyway, southern Illinois has always been the location of important waterfowl concentrations" (USFWS 1946). Prior to construction of the Crab Orchard Lake dam, thousands of acres of annually flooded wet meadows and bottomland forest existed within the Crab Orchard Creek bottoms. Creating the lake dramatically reduced the local availability of these habitat types. Moist-soil seed producing impoundments, marshes, lakes, and ponds exist throughout the refuge and were created and managed to replace those lost habitats. They provide foraging and loafing habitat, escape cover, and refugia for waterfowl, bald eagles, wading birds, shorebirds, and other priority resources of concern.

Although the dominant communities are mixed hardwoods and pine plantations, the suite of communities present at the refuge are extremely varied. This reflects the unique position the refuge holds at the landscape scale, straddling the boundary between the unglaciated Shawnee Hill region in the southern half of the refuge and the Southern Glacial Till region in the northern half. Cypress plantations, maple-ash communities, ruderal eastern red-cedar forests, post oak flatwoods, and swamp white oak bottomland forests are just a small sampling of the diverse forest communities present. Additionally, savannas, glades, and a variety of grasslands are managed at the refuge. Most wetlands at the refuge are man-made lakes and ponds and their associated permanent and seasonal emergent wetlands. Multiple wetland types occur within the bays and edges of Crab Orchard Lake (6,965 acres) although it is predominantly open water. Other major lakes include Devil's Kitchen Lake (810 acres) and Grassy Lake (1000 acres) with additional lakes dispersed across the refuge landscape (293 acres). Other major wetlands include bottomland hardwood forests and forested wetlands (2,137 acres), beaver impoundments (>1,000 acres), ponds (204 acres), streams and riverine habitats (>8 acres), floodable agricultural fields (188 acres), and managed wetland units (450 acres).

Moist soil units and other seasonally flooded impoundments are dominated by early seral stages of annual moist soil plants that produce an abundance of seeds and invertebrates as food sources for resident and migratory waterbirds and other wetland dependent species. Cyclical disturbance of soils and/or the plant community is required every two to five years via disking, herbicide treatment, or long duration flooding of one to two years; prescribed fire can also be used in some situations to achieve the desired effect. A lack of disturbance allows perennial plants that are less desirable for waterfowl to supplant the annual plant community. Disking to set back succession mimics the natural process of riverine flooding and soil scarification to maintain an annual plant community. Early drawdown (i.e. prior to May) and disking is preferred to allow rainfall to irrigate fields and germinate moist soil plants. However, wet conditions usually preclude disking moist soil units until June or after. If a unit cannot be irrigated or re-flooded after mid- to late-season disking, dry conditions will tend to favor undesirable plants such as cocklebur. In some situations, it may be prudent to plant grain crops such as corn, milo, or millet by force account or via cooperative farming. A unit can be managed for shorebirds following disturbance if it is too late in the year to produce a successful moist soil or grain crop due to drought or when there are less than 60 days left in the growing season.

Environmental Consequences

Impacts on Affected Resource

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

Under this alternative, the amount of managed moist-soil or other natural habitat resources on the refuge that commonly use agricultural practices would likely decrease. This decrease would result in a substantial reduction in food for waterfowl and other wildlife and prevent the refuge from meeting certain objectives. For example, intense management of floodable row crop fields, moist-soil, and other seasonal emergent wetlands have increased on the refuge from 2012 to 2022, concurrent with the phase out of genetically modified crop use. However, as weed pressures continue to mount, this trend of increased management may reverse. If crop failures consistently occur and if cooperators cannot maintain profitability, or if the refuge cannot retain or recruit adequate cooperators, there is potential for these areas to become less intensively managed, produce less wildlife foods, or succeed to climax plant communities.

The negative economic impacts of farming with non-GMCs in combination with poor outcomes is not a sustainable path currently, given the threats and concerns outlined in this document and the difficulties faced by management and cooperative farmers. Research indicates a potential 21% reduction in crop yield associated with non-GMCs (Klumper and Qaim, 2014). Under this alternative, a decline in crop yields along with increased input costs will likely result in a decline in cropland acres and an increase in natural habitat resources with lower food densities on the refuge. Due to the difference in energy between agricultural and natural habitat resources, this alternative will likely result in substantially reduced energy supply for waterfowl and certain other wildlife. However, some wildlife species may realize localized benefits of failing croplands converting to native habitats. Although they should never completely replace natural foods, grain crops are essential if the refuge is to contribute to meeting the stepped-down waterfowl objectives of refuge plans and the North American Waterfowl Plan (NAWMP) and associated goals.

The refuge committed to providing 6.4 million use days for Canada geese in the 2007 CCP. However, that was modified in the 2018 Environmental Assessment where "waterbirds" replaced "Canada geese". The draft habitat management plan (in preparation) indicates that the refuge could provide habitat and food resources to support approximately 6.1 million duck energy days for dabbling ducks and approximately 2.8 million duck energy days for diving ducks. The Upper Mississippi Great Lakes Region Joint Venture (UMGLJV) includes Illinois and was the first joint venture to establish a migration habitat objective that was biologically based. The refuge contributes to the joint venture objective of providing 216,000 hectares of migration habitat capable of supporting 266 million duck use days during the fall migration (UMRGL JV MB 2007).

The 2012 NAWMP recognized the UMGLJV's importance to waterfowl. This Joint Venture refined its approach to meeting NAWMP goals in 2017 (Soulliere et al. 2017) and identified a restoration target of 18,136 hectares of emergent habitat primarily for dabbling ducks and 97,132 hectares target for unconsolidated open water habitats for diving ducks. The 2017 update did not include habitat objectives for geese. All UMGLJV migration habitat objectives are based on energetic demands of nonbreeding waterfowl populations. High energy habitats provided by moist-soil vegetation and flooded crops can make a disproportionate contribution to the energetic demand of both geese and dabbling ducks. For example, emergent habitats in the UMGLV planning approach are equivalent to 2,575 mallard energy days per acre; in 2021, moist-soil seed production estimates from Crab Orchard Lake estimated 4,357 mallard energy-days per acre. The refuge's draft HMP estimates 37,022 mallard energy-days in unharvested flooded corn.

Alternative B: Use of Genetically Modified Crops (Proposed Alternative) as part of an Integrated Pest Management Approach

Genetically modified crop use could result in higher yields and require less agricultural land to meet duck energy day objectives. When using GMCs, the productivity of agriculture allows for fewer acres of cropland to produce food for wildlife. Economic factors associated with the use of non-GMCs, such as additional input costs and declines in crop yields due to pest species, would not be issues under this alternative. Genetically modified crop use has been associated with decreased pesticide use by over 37%, increased crop yields by over 20%, and increased farmer profits by over 68% (Klumper and Qaim, 2014). A plethora of studies in recent years have indicated that the adoption of GMCs dramatically reduces pesticide use, increases yields, provides overall cost savings, and increases revenues (Paul et. al 2018; Khan et al 2021). Brookes and Barfoot (2020) found that for every dollar spent on genetically modified seeds above the cost of conventional seed, farmers gain an average of $3.75 in extra income. These positive effects of using GMCs could reduce the amount of land needed for agricultural crops to supplement wildlife food sources, while reducing pesticide use and increasing revenues to cooperators and the refuge. This may permit management of additional acres that are currently farmed to provide natural habitats and produce native food resources beneficial to many species of wildlife. Increased revenues may provide additional funding that can be used to further improve the agricultural and habitat management programs at the refuge.

The use of GMCs (e.g., glyphosate/glufosinate tolerant corn and soybeans) has enabled farmers to control invasive weed species that were once targeted by Atrazine with less persistent chemicals. The refuge uses agriculture as a management strategy to control invasive plants and set back plant succession in the management of moist-soil wetlands as authorized by the 2018 Farm Program Environmental Assessment (USFWS 2019). For example, the refuge seeks to employ agriculture to control phragmites, which is an aggressive and difficult to control exotic plant. One strategy to control phragmites is by permitting a farmer to plant a unit that has been invaded by the plant so agricultural herbicides can be used. The refuge has a history of utilizing agriculture in periodic rotation with moist-soil vegetation as a tool to set back plant succession, treat invasive plants, and improve moist-soil seed production in subsequent years. In both of the instances where agriculture is used as a management tool, GMCs would greatly increase the likelihood of success because soils of impoundments typically dry later in the year delaying agriculture planting. Insect and weed pressure are greater on late-planted crops (e.g., June-July), which can eliminate the viability of non-genetically modified crop varieties for use in cooperative farming partnerships. Moreover, European corn borers (*Ostrinia nubilalis*) are a threat for conventional seed varieties but can be readily controlled using GMCs.

Effects on Adjacent Private Lands

Description of Relevant Environmental Trends and Planned Actions

Impacts to adjacent private lands are analyzed including the potential for the refuge to remain a pest reservoir and a vector for herbicide resistant weed dispersion. Increased crop depredation by wildlife on private lands resulting from reduced agricultural production on-refuge is also analyzed. Since the phase out of GMCs, agricultural practices have evolved and increased in complexity on the refuge and the refuge has implemented a wide range of best management practices yet decreased production has been a consistent result.

Lands outside of the refuge consist of a mix of adjacent residential, commercial, municipal, agricultural, and conservation lands. The refuge's agricultural acreage is confined to the northern half of the refuge, north of Grassy Road. In this section of the refuge, approximately 15% of adjacent lands are agricultural lands that abut refuge agricultural fields. In some instances, the refuge's conventional crops are immediately bordered by private crop fields with no buffers between crops. In other instances, refuge crop fields border private forest or grassland habitats.

Environmental Consequences

Impacts on Affected Resource

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

Crab Orchard National Wildlife Refuge is surrounded by similar topography and land use practices as occur on the refuge. The landscape is dominated by farm fields with wooded edges. Less than 10% of the 44,000 acres of the refuge are in the row crop program. There are over 100,000 farm acres in Williamson County, the county surrounding most of the refuge, and most farming surrounding the refuge employs the use of GMCs. GMCs will likely continue to increase in use on these adjacent private lands, therefore, any potential impacts to wildlife and water resources are likely not prevented by their non-use on the refuge.

Under this alternative, there would be no direct effects on adjacent farming operations from non-GMCs used on the refuge. The indirect effects of using non-GMCs on the refuge have resulted in the refuge becoming a reservoir and vector for agricultural pests, especially multi-modal herbicide resistant weeds such as palmer's amaranth. Increased abundance and dispersion of such species in the local area may have spread from refuge fields, from transport off-refuge by wildlife, by refuge cooperators and their equipment, and by visitors (especially hunters) traversing through infested areas. Although quantitative data has not been collected regarding these weed species, visual inspections, anecdotal evidence, and grain elevator dockage indicates that their prevalence is increasing at exponential rates. Additionally, reduced agricultural production on the refuge may lead to increasing occurrences of crop depredation by wildlife going beyond refuge boundaries to feed.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

Effects from genetically modified crop use on the refuge, compared to traditional, non-organic farming operations on- and off-refuge, potentially include insect resistance and suppressed regional insect pest populations (halo effect).

Given the widespread use of genetically modified corn and soybeans immediately adjacent to most refuge fields, the likelihood that GMCs used on-refuge affecting non-GMCs on adjacent private lands is extremely low. Organic farming operations, as described by the United States Department of Agriculture's National Organic Program, are required to have distinct, defined boundaries and buffer zones to prevent unintended contact with excluded methods from adjoining lands that are not under organic management. Organic production operations must also develop and maintain approved organic production system plans to achieve and document compliance with the National Organic Standards (USDA NOP 2011). The likelihood of genetically modified crop agricultural practices on-refuge impacting surrounding organic farmers is extremely low, especially considering that no organic farmers are known in the local vicinity.

Weed Resistance

Description of Relevant Environmental Trends and Planned Actions

Resistance to herbicides is a concern in agricultural practices. Impacts to weed resistance under each alternative are analyzed, including impacts to trends in resistance and best management practices. Soybean crops at Crab Orchard National Wildlife Refuge are the crops impacted most severely by multimodal herbicide resistant Palmer amaranth, horseweed, waterhemps, and other pigweeds. Several other species are suspected of being resistant including Johnson grass, common lambsquarters, giant foxtail, and morning glory. Fields have been observed in recent years with 100% infestation rates and the problem is widespread, with infested fields occurring within several fields in nearly every farm unit. These weeds reduce production, yields, and revenues and result in severe dockage at grain elevators when cooperators sell their soybeans. Additionally, these weeds create severe problems at harvest when they clog harvesting equipment. These weeds do not respond to the "normal" suite of chemicals and tend to persist and expand once introduced into a given field. Currently, only one approved chemical, Fierce, seems to work well at suppressing and treating these weeds in infested fields. Additional chemicals with different modes of action are needed to address the concerns. However, the shallow depth to water table in refuge fields precludes the use and approval of many of the chemicals that could potentially alleviate the concern. Currently, soybean fields are cover cropped and allowed to “rest” for one year. These fields can be harvested by cooperators for hay in the following summer after the soybean crops. Often the practice of resting these fields leads to intense production of solid stands of herbicide resistant weeds that prevent their use for hay.

Environmental Consequences

Impacts on Affected Resource

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

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

One specific weed, Palmer amaranth, which has been found to have resistance to multiple herbicides of different chemistries and modes of action, has quickly become one of the most troublesome weeds in row crops in the United States (Chahal 2017) and at the refuge. Farmers on the refuge are struggling with multiple herbicide-resistant Palmer amaranth with populations occurring on all farm units. Increasingly, in order to control weed species such as Palmer amaranth that have become, or are more resistant to herbicides, it is necessary to utilize various herbicides with multiple modes of action and usually in combination with tillage. Weed resistance is likely to continue and increase in severity under this alternative due to the limited suite of effective herbicides currently available.

In the effort to increase the diversity of chemicals and herbicide modes of action, the refuge proposed and sought regional and national office approvals for a wide variety of chemicals in 2022. Several chemicals proposed for use were denied based on their potential for environmental harm. Although some of the chemicals were approved for use on the refuge, their label restrictions prevent their use across most of the refuge. In the spring of 2022, the refuge conducted an investigation of depth to water table and over 73% of refuge fields were found to have depths of less than 10 feet to subsurface water. Additionally, the Natural Resource Conservation Service Soil Survey Mapper (Soil Survey Staff 2021) shows 95% of the row crop fields on the refuge have a water table depth of 0.49 to 2.99 feet. These data conclusively preclude use of most of the additional chemicals approved for use in 2022 except in very limited field locations.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

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

The risk of further evolution of herbicide resistant weeds can be managed by rotating crops, implementing weed management strategies (USDA-APHIS 2000, Jones 2011), and incorporating herbicide tolerant crops as part of an overall integrated weed management strategy (Mortensen et al. 2012). Under this alternative, the refuge would implement a rotational regiment with GMCs and conventional farming to maximize weed management. Additionally, the refuge will require different GMCs be planted in rotation with Roundup-Ready varieties no less frequently than every other year. An example crop rotation may be to use glyphosate resistant corn in year one, glufosinate resistant beans in year two, winter wheat in year three, and a conventional corn crop in year four, followed by glyphosate resistant soybeans in year five. Crop rotation results in the use of different pest control strategies, herbicide chemistries, and herbicide modes of action, that slow the evolution of resistance consistent with the Service's Integrated Pest Management policy (569 FW 1). Accordingly, this alternative would be beneficial in addressing weed resistance issues. Yields would likely increase, multimodal herbicide resistant weeds are expected to decrease in distribution and prevalence, and the refuge would reduce its potential to remain as a vector for dispersal of those weed seeds throughout the local area.

Wildlife

Description of Relevant Environmental Trends and Planned Actions
Agricultural units are Priority I habitats due to a mandated purpose in the establishing legislation of Crab Orchard National Wildlife Refuge. The challenge is to balance the needs of producers (i.e. profit), with the needs of wildlife and their habitats in a sustainable way. One result of agriculture is increased diversity of grasslands, their types and structure, across approximately 20,000 acres of the refuge. The diverse grasslands are managed for their inherent ecological integrity and diversity, to benefit grassland-dependent wildlife, such as Henslow's sparrows, northern bobwhite, grasshopper sparrows, dickcissels, eastern meadowlarks, and monarch butterflies and to protect endemic species.

The refuge gives greater emphasis to resilience and adaptive capacity rather than seeking to maximize efficiency of agricultural production. Spatial and temporal variability is favored above homogeneity to ensure long-term sustainability and resilience of the ecosystem (Holling and Meffe 1996; Walker and Salt 2006). The use of wildlife-friendly farming, such as cover cropping, leaving crops unharvested, no-till, conservation tillage, and low-tillage farming, can benefit resident, migratory, and game species when compared to conventional farming (Koford and Best 1996). Fallow fields and planted cover crops provide habitat for grassland birds, pollinators, deer, rabbits, turkeys, and many other species. Even fields of introduced cool-season grasses and grass-legume mixtures, such as fescue-clover, are considered important for some non-game, grassland specialist bird species like grasshopper sparrows and eastern meadowlarks (Herkert et al. 1996; Scott and Lima 2004).

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

For over a century, the National Wildlife Refuge System used agriculture to supplement the losses of wetland habitats. Most refuges have returned to primarily native vegetation to provide wildlife foods that provide broader ecological and wildlife benefits with fewer inputs. However, the use of agricultural crops to benefit waterfowl has been well documented in the scientific literature (Bellrose 1980; Baldassarre and Bolen 1984; Delnicki and Reinecke 1986; Ringelman 1990; Combs and Fredrickson 1996; Heitmeyer 2006) and have their place in wildlife management especially where it may be difficult to restore native vegetation. Floodable row crop fields and upland fields surrounding wetlands have contributed significantly to the past successes of goose and waterfowl management at Crab Orchard National Wildlife Refuge. Agricultural crops sometimes produce greater amounts of seed per unit area than natural wetland plants (Kross et al. 2008; Foster et al. 2010) resulting in less land needed to replace the habitat losses that have occurred. Foods that are high in carbohydrates, such as corn, rice, soybean, millet, and milo, can provide the energy needed for ducks wintering on the refuge so that they arrive on the breeding grounds in good condition (Ringelman 1990; Checkett et al. 2002; Kaminski et al. 2003). In the fall at least 100 acres of unharvested corn, milo, or other crops, will be retained in traditional waterfowl use areas that are within a largely open landscape adjacent to wetlands, along the refuge's Wildlife Drive, or in other high priority public use areas.

Environmental Consequences

Migratory and Resident Waterfowl

Effects on Waterfowl and Waterfowl Habitat Objectives

One of the primary reasons that Crab Orchard National Wildlife Refuge was established was to support migratory waterfowl, specifically Canada geese (*Branta canadensis*). Initially, the intended beneficiaries of agricultural practices on the refuge were migrating Canada geese. Now, it is widely recognized that supplementary, planted foods can be valuable for a wide variety of waterfowl and other game and nongame species (Donalty et al. 2003) depending on the availability of native foods in the area. The refuge also uses agricultural practices in a wide variety of natural resource management activities, such as for restoring native grasslands, managing moist-soil wetlands, and invasive species control.

Canada goose populations and migratory patterns have changed, and the refuge realized that agricultural strategies could also benefit ducks and other waterbirds. The CCP had acres of row crop, hay, and pasture identified as well as management techniques to restore and manage certain habitat types for waterfowl. Under the selected alternative in the 2018 Farm Program

Environmental Assessment, the CCP goal and objective for Canada geese is no longer used and the management emphasis is under the existing "Ducks, Shorebirds and other Waterbirds Goal and Agriculture Goal" from the CCP with some modified strategies (USFWS 2018). Providing food for large numbers of waterfowl is often accomplished by managing natural wetlands, impoundments, and cultivated areas to produce crops (Reinecke et al. 1989, Gray et al. 2013).

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

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

The ability to produce high-energy food sources to meet wildlife and waterfowl objectives will continue to be compromised. Lack of control and proliferation of invasive weeds will likely continue to lower habitat quality and make these areas difficult to recover or manage over the long term.

Agricultural practices, including crop production, provide an efficient and practical way to meet waterfowl objectives on a limited land base, control invasive species, and set back succession to benefit waterfowl and other wildlife (Gray et al. 2013). The refuge currently has waterfowl objectives in the CCP of providing approximately 6.4 million use days (USFWS 2007). Additional and more species-specific, duck energy day objectives were included in the final refuge Habitat Management plan. These current objectives, which were stepped down from the North American Waterfowl Management Plan, cannot be met using the current land base without viable agricultural practices and are jeopardized if the refuge is unable to recruit or retain cooperators.

The economic factors associated with the reduction in acres where agricultural practices were used for natural resource management include additional input costs associated with pest control for non-GMCs, decline in crop yields associated with increased weed and insect pest problems, dockage for presence of weed seeds in harvested crops, and limited availability of non-GMCs in a market focusing on genetically modified crop technology. These factors have already directly affected the refuge's ability to recruit cooperative farmers, develop partnerships, and to meet refuge objectives.

The phase out of genetically modified crop use on refuges has also made it increasingly difficult to recruit and maintain cooperative farming partnerships (Wood and Skaggs, personal communication). These partnerships produce agricultural foods for waterfowl and other wildlife on the refuge. Allowing professional farmers to conduct agricultural production on refuges is efficient and practical; however, deviations from farming practices used on private lands reduce the likelihood of attracting and maintaining farmers in cooperative farming partnerships with the refuge, especially if cooperator profits are reduced.

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

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

As presented in Alternative A, the refuge has specific waterfowl objectives for energy day provisions. Genetically modified crop use on the refuge would protect or restore viable cooperative farming partnerships, instill confidence in current and potential cooperators, and facilitate meeting waterfowl objectives. Genetically modified crop use through an IPM approach, in combination with managed natural habitat resources (e.g., marshes, moist soil) provide the best option for the refuge to meet its current waterfowl habitat objectives.

The number and quantity of insecticides used for production of non-GMCs varieties is greater than that needed for GMCs (Klumper and Qaim 2014). GMCs can also produce yields on average of 22% more than non-GMCs varieties (Klumper and Qaim 2014), especially in areas with pest problems or other production challenges. For example, genetically modified crop use could result in disproportionately greater benefits in fields where conditions often include later planting dates in bottomland settings, reduced pesticide use, poor soil quality, and high soil moisture. The entirety of the row crop program exists within Williamson County, Illinois, which has some of the poorest soils in the entire state of Illinois. (USFWS 2018). Poor soil quality can lead to increased prevalence of undesirable and invasive species. Because some refuge fields occur on low-lying areas with diverse ecological functions, including floodwater retention and provision of habitat to spring-and summer-breeding species, conditions for agricultural practices are often less optimal than on nearby private lands. Thus, genetically modified crop use on the refuge is disproportionately important for successful agricultural production and providing increased high-energy food production for waterfowl.

Effects on Waterfowl from Ingesting Genetically modified crops

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

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

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

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

There are no published studies comparing waterfowl use of GMCs to non-GMCs notwithstanding that waterfowl readily feed on both crops (USFWS 2020). Studies of nutritional content and toxicological profiles indicate that GMCs are equivalent to non-GMCs on domestic livestock, including poultry (Aumaitre et al. 2002, Flachowsky et al. 2007). Published data on acute toxicity or other direct effects of consumption of GMCs or associated *Bt* residue on birds and other wildlife indicated "no hazard." (Mendelsohn et al. 2003, USEPA 2001).

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

Other Birds

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

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

As is the case for waterfowl, there have been no documented negative effects on other birds due to the consumption of non-GMCs or their residue (USFWS 2020). However, extensive data are available on the adverse effects of commercial insecticides on migratory birds (Parsons et al. 2010, Mineau and Palmer 2013). Non-GMC crops sometimes require more use of insecticides.

Increased use of conventional tillage associated with non-GMCs on the refuge will result in more soil disturbance, erosion, and removal of residual cover. This, in turn, decreases the amount of cover and food availability to insectivorous birds. The refuge manages forests and grasslands for migratory landbirds. The reduced yield potential of non-GMCs could negatively affect the amount of natural habitat, such as moist soil and grasslands, occurring on the refuge. When yields per unit area decrease (Brookes and Barfoot 2013), the amount of farmland needed for the refuge to meet wildlife objectives may increase. Reduction in the refuge's shares to mitigate the reduced profitability of non-GMCs farming could require the refuge to increase the amount of farmland needed to meet wildlife objectives.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

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

Some evidence suggests that no-till and conservation tillage, which is promoted for genetically modified crop use, could provide a better habitat resource for birds than conventional tillage (Holland 2004), and crop residue provides nesting and foraging substrate (Field et al. 2007). No-till and conservation tillage systems would promote earthworm populations (House and Parmelee 1985) and enhance nocturnal wintering habitat for American woodcock (Berdeen and Krementz 1998).

Mammals

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

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

As is the case for waterfowl, there has been no documentation of negative direct effects on mammals due to the consumption of non-GMCs or their residue (Aumaitre et al. 2002, Flachowsky et al. 2007). Conventional tillage, which is most associated with non-GMCs, will decrease residual cover and potential habitat and cover for small mammals and the insects upon which they prey upon. The use of non-GMCs rather than GMCs poses more overall risk to wildlife on refuge due to the increase in the variety, amount, and toxicity of the pesticides (Klumper and Qaim 2014; Figures 2 and 3). This increased risk exists despite refuges' following EPA label restrictions, Regional and refuge best management practices, Service policies, and agricultural practices guidance in an effort to avoid negative effects to wildlife.

The refuge provides habitats for a large mammal species, white-tailed deer, which reduces crop depredation on private property. The reduction in crop yields, refuge shares, or overall reduction in agricultural practices on refuge due to lack of cooperator interest and profitability could cause mammals to relocate to private properties and increased conflicts with humans. For example, if cooperative row cropping were to end because of the continued prohibition on the use of GMCs, increased input costs, decreased yields and cooperator revenues, and an increase prevalence of multimodal herbicide resistant weeds (a trend the Service is observing), the refuge would be unable to do force account farming on the same scale and the amount of area farmed would be reduced. As a consequence, white-tailed deer and other mammals would likely relocate to adjacent farmland and/or communities to find resources. Depredation pressure and nuisance animal presence would increase in the surrounding community and lands.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

The use of GMCs has direct and indirect conservation advantages for mammals. There have been no documented negative direct effects on mammals from consumption of GMCs or their residue.

The high-energy crops left for wildlife on refuges provide an important food source for species such as deer, raccoons, and other mammal species. The use of GMCs also allows refuges to provide consistent sources of food for these species. Extensive research into potential effects of herbicide tolerant crops on livestock has failed to uncover any adverse effects or differences between transformed and conventional feeds (Aumaitre et al. 2002, Flachowsky et al. 2007). At least one study suggests that agronomic systems using genetically modified soybeans are preferable to conventional crop systems from the standpoint of mammalian toxicity because some of the herbicides used in conjunction with GMCs are less toxic than those used with non-GMCs (Nelson and Bullock 2003). The Service and the refuge were able to apply lesser amounts of, and more benign, pesticides to manage genetically modified crop systems (Figures 2 and 3) prior to the 2012 planting season. The increased crop residue from no-till and conservation tillage can provide habitat for insects and other arthropods, which increases prey for mammalian insect predators (USDAAPHIS 2013a).

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

Amphibians and Reptiles

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

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

The individual effects to amphibians and reptiles from non-GMCs include increases in conventional tillage, use and variety of agricultural chemicals, especially the more toxic chemicals needed in conventional crop systems. Conventional tillage decreases residual cover that serves as potential habitat and cover for amphibians, reptiles, and insect prey. Under this alternative, indirect adverse effects to amphibians and reptiles can be expected with the increased use of tillage to suppress weeds and through increased soil erosion. Similarly, if chemical inputs change with non-GMCs use, there could be other impacts on wildlife. The particular mix of weed management tactics selected by a farmer would be dependent upon many important factors, including landscape context, the problem weed type, and agronomic and socioeconomic factors (Beckie 2006). Since the switch to non-GMCs in 2013, an increased need to use more toxic and more restricted use pesticides has been observed and quantified (USFWS Pesticide Use Proposal Database 2018; Figures 2 and 3). As discussed above, tillage that is more intensive can reduce wildlife habitat, contribute to increased sedimentation, and transport of pollutants in runoff to nearby surface waters affecting water quality and negatively affecting amphibians and reptiles.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

The use of GMCs will not have a direct effect on reptiles and amphibians. Prior to 2013 when non-genetically modified crop use was the only option available, the Service and the refuge used more benign and lesser amounts of chemicals on refuges with less likely impacts on reptiles and amphibians (Figures 2 and 3). No-till and conservation tillage will increase residual cover, which will increase potential habitat for amphibians, reptiles, and insect prey. Fewer agricultural inputs in the form of pesticide applications and less frequent mechanical disturbance also could decrease possible negative effects on these populations. The EPA has discounted the possibility that Bt toxins could bioaccumulate because the toxins are proteins that are subject to metabolic decomposition (USEPA 2001).

Insects

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

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

Under this alternative, there could be an increase in the use of synthetic insecticides that could have negative effects on non-target insect species given the toxicity and required amounts of the chemicals. The widespread use of insecticides can affect target and nontarget insects. Beneficial insect species are more likely to be impacted by the use of broad-spectrum insecticides where non-Bt inserted crops are planted. These impacts are likely short term and localized considering that less than 10% of refuge lands consist of row crop fields. Non-target insects have the potential to be affected by broad application of insecticides. This could potentially impact pollination services and food source availability to other wildlife such as birds, shrews, and other insect eating wildlife.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

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

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

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

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

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

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

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

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

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

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

Regardless of the debate regarding the role of glyphosate in supporting milkweed and other larval food plants for butterflies, the refuge requires 25 to 250-foot spray buffers from roads, ditches, and surface water, and requires other vegetated filter borders in and around crop fields to mitigate problems there may be with herbicide use.

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

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

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

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

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

Aquatic Species

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

The greatest impacts to aquatic species would occur from runoff of sediments and pesticides into nearby surface and subsurface waters. To reduce potential impacts to amphibians, reptiles and other aquatic animals, the refuge has implemented a mandatory 25 to 250-foot spray buffer to surface water depending on the chemical used. This is detailed in the best management practices. The Region 3 buffer requirements are beyond the requirements on EPA labels for each chemical application and has been adopted as a best management practice. EPA label instructions allow many chemicals to be sprayed to the water's edge.

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

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

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

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

Under this alternative, the planting of GMCs should not have any direct negative effects on aquatic species, and potential indirect impacts should be less than associated with non-GMCs. The use of GMCs may increase the use of conservation and no-tillage practices eliminating extra plowing at the beginning and end of the growing season and partial tillage during the growing season. These activities would decrease the disturbance of the soil and increase the amount of crop residue. Both have the potential to decrease soil erosion and benefit aquatic species.

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

Threatened and Endangered Species, and Other Special Status Species

Affected Environment

Description of Relevant General Features of the Affected Environment

Two federally listed endangered species, the Indiana bat and whooping crane, are known to occur on the refuge. In addition, the federally threatened northern long-eared bat, the proposed endangered tricolored bat, and the candidate species monarch butterfly occur on refuge. Whooping cranes are rare migratory visitors to the refuge with only two recent sightings. One pair stopping at the refuge in 2015 and three stopping in March 2022. Northern long-eared bats and Indiana bats roost under the peeling bark of dead and dying trees during the summer months and overwinter in large colonies in caves. Indiana bats eat a variety of flying insects and typically forage along rivers or lakes and in uplands, while northern long-eared bats primarily forage in the understory of forested areas. Even though the northern long-eared bat is listed as threatened, Section 4(d) of the Endangered Species Act directs the Service to issue regulations deemed "necessary and advisable to provide for the conservation of threatened species." It allows the Service to promulgate special rules for species listed as threatened (not endangered) that provide flexibility in implementing the Endangered Species Act. The tricolored bat likely utilizes forests and adjacent open areas for foraging on the refuge between spring and fall. Typically, the species roosts in dead leaves suspended in the canopies of deciduous trees, dead pine needles suspended in branches, in the bole of large pine trees, and within lichens suspended in tree canopies. Roosts may be found in man-made structures in summer months, including in caves, abandoned mines, old houses, sheds, barns, wells, road culverts, dams, etc. (Taylor et. al 2020). Foraging habitats consist of open areas adjacent to forested roost habitats, with abundant water. They feed along roads and watercourses, over lakes and ponds, and along transitional edges, forested corridors, and buffer strip areas (Taylor et. al 2020). The monarch butterfly (adult form) utilizes a variety of habitats and geographic areas to meet its life history requirements. On refuge, the grassland habitats and forest edges with flowering plants and milkweeds are utilized during the day, while they roost in various types of deciduous and coniferous trees at night. The non-adult life forms exclusively utilize milkweed. They are present on the refuge during the warmer months, from April to October.

Description of Relevant Environmental Trends and Planned Actions

Section 7(a)(2) of the Endangered Species Act requires that Federal agencies, in consultation with the Service and/or the National Marine Fisheries Service, ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. The refuge engaged in development of Section 7 documentation for the use of GMCs in agricultural practices on the refuge for all species except the tricolored bat which was recently proposed for listing as endangered. The refuge is currently in consultation regarding tricolored bats, and the process will be completed and considered in the Service's decision on this proposed action.

The Service's state and federal partners have developed management and recovery plans for each of the federal and state listed species found on the refuge. These plans provide land managers with guidance regarding conservation strategies that can be used in managing species and habitats. These plans establish regional population and habitat conservation objectives and provide estimates of the size and types of habitats required to increase and sustain wildlife populations at target levels. Species identified in these plans, and their associated objectives and strategies, were considered during evaluation specific to the refuge and in the development of the Habitat Management Plan objectives and strategies. refuge staff will continue to manage habitats on refuge for the benefit of threatened, endangered, and special status species. The refuge works to implement these plans to maintain and enhance grassland and forest habitats that benefit foraging, nesting, and roosting areas for Indiana bats, northern long-eared bats, tricolored bats, and monarchs.

Environmental Consequences

Impacts on Affected Resources

Alternative A

Under this alternative, whooping cranes, Indiana bats and northern long-eared bats would have no impacts to their reproduction, population numbers, or critical habitats.

Alternative B

Indiana bats likely forage over the wetlands in the row crop fields but will not be negatively impacted by the use of GMCs because adequate food will continue to be available across the refuge. Northern long-eared bats utilize the forest understory, which will not be impacted by the use of GMCs. Tricolored bats may benefit from the heterogeneous mosaic of forests, grasslands, and agricultural lands, and abundant associated lakes, ponds, and wetlands. Grassland and forest edge habitats utilized by monarch butterflies on the refuge will not be impacted by the use of GMCs. Increases in milkweeds could be expected; adult monarchs are known to lay their eggs only on milkweed plants. Whooping cranes are rare visitors to the refuge; they do not nest here and are not expected within the small ponds or lakes associated with most farm fields. Whooping cranes could utilize crop fields adjacent to larger managed wetlands feeding on waste grain.

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

Any potential effects on whooping cranes and Indiana Bat are consistent with those already outlined and covered in the environmental impact statement completed as part of the refuge comprehensive conservation plan (USFWS 2007) and the associated biological assessment and biological opinion (USFWS 2006, [Appendix J in the 2007 CCP]). These were completed during formal consultation in accordance with Section 7 of the Endangered Species Act of 1973. The plan, biological assessment, and biological opinion were all developed when the refuge was utilizing GMCs, prior to the phase out. It can be assumed, due to the similarities of habitat use between the species, that any potential effects on Indiana bat are also consistent with those on Tricolored bats.

In 2020, the United States Fish and Wildlife Service, Region 4, completed a programmatic environmental assessment for the use of GMCs on refuges in that region. Additionally, the Service's Refuge section and Ecological Services division engaged in Section 7 consultation on the proposed action with Ecological Services. They concluded, at that time, that the proposed action is not likely to adversely affect any threatened or endangered species or to adversely modify the designated critical habitat of a species and issued an Intra-Service Section 7 Biological Evaluation found in Appendix E of its Environmental Assessment.

Socioeconomic Resource Effects

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

Economic Role of non-genetically modified crops

Economic impacts to agriculture related industries are assessed, including impacts of costs related to pesticide use, fuel, labor, and resulting productivity of use of non-GMCs and genetically modified crop use associated with refuge agricultural practices. Impacts to cooperative farming agreements on the refuge are also assessed.

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

Although actual costs will vary across farm units and from farmer-to-farmer, additional costs of pesticides, fuel, and labor associated with non-GMCs could increase the costs per acre and or cost per bushel for these crops compared to those from genetically modified crop use. The University of Tennessee Agricultural Extension found that genetically modified crop seed was 25-43% higher in cost; however, non-GMCs pesticide costs were up to 90% greater depending on the pest issues. Machinery costs were up to 36% greater and labor costs were up to 71% greater when using non-GMCs rather than GMCs. Yield for non-genetically modified corn is up to 16% less than that of genetically modified corn across the Southeast thus reducing overall profits when production costs are included (USFWS 2020).

Comparing non-genetically modified soybean to genetically modified soybean crop budgets, the University of Tennessee Agricultural Extension found that seed costs were 23-48% less for non-GMCs but that chemical/weed control costs were up to 258% greater for non-GMCs, depending on pest issues. Total costs for non-genetically modified soybeans ranged from 9% lower to 7% higher than genetically modified soybeans. However, yields were up to 30% less with non-genetically modified soybeans again reducing the profit margin of non-GMCs compared to genetically modified crop varieties (USFWS 2020). Variations in input costs primarily result from differences in pest severity, which determines the amount of pesticide needed as well as machinery and labor costs.

Enhanced genetic traits (associated with Bt GMCs), which protect against pests like Southwestern and European corn borer, help to reduce the amount of insecticide applied on fields by controlling the pests before they become a problem. By increasing the need for insecticide use associated with non-GMCs, the need for additional application by large, specialized equipment will increase fuel and labor expenses. Aerial application is sometimes necessary to prevent loss of non-GMCs, generating public concern relative to adjoining crops. Under this alternative, more complex, selective, and expensive pesticides are needed to control pests. Prior to the use of non-GMCs, the refuge used approximately 18 different pesticides (active ingredients). With non-GMCs, more than 51 different pesticides (active ingredients) were proposed in 2021 (Figure 2). In addition, the amount of pesticide applied went from 4,179 pounds in 2010 (with the use of GMCs) to 7,130 pounds (with non-GMCs) in 2021 (Figure 3).

Use of agriculture on the refuge has been accompanied with an increase cost in pesticide application since 2013, due to using non-GMCs varieties. For example, the pesticide expenses for non-GMCs are estimated to be $100 to $200 more per acre due to the greater number of chemicals required, increased fuel consumption due to tillage, compared to use of genetically modified corn at the refuge. Additionally, yields are reduced when using non-genetically modified corn by at least 20 bushels per acre and by at least 10 bushels per acre for soybeans (Fosse personal communication). It is important to note that these are extremely conservative estimates.

Rising fuel prices and more frequent cultivation practices and application of pesticides would also increase the cost to cooperative farmers and the refuge. Recent communications with cooperators currently operating on Crab Orchard National Wildlife Refuge indicate that some are seriously contemplating whether it makes sense, economically, to continue cooperative farming on the refuge if the non-use of GMCs were maintained. Specific economic impacts that have occurred on the refuge include: 1) a substantial increase in the amount and costs of pesticides needed to control weeds, insects and diseases; 2) increased refuge personnel time to address the pest problems; 3) increased fuel costs associated with pesticide spray equipment and tillage operations; 4) lower crop yields due to pest issues and the limited selections of available seed varieties; 5) reduced revenues on harvested crops due to grain elevator dockage for herbicide resistant weed seed abundance in harvested products; 6) increased time and labor involved in securing outdated chemicals used in conventional row crop operations; 7) increased time and labor developing and testing methods to overcome all of the previously outline issues; and 8) increased time and labor to clean out harvest equipment due to the abundance of herbicide resistant weeds that clog machinery.

Lowered and more variable yields from non-GMCs may result in the refuge needing to farm more acres to meet waterfowl and habitat objectives in refuge plans. An additional consequence of decreases in cooperative farming partnerships due to negative economic factors associated with non-GMCs is losses to local economies. Cooperative farming partnerships provide inputs to local economies while helping the refuge meet its objectives and accomplish the agricultural and wildlife purposes for which it was established.

Reduced cooperator revenues can be expected for multiple reasons, including dockage from the presence of weed seeds in harvested grains, reduced yields, increased input costs due to more expensive herbicides applied at greater rates. Retention and/or recruitment of high quality, effective cooperators is unlikely over the long-term as profitability declines. There is a high likelihood of the program morphing into a subsidy farming operation or failing completely.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

The use of GMCs allows the refuge to sustain partnerships with local cooperative farmers, which in turn bolsters the local economy, provides an economically efficient means of natural resource management, and enables the refuge to accomplish a broad assortment of wildlife management objectives. Genetically modified crop use also gives cooperative farmers greater latitude in addressing pest issues in accordance with the Service's IPM Policy through reductions in chemical applications, labor and machinery costs, and carbon footprints. (USFWS 2020). GMCs also optimize crop yields, which increase and sustain the economic feasibility of cooperative farming.

Economic impacts are a particularly sensitive issue in that cooperative farming must be profitable to the cooperator. Restrictions on farming tools, such as the use of GMCs, discourage local farmers from entering cooperative agreements with refuges. Klumper and Qaim (2014) consolidated the evidence of the economic impacts of genetically modified crop use through a meta-analysis of 147 studies and found a reduction of pesticide cost by 39%, an increase in crop yields by 21%, and an increase in farmers' overall profits by 69% compared to non-GMCs.

Fernandez-Cornejo et al. (2014a) concluded that pesticides were a contributing factor to the substantial increase in the average corn yield of 20 bushels/acre in 1930 to more than 150 bushels/acre around 2014, demonstrating that, if left uncontrolled, crop pests result in lower yields. For example, in 2016, the Tennessee National Wildlife Refuge experienced a significant reduction in corn yield because of excessive pest problems. The 2016 average corn yield declined by 58% from the previous year. The effects of increasing weed pressure since 2013, along with weather conditions that were favorable to insect and disease outbreaks, resulted in a devastated corn crop such that the refuge failed to meet its waterfowl foraging objectives. In a specific case, an entire cornfield was lost because of damage to developing ears of corn by fall armyworms (*Sopdoptera frugiperda*). This damage provided entry of a fungal disease, corn smut (*Ustilago maydis*), that resulted in a yield of 11 bushels/acre compared to 190 bushels/acre of corn in 2014 (USFWS 2020). Crab Orchard National Wildlife Refuge has experienced similar situations, although not quantified, nor near the magnitude of that experienced at Tennessee National Wildlife Refuge. Many genetically modified *Bt* corn varieties are resistant to fall armyworms and, if used, can prevent this type of loss. GMCs may not always increase yields, but they do have a greater potential of preventing yield losses from pests than do non-GMCs (Fernandez-Cornejo et al. 2014b).

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

The National Research Council (NRC 2010) reports the following indirect cost benefits from the use of GMCs: 1) increased use of no-till or conservation tillage practices that reduce the use of machinery and fuel by around 50% and labor costs by 40%; 2) decreased use of more costly and, in many cases, more toxic herbicides; and 3) reduced use of highly toxic insecticides due to use of insect resistant GMCs. The National Research Council cited one study (Rice 2004) that estimated a reduction of 5.5 million pounds of insecticide active ingredient per 10 million acres of Bt corn. These indirect cost benefits offset increased seed costs and make the use of most genetically modified products profitable (National Research Council 2010).

Visitor Use and Experience

Crab Orchard National Wildlife Refuge also has a legislated recreation purpose and receives about one million visitors per year for a variety of outdoor activities. Occurrence of concentrated populations of waterfowl and other wildlife species on the refuge makes it a popular destination for wildlife dependent recreation enthusiasts. Bird watching, photography, kayaking, canoeing and wildlife observation are a few activities common on the refuge. The refuge is also a popular destination for hunters and fishers. The growing recreational industry also generates income for local economies near the refuge. Some portions of the refuge are closed to public use due to the needs of industrial tenants, contaminated sites, or physical hazards. Crop fields are spread throughout the northern 20,000-acre former Illinois ordnance plant. This area is also the location of the majority of public use areas. Many crop fields are immediately adjacent to high use public areas such as trails, roads used for biking and running, hunting areas, fishing ponds or lakes, and the auto tour. Pesticide use can directly affect the availability of these locations during applications and during the restricted- entry intervals. Restricted-entry intervals are the time immediately after a pesticide application when entry into the treated area is restricted per federal law as outlined within each pesticide product's label.

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

The volume and variety of herbicides applied on refuge will continue to increase in an attempt to control herbicide resistant weeds and other invasive plants that are expected to expand under this alternative. The refuge will continue to evaluate the use of pesticides that have a greater potential to harm wildlife, impact surface and subsurface waters, and pose a greater risk to the public, refuge staff, contractors, tenants, and agricultural cooperators. Decreased access and availability to agricultural fields and access routes can be expected for the public, hunters, fishers, contractors, tenants, and staff due to increased reentry intervals from pesticide applications The refuge uses agricultural practices and other habitat management activities to meet specific agricultural and wildlife objectives that are warranted due to the legislated purposes of agriculture, industry, recreation, and wildlife that is unique to Crab Orchard National Wildlife Refuge. The refuge sustains waterfowl for nearly the entire fall migratory and wintering period. With the loss of millions of acres of wetlands, agricultural practices have become essential to provide much needed food resources for millions of waterfowl across the flyway. Non-genetically modified crop use has great potential to reduce the refuge's abilities to sustain wintering waterfowl populations that support migratory bird-related recreation, and the refuge's CCP, draft Habitat Management Plan, and the North American Waterfowl Management Plan goals and objectives.

If agriculture practices are reduced in scale or eliminated due to challenges associated with using only non-GMCs, the refuge may host fewer waterfowl and diminish migratory bird-related recreational opportunities both within and outside of the refuge. These opportunities may also decrease on nearby public and privately owned lands as locally wintering waterfowl numbers decline. Decreasing wintering waterfowl numbers and migratory bird-related recreation opportunities may substantially affect local economies and the southern Illinois region as refuge visitation and visitation-related spending decline. Additionally, if agricultural practices cease on any given tract, invasive species are almost certain to proliferate. This was observed when fields, five acres or smaller, were removed from production in 2013. Most of the fields that were removed from the program experienced rapid succession to shrubland or forest with strong invasive species components present. Bradford pear quickly took over one field, and autumn olive is present and abundant in several other fields. Recreational users are impacted by dominant stands of invasive species, and in particular, autumn olive makes it extremely difficult to walk much less take part in recreational activities such as hunting or wildlife observation.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

The volume and variety of herbicides applied on refuge is expected to decrease overall. The refuge could reduce the use of pesticides that have a greater potential to harm wildlife, impact surface and subsurface waters, and pose a greater risk to the public, refuge staff, contractors, tenants, and agricultural cooperators. Increased access and availability to agricultural fields and access routes can be expected for the public, hunters, fishers, contractors, tenants, and staff due to decreased reentry intervals from pesticide applications.

Genetically modified crop use enhances the ability of refuges to sustain wintering waterfowl populations and support migratory bird-related recreation. The refuge will remain a destination for hunters, wildlife observers, and wildlife photographers due to its relatively large concentrations of waterfowl. Spending associated with these recreational visits will benefit local economies and the southern Illinois region. The refuge hosts approximately 1.2 million visitors annually, who participated in a wide variety of recreational activities including hunting, fishing, wildlife observation, photography, environmental interpretation and education. On average, National Wildlife Refuges return $4.87 to local economies for every $1 Congress provides in federal funding (USFWS 2015).

Waterfowl are vital to the communities, hunters, and economy in areas surrounding the refuge and throughout the Mississippi Flyway. The refuge exists within the heart of the flyway. The refuge offers several birding and hunting events annually for visitors to view, hunt, and learn about waterfowl and other migratory and resident birds. The events depend on the presence and abundance of birds and waterfowl and attract visitors and hunters from outside the local area who spend money on food, lodging, gas and other items during their visits.

Socioeconomics

Affected Environment
Description of Relevant General Features of the Affected Environment

Local and regional economies
Located west of Marion, Illinois, on the northern edge of the Ozark foothills, the refuge is one of the largest refuges in the Service's Midwest Region at 45,446 acres. The refuge is unique in having an industrial program that generates $40 million annually to the local economy. Additionally, the refuge is an attraction for anglers, hunters, campers, boaters, bird watchers and other outdoor enthusiasts. Recreation results in large expenditures for both travel-related goods and services and activity-related equipment purchases. Refuge hunting opportunities provide benefits to the local economy through the sales of food, gas, supplies, or lodging. According to research on economic effects, hunting on the refuge resulted in $684,000 in hunting expenditures for both travel-related goods and services and activity related equipment purchases (USFWS 2019b). Furthermore, the row crop program on refuge provided 5.29% of the available row crop acreage for Williamson County in 2017 (USDA 2017). This generated approximately $1,301,391.17 annually to the local economy. Annual rent payments from row crop cooperators totaled $186,410.39 in 2021.

Employment
In 2019, there were 24,460 full- and part-time jobs in Williamson County (US Census Bureau 2019). Healthcare, retail trade and educational services occupations accounted for about 43.2% of the jobs across the area followed by food serving and law enforcement occupations (10.4%) (U.S. Census Bureau 2010).

Income and Education

Williamson County has slightly decreased in population size by just under 1% since 2010. In 2021, the median household income in Williamson County was $50,734, an increase of $4,832 since the 2016 census. The percent of population below the federal poverty line is an indicator of the economic distress within a community. The percent below the poverty line in Williamson County, 13.9%, is down one percent since 2016, and below the national average of 14.0%.
In 2021 in Williamson County, approximately 92% of residents over the age of twenty-five were high school graduates and 24.3% have earned a bachelor's or advanced degree. These figures were both slight increases since the 2016 census (2019 U.S. Census Bureau).

Description of Relevant Environmental Trends and Planned Actions

Spending associated with recreation can generate a substantial amount of economic activity in local and regional economies. Refuge visitors spend money on a wide variety of goods and services. Trip-related expenditures may include expenses for food, lodging, and transportation. Anglers, hunters, boaters, and wildlife watchers also buy equipment and supplies for their particular activity. Because this spending directly affects towns and communities where these purchases are made, recreational visitation can have a major impact on local economies, especially in small towns and rural areas. These direct expenditures are only part of the total picture, however. Businesses and industries that supply the local retailers where the purchases are made also benefit from recreation spending. Each dollar of local retail expenditures can affect a variety of businesses at the local, regional, and national level. Consequently, increases or decreases in availability of recreational uses and associated consumer spending can have a major impact on economic activity, employment, household earnings and local, state, and Federal tax revenue. A study was conducted in 2017 to evaluate the economic contribution of Crab Orchard National Wildlife Refuge to the local economy (USFWS 2019b). Based on that study, recreational spending in local communities was associated with about 315 jobs, $8.37 million in employment income, $2.3 million in tax revenue, and $29.2 million in economic output. In 2007, the economic value of crops produced on the refuge was more than ten percent of the total economic value of all Williamson County crops. For commercial and industrial space, the refuge accounts for just over one percent of industrial/ commercial site acreage in the Greater Marion area (USFWS 2007).

Impacts on Affected Resources
Description of Affected Resource

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

The annual value the refuge receives from the row crop program is outlined in Table 3. Over the past five years, the refuge has received an estimated value of $1,321,254.21. This has been adequate to maintain the program from a refuge standpoint, however, current economic trends show an increase in value for fertilizer, herbicide, and seed cost that is concerning long-term for the profitability for cooperators farming non-GMCs. The outcome of only allowing non-GMCs on refuge is likely to lead to subsidy farming with the knowledge that this is not sustainable or profitable for the farmer. Eventually, the cost will make farming at Crab Orchard National Wildlife Refuge an unprofitable endeavor for our cooperators, thus not fulfilling our purpose to maintain an agricultural program on the refuge.

For example, in 2022, total farming costs will be at an all-time high for farmers regardless of their farming methods. While it is well known that decreased yields are expected with non-GMCs, the concern of increased herbicide resistant weeds, docking charges for weed seed in farmer-harvested grain and changes in climate are resulting in more and more unpredictable economic outcomes for cooperators. For example, corn total direct costs from 2015 to predicted 2022 costs for fertilizers, pesticides, seeds, drying, storage, planting, etcetera has increased from

$378 to $479 per acre in Southern Illinois (University of Illinois 2022). For soybeans, this same cost has increased from $179 to $269 per acre. This cost increase is survivable for GMCs but will be difficult for conventional crop farmers to be profitable long-term if the same trends continue. Furthermore, the refuge would likely not be able to farm these areas without the assistance of a cooperative farm program; the overall cost and need for more employees would be too great to overcome if we transitioned away from a cooperative program.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

The refuge does not have an objective of profiting from row cropping but needs to balance revenue with the costs of running the program. Additionally, cooperators have an inherent need to produce a profit from their efforts. The refuge's row crop program is more likely to be cost effective, efficient, and sustainable in the near term and will better meet refuge purposes and objectives related to agriculture by incorporating an IPM approach that allows the use of GMCs (under the caveats outlined previously in this environmental assessment). Socioeconomic impacts under this alternative are expected to be highly beneficial because the cost to operate this program for the refuge and for the cooperators will be much less than under Alternative A and the revenues generated will likely be much greater than under current conditions for both parties. Increased bids on farm units should be expected as well as increased interest from a more diverse applicant pool. Furthermore, the in-kind services needed on the refuge landscape will be more sustainable with increased revenues. In-kind services reduce the refuge's cost and labor inputs for operation and maintenance of a sizable portion of the refuge. In addition, an increase in row crop opportunities afforded by the use of GMCs would lead to a substantially higher economic value to the local communities and the refuge than the refuge provides currently with the no action alternative.

Refuge Management and Operations

Affected Environment

Relevant Environmental Trends and Planned Actions

The costs of administering and enforcing the refuge's agriculture, fishing, hunting, visitor use, maintenance, and water management programs comes out of the refuge's annual budget. Expenses include program management (reviewing bids, issuing permits, etc.), staff resources, boundary posting, signage, facility maintenance, and other management activities. The refuge also has a cash bid process for each agricultural unit where in-kind services can be completed in lieu of cash payment. Maintenance and biology staff annually address infrastructure issues, road washouts, and levee repairs; however, the row crop cooperators provide in-kind services to address the majority of issues that arise annually. Approximately 40% of annual roadside mowing is conducted by cooperators and is priced into existing bids for each unit. Staff regularly deal with beaver dams and beaver control within streams or ponds affecting row crop fields. Compliance checks on cooperator operations, such as testing for presence of genetically modified traits in row crops, ensuring herbicide applications are approved and follow best management practices and other policies, and ensuring crops and cover crops are planted and harvested in accordance with established agreements all require substantial time and involvement from multiple staff members.

Annual testing of crop fields would continue in order to detect the presence of genetically modified traits to ensure compliance from cooperators. However, the difficulties of testing for their presence will likely continue to pose challenges to refuge staff as additional varieties enter the market. Enforcement will be difficult to manage as the diversity of genetically modified seeds outpace the refuge's capacity for testing. The challenge of defensible testing is likely to become exacerbated resulting from crosspollination, contaminated equipment (e.g. planters and other equipment), and accidental plantings.

Impacts on Affected Resources
Description of Affected Resource

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)
Using conventional crop varieties rather than GMCs requires a substantially greater amount of refuge staff time for pest scouting, pesticide applications, and other alternative pest-control practices, research of alternative pesticides, pesticide use proposals, pesticide use tracking, compliance testing for presence of genetically modified traits, and overseeing cooperative farmers. The refuge saw a substantial increase in staff time following the switch from GMCs to non-genetically modified crop varieties.

Under this alternative, refuge staff and cooperators will continue to deal with increased workloads associated with researching, developing, proposing, and approving alternative herbicide lists and associated best management practices. Increased buffers surrounding farm fields and water sources will be likely. Compliance checks testing for the presence of transgenic traits in cooperator fields will continue and the labor and costs associated are likely to continue on an upward trend. Compliance checks and monitoring the use of more environmentally toxic chemicals will also continue to increase workloads over time. As fields become unsuitable due to monotypic dominance of multimodal herbicide resistant weeds, refuge staff will be forced to develop alternative management regimes, possibly removing problematic fields from row crop production. Alternative field management may require restoration to native habitats, hay crops, clover fields, or other plant communities to eliminate weed issues. It may not be feasible to address all fields, and in the instance that cooperative farmers give up on row crop units due to lack of profitability from decreased yields, increased input costs, and herbicide resistant weed prevalence, it may become difficult or impossible to secure cooperative farming agreements on a given unit. The scale and magnitude of the row crop program at the refuge makes it unlikely that resources will be available to transition abandoned row crop units to suitable alternative crops or habitats and hundreds to thousands of acres could be overtaken by autumn olive and/or other invasive species due to lack of capacity for management.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

Under this alternative, it is expected that cooperative farmers will have increased incentive in the form of increased yields and profits, and decreased costs and inputs, to maintain the row crop program. Additionally, reduced staff time will be required to manage the program overall due to elimination of transgenic gene testing and reduced workloads associated with pesticide research and proposals. Reductions in buffer sizes on the farm units also translates into increased yields. Increased bids are likely which translates into increased refuge revenues; increased revenues allow greater ability to address infrastructure needs and overall program management. Additionally, increased revenues provide greater flexibility to address program needs through in-kind services. Compliance will likely be greater as cooperators have an increased incentive, which reduces management burdens. Reductions in the abundance and prevalence of herbicide resistant weeds is likely which reduces overall program planning, monitoring, and compliance issues.

Annual testing of crop fields would be discontinued for detecting the presence of genetically modified traits, reducing the staff time spent monitoring compliance from cooperators. Increased cooperator revenues can be expected for multiple reasons, including a reduction in dockage from the presence of weed seeds in harvested grains, dramatically increased yields, decreased input costs due to less expensive herbicides being applied at lower total volumes. Retention and/or recruitment of high quality, effective cooperators is likely as profitability increases. Increased candidate pools during the next bid cycle should be expected, as a greater number of potential cooperators are familiar and capable of farming GMCs versus conventional crops. There is a low likelihood of the program morphing into a subsidy farming operation. GMCs will likely increase the bid prices and overall revenue generated from the row crop operations for the refuge and because they can generate higher productivity on smaller acreages.

Cumulative Impacts

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

The GMCs proposed for use on refuges have been analyzed and deregulated through Animal and Plant Health Inspection Service and are currently used extensively on private lands and by state agencies on wildlife management areas. In conducting National Environmental Policy Act documentation, APHIS conducts a detailed nationwide analysis of the potential cumulative effects of deregulation of a specific genetically modified crop. The analysis includes such relevant factors as the long term and cumulative effects on physical, biological and socioeconomic resources among other factors analyzed. The most significant factor in evaluating the cumulative effects of future use of GMCs on the refuge is the widespread use of GMCs across the nation, including the southern Illinois. Based on United States Department of

Agriculture survey data, 94% of domestic soybean, 91% of cotton, and 90% of corn acres were genetically modified (herbicide tolerant) varieties in 2014 (USDA Economic Research Service 2018). Similarly, domestic *Bt* corn acreage was 82% in 2018, with 80% cultivated in stacked seeds with both HT and *Bt* traits (USDA Economic Research Service 2018).

The refuge's genetically modified crop guidance, included in the cooperative agreements and Special Use Permit special conditions, will limit the scope and effects of genetically modified crop use on refuge and surrounding lands and communities. The use of GMCs would increase the efficiency of agricultural and natural resources management and help staff meet the refuge and National Wildlife Refuge System purposes and objectives. Moreover, the specific use of GMCs on the refuge must be recommended by the refuge manager and approved by the National Wildlife Refuge System Regional Chief in accordance with Service policies. In particular, the refuge's genetically modified crop guidance will provide for crop types, crop rotation, and pesticide spray buffers that will avoid or minimize the potential negative effects of using GMCs the field and refuge wide (cumulative) level. The Service policies and genetically modified crop use would not affect or interact with local planning, communities, and landscapes.

Cumulative Impacts: Physical Resources

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

Cumulative Impacts: Biological Resources

The scale of genetically modified crop use on the refuge would be insignificant when considered as part of this Region as a whole. Of the 45,446 acres of refuge land, row crop agricultural practices are conducted on less than 3,899 acres (<8.58%) annually. In fact, genetically modified crop use on the refuge would not be applied broadly across all row crop fields each year and therefore that percentage will be much lower. In addition, this refuge's genetically modified crop use would constitute only 0.0004356% percent of the total cropland within the United States.

Positive impacts of genetically modified crop use to help control weeds and invasive species include stabilizing no-till and conservation tillage practices, which would enhance biodiversity due to decreases in runoff and erosion (Carpenter 2011). It is noted that the EPA will have new regulatory mechanisms in place to oversee herbicide tolerant crops and deter resistant weed development. In addition, the refuge and the National Wildlife Refuge System will incorporate and implement best management practices in association with genetically modified crop use to protect biodiversity and deter resistance.

From a wildlife conservation perspective, as well as an effective use of IPM, genetically modified crop use would allow the refuge to maximize yields to meet the objectives of the CCP, North American Waterfowl Management Plan, and other planning documents. Additionally, it would minimize chemical use on refuge lands and reduce exposure to species utilizing these lands and minimize the use of refuge staff in overseeing agricultural practices. Plant and wildlife diversity would remain a top priority in establishing best management practices for the refuge. The current Biological Integrity, Diversity, and Environmental Health Policy (USFWS 2006) would continue to apply to the refuge. This means that the Service would continue to evaluate the use of a genetically modified crop on the refuge on an individual, case-by-case basis in accordance with the individual needs and founding purpose of the refuge.

Cumulative Impacts: Socioeconomic Resources
The scoping effort by the Service as well as the analysis done in this document indicate that the use of GMCs is the most economically feasible tool to incentivize continued participation in cooperative farming partnerships with refuges. A decrease in the use of GMCs on private lands near the refuge is highly unlikely. It is much more likely that local farmers will continue to use current GMCs and combinations of genetically modified crop traits as well as new technologies as they become available. The Service's proposed alternative, i.e., use of GMCs as part of an IPM approach on the refuge, would allow the use of only Animal and Plant Inspection Service-deregulated GMCs.

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

Short-term Uses of Genetically modified crops versus Long-term Productivity

Based on the analysis above, incorporating GMCs in the refuge's agricultural and natural resource management programs, would be more economical to address current issues with the refuge's agricultural program. Efficiencies realized due to a decrease in the amount and severity of pesticides, and in refuge staff's time and effort in administering or implementing agricultural practices for agricultural, and natural resource management purposes would benefit the refuge in general. With the current technology available, the use of GMCs on the refuge for agricultural and natural resource management purposes is the most effective way to achieve the current refuge waterfowl and wildlife management objectives.

Monitoring

Monitoring will occur regardless of the alternative selected to ensure that the alternatives continue to have no adverse impacts on the environment beyond those already described. The refuge uses an adaptive approach as part of all management programs to address impacts to the extent possible. Impacts from the use or non-use of GMCs to refuge management, visitor services, fish, wildlife, erosion, soil nutrients, invasive species, infrastructure maintenance, Comprehensive Environmental Response, Compensation, and Liability Act safety guidelines, and user conflicts will continue to be monitored through ongoing efforts. Furthermore, vegetative response monitoring may be increased under alternative A, especially regarding invasive and herbicide resistant species as described previously. Additional follow-up monitoring of plant species populations may be implemented to ensure success from management prescribed resulting from monitoring under Alternative A or B.

Summary of Analysis

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

Alternative A: Use only conventional farming practices on the Refuge. (No Action Alternative)

A summary of this alternative is provided in the table below. While this alternative could perhaps meet the purpose and needs of the Service in achieving agricultural, wildlife, and waterfowl foraging objectives, the purposes for which Crab Orchard National Wildlife Refuge was established, and the mission of the National Wildlife Refuge System, potential loss of cooperative farmers, decreased residual cover, increased pesticide use, increased personnel time to address farming and the associated practices, lower yields and revenues due to pest issues, and the limited selections of available seed varieties would make it more difficult for the refuge to achieve these respective purposes, goals, and objectives.

Alternative B: Integrated Pest Management Approach Allowing Use of Genetically Modified Crops (Proposed Alternative)

A summary of this alternative is provided in the table below. This alternative meets the purpose and needs of the Service as described above because it would facilitate the refuge efficiently and effectively achieving current agricultural, wildlife, and waterfowl foraging objectives, contribute to the purposes for which the refuge was established and accomplish the mission of the National Wildlife Refuge System.

Table 1. Summary of effects by alternative

Resource	Alternative 1 (No Action Alternative)	Alternative B: Integrated Pest Management Approach Allowing Use of GMCs (Proposed Alternative)
Soil	Increased soil erosion from increased conventional tillage cropping system	Decreased soil erosion from increased use of conservation tillage
Water Quality	Decreased to unchanged water quality effects from increased use of conventional tillage and increased use and variety of agricultural chemicals.	Increased water quality from use of conservation tillage and use of more benign chemicals.
Effects on Adjacent Fields (GMCs)	No effects.	No effects.
Organic and Conventional (non-GMCs) Crop Issues	None to minimal effects for conventional farming and no effects to organic farmers due to the requirements to maintaining buffers and to EPA label spray drift requirements.	None to minimal effects for conventional farming and no effects to organic farmers due to the requirements to maintaining buffers and to EPA label spray drift requirements.
Weed Resistance	The potential for weed resistance exists and addressed through the best management practices and IPM techniques.	The potential for weed resistance is minimal to no effect.
Habitat	Use of non-GMCs would either require refuge to increase cropland and potentially decrease natural habitat resources to meet current waterfowl objectives or result in failing to meet current waterfowl objectives.	Use of GMCs allows refuge to meet current waterfowl objectives.
Migratory and Resident Waterfowl	Negative effects to waterfowl due to not achieving objectives; potential loss of cooperators	No known effects to waterfowl.
T&E Species and Resident Wildlife	Potential effects from less environmentally friendly pesticide use	No known effects to wildlife or threatened and endangered species
Effects on Cooperator Recruitment and Retention	Reduced candidate pool during bidding process; increased likelihood of cooperators quitting.	Increased candidate pool during bidding process; cooperator retention likely at 100%.
Effects on Revenues	Decreased cooperator and refuge revenues	Increased cooperator and refuge revenues

Resource	Alternative 1 (No Action Alternative)	Alternative B: Integrated Pest Management Approach Allowing Use of GMCs (Proposed Alternative)
Effects on Yields	Reduced corn and soybean yields by at least 20 and 10 bushels per acre respectively	Increased corn and soybean yields by at last 20 and 10 bushels per acre respectively

List of Source Documents Consulted or Adapted in the Development of this Environmental Assessment

Primary analyses of impacts were largely taken or adapted from the:

U.S. FISH AND WILDLIFE SERVICE PROGRAMMATIC ENVIRONMENTAL ASSESSMENT FOR USE OF GENETICALLY ENGINEERED AGRICULTURAL CROPS FOR NATURAL RESOURCE MENT ON NATIONAL WILDLIFE REFUGES IN THE SOUTHEASTERN UNITED STATES
U.S. Department of the Interior, Fish and Wildlife Service, Southeastern United States Atlanta, Georgia. June 2020

Additional source documents included the:

U.S. FISH AND WILDLIFE SERVICE ENVIRONMENTAL ASSESSMENT FOR THE CRAB ORCHARD NATIONAL WILDLIFE REFUGE AGRICULTURE PROGRAM
U.S. Department of the Interior, Fish and Wildlife Service, Crab Orchard National Wildlife Refuge, Marion, Illinois. November 2018

U.S. FISH AND WILDLIFE SERVICE ENVIRONMENTAL ASSESSMENT FOR THE CRAB ORCHARD NATIONAL WILDLIFE REFUGE GRAZING PROGRAM
U.S. Department of the Interior, Fish and Wildlife Service, Crab Orchard National Wildlife Refuge, Marion, Illinois. March 2022

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Tribal Consultation

Tribes and tribal members are welcome to provide comments during the public comment period. Formal tribal consultation was not required during this process as there are no federally recognized tribes active in the area to consult.

Public Outreach

The draft environmental assessment will be made available to the public for review for a period of 30 days. The draft environmental assessment will be posted on the refuge website, a hard copy provided at the refuge's headquarters, and a press release sent to ~30 media outlets. Public comments are solicited from **September 26 through October 25, 2022**. Comments or requests for additional information could be submitted in person at the public meetings or through any of the following methods:

- **Email:** justin_sexton@fws.gov or craborchard@fws.gov. Include "Crab Orchard Grazing Program Environmental Assessment" in the subject line of the message.
- **Fax:** "Attn: Crab Orchard Row Crop Environmental Assessment" to (618) 997-8961.
- **Mail:** U.S. Fish and Wildlife Service,
  Attn: Justin Sexton
  8588 Route 148
  Marion, Il 62959

All comments received from individuals will become part of the official public record. All requests for such comments are handled in accordance with the Freedom of Information Act and National Environmental Policy Act regulations in 40 CFR 1506.6(f). The Service's practice is to make comments, including names and home addresses of respondents, available for public review during regular business hours. Individual respondents are able to request that we withhold their home address from the record, which we will honor to the extent allowable by law. Individuals wishing to withhold their name and/or address are asked to state this prominently at the beginning of their comments. Individual comments will be categorized and summarized, and if substantive, will be addressed. Individuals are not identified in the summary document. The Service response to comments will be found in an Appendix to this environmental assessment and will be reflected in edits made to this final environmental assessment in the appropriate sections.

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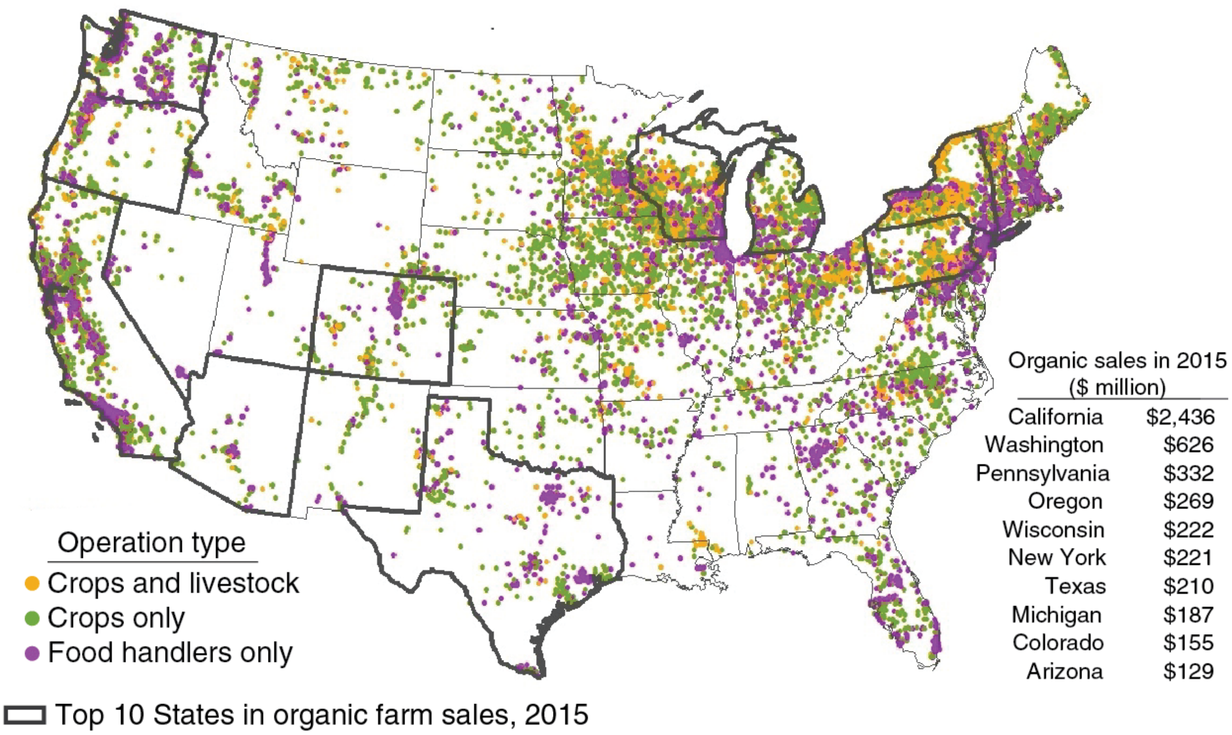
Tables and Figures

Figure 1. Organic Operations in the United States

Certified organic operations are concentrated in the West, Northeast, and Upper Midwest



Note: The category "Food handlers only" includes food processors, manufacturers, and other handlers.
Source: USDA, Economic Research Service using data from USDA's National Organic Program, Organic Integrity Database (U.S. certified operations in January 2016), and USDA's National Agricultural Statistics Service, 2015 Certified Organic Survey.

Figure 2. Number of Agricultural pesticides (active ingredients) applied on Crab Orchard National Wildlife Refuge from 2010-2021

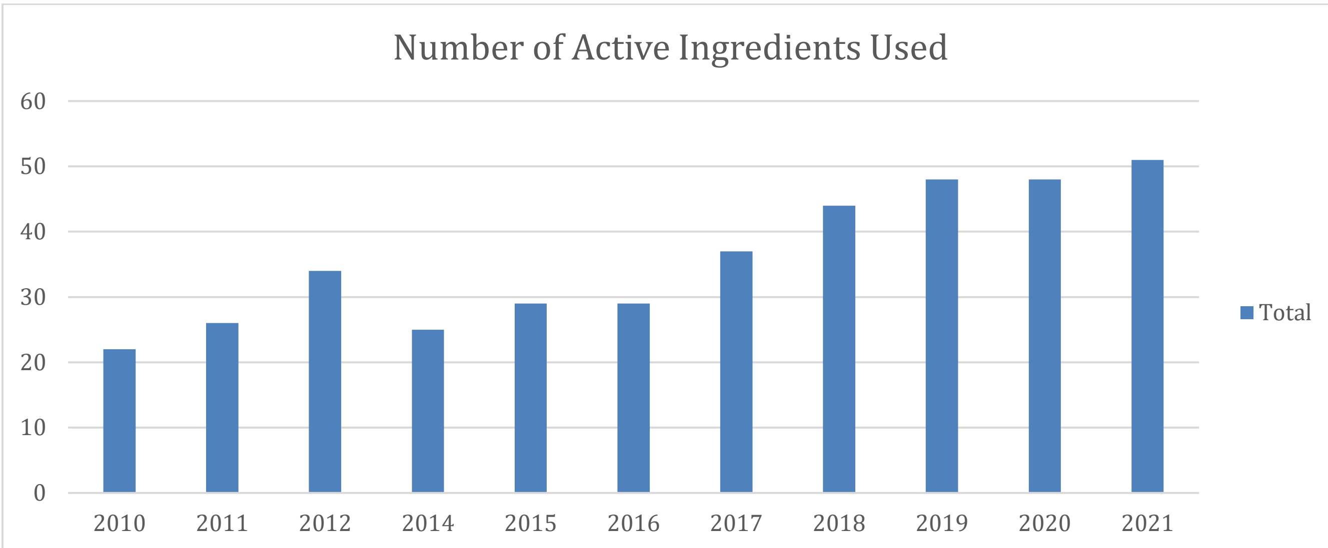


Figure 3. Pounds of Agricultural pesticides (active ingredients) applied on Crab Orchard National Wildlife Refuge from 2010-2021

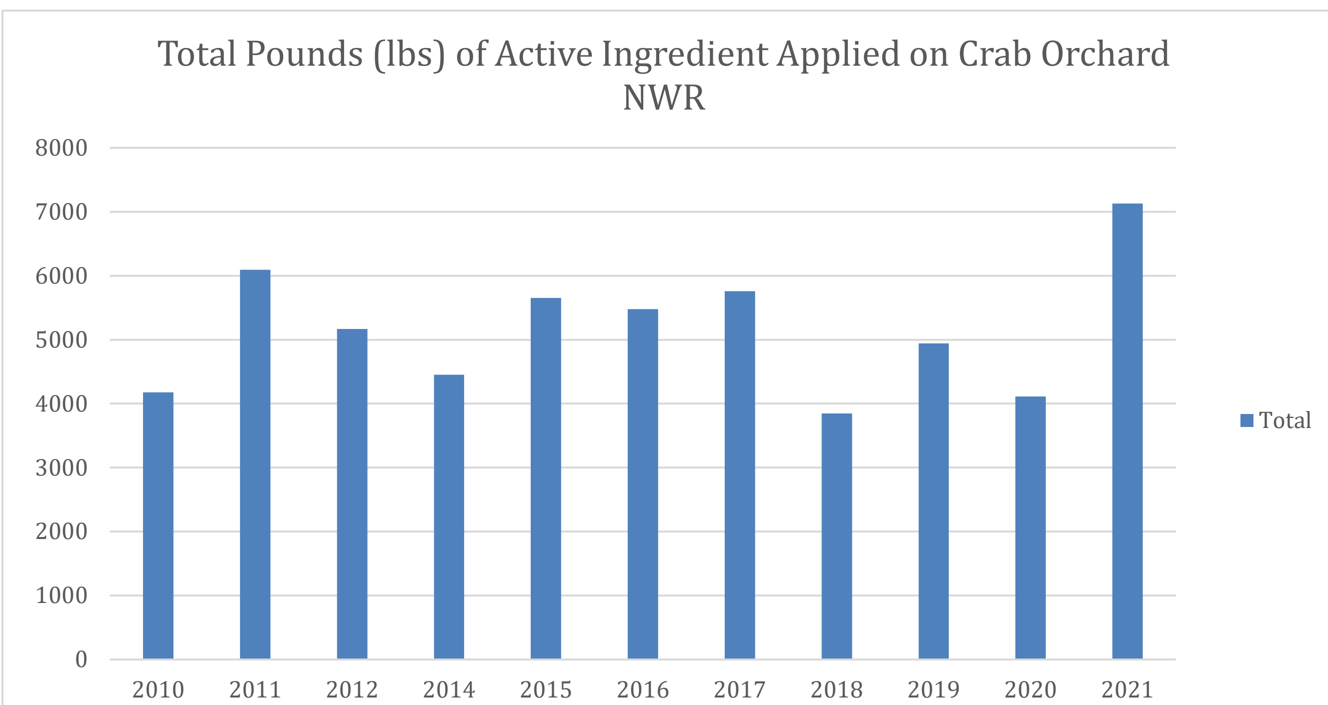


Figure 4. Location and General Map of Crab Orchard National Wildlife Refuge. The refuge is in southern Illinois within Williamson, Jackson, and Union counties.

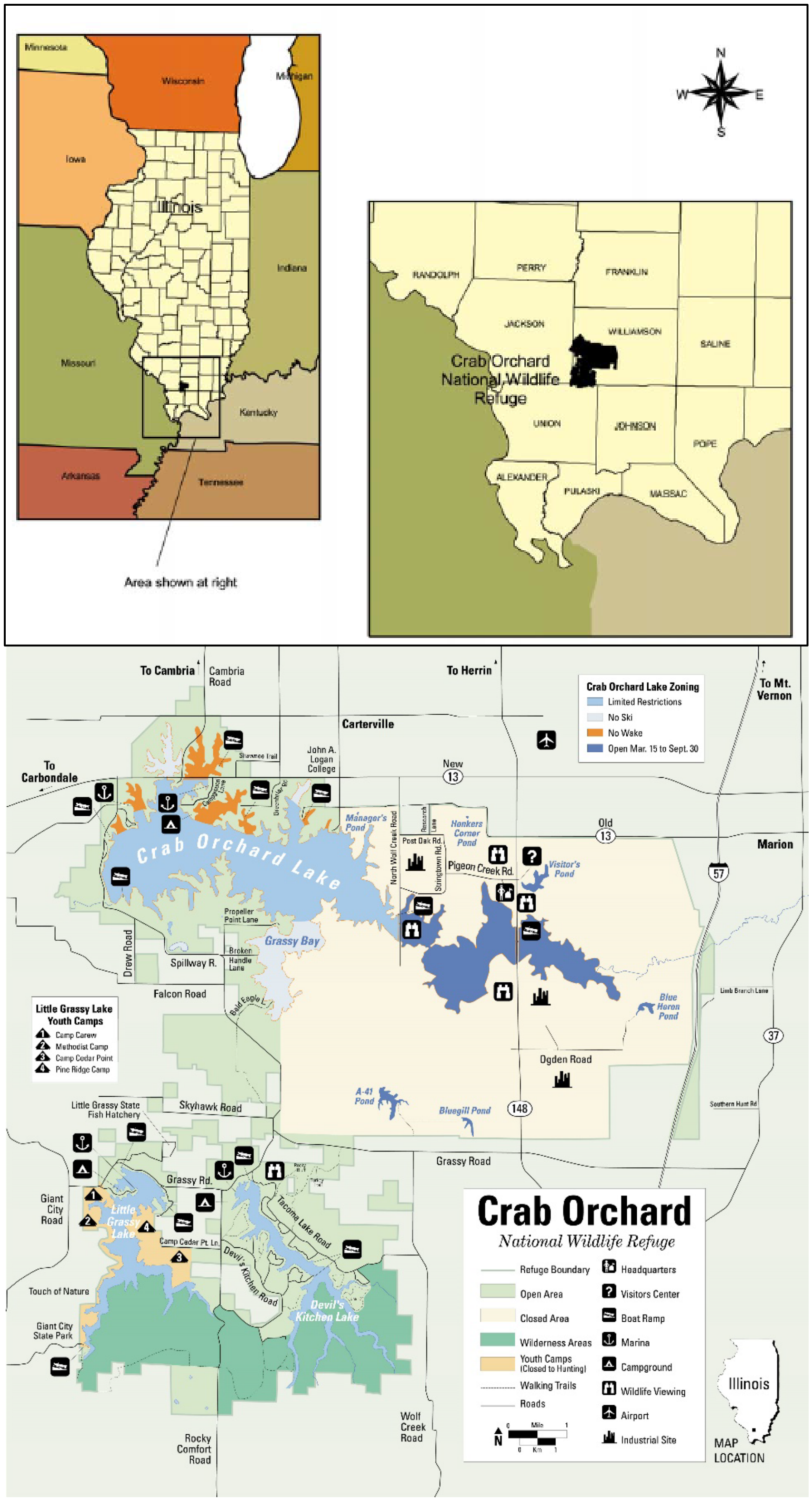
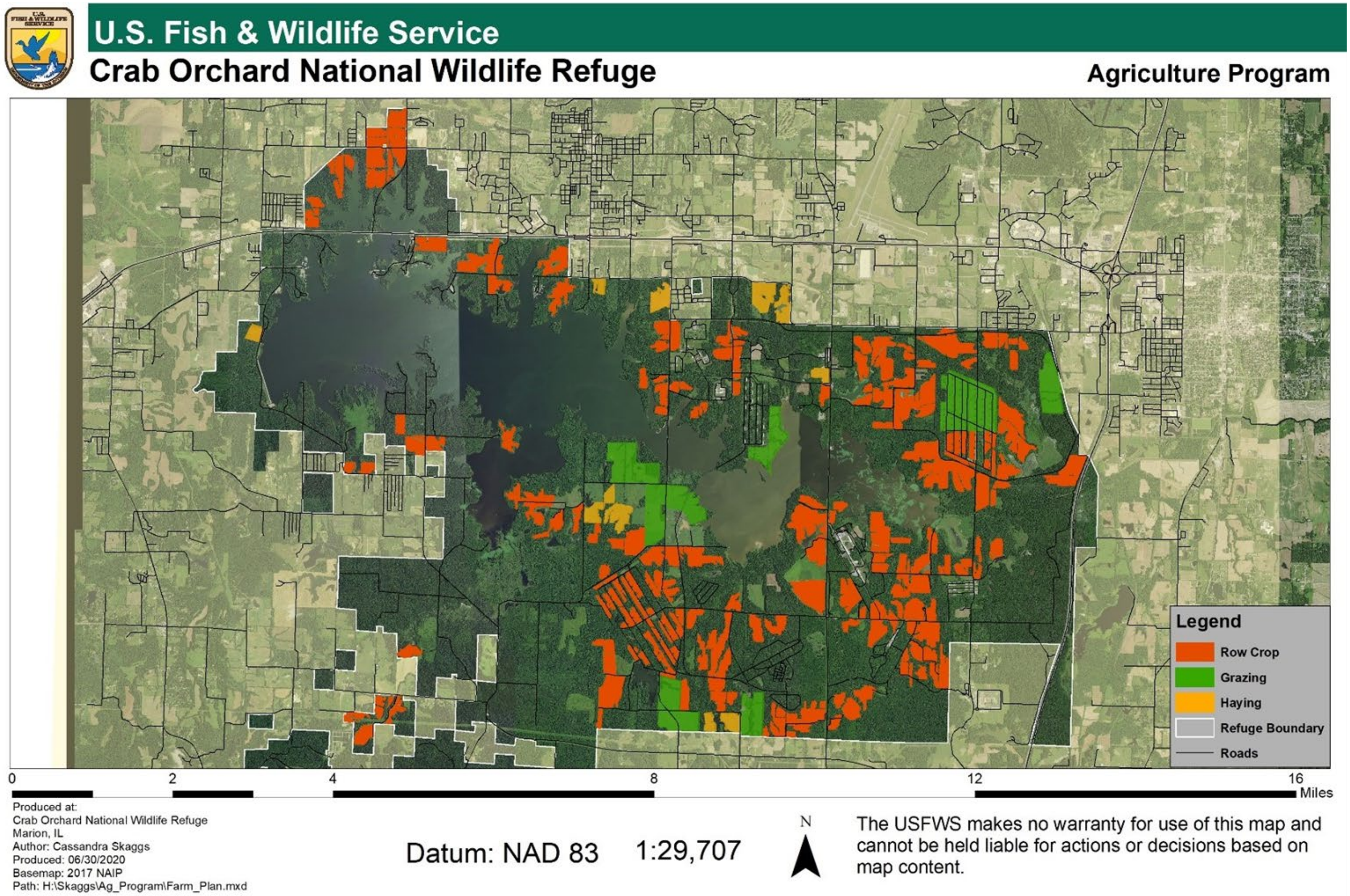


Figure 5. Location of Crab Orchard National Wildlife Refuge (refuge) entire agricultural program.



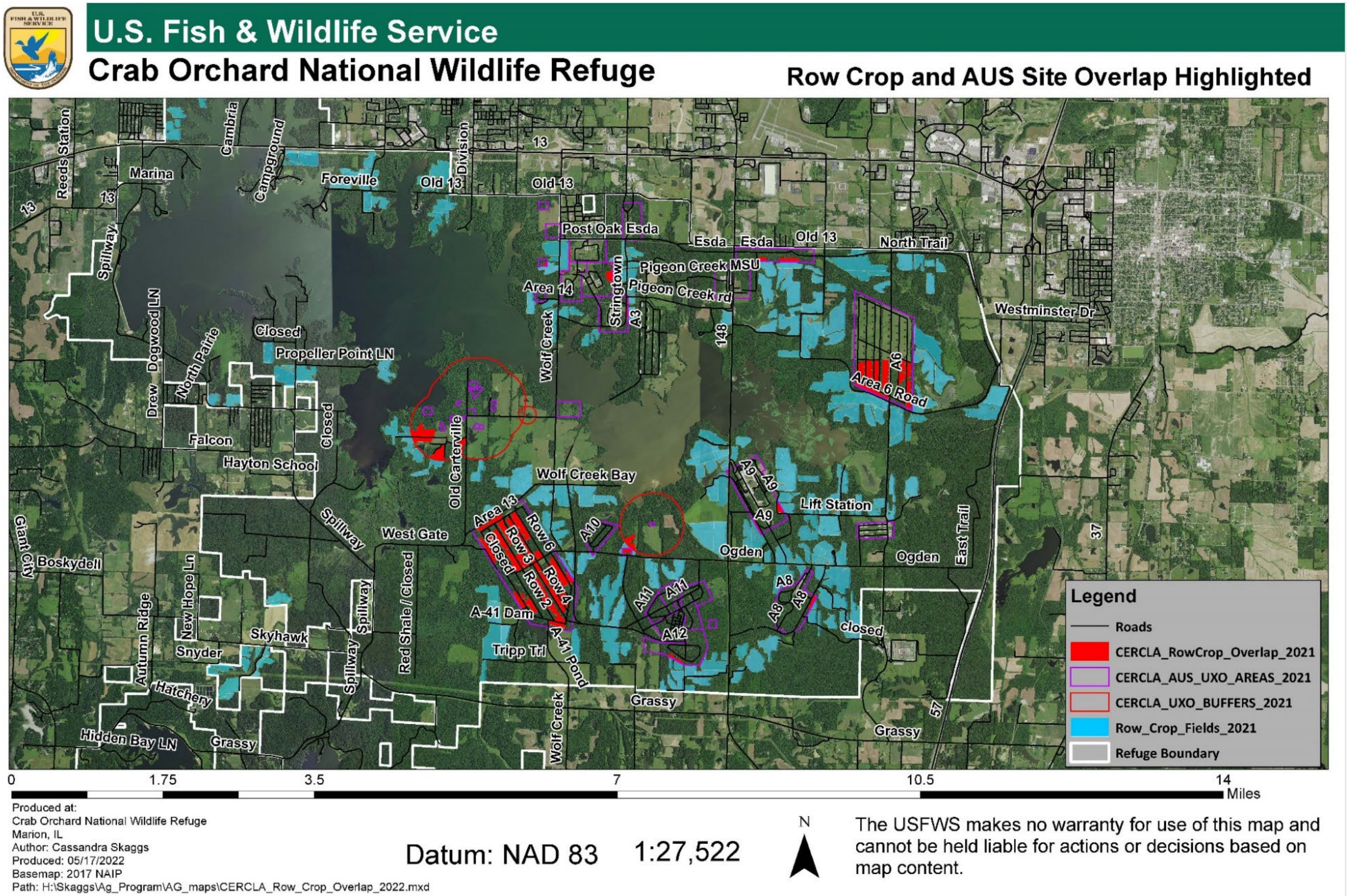


Figure 6. Location of Crab Orchard National Wildlife Refuge (refuge) row crop fields and overlap with CERCLA area use restrictions.

Table 2. 2022 Row Crop Farm Units with a total of 3899 acres of row crop fields.

UNIT	ACRES	NO. OF FIELDS	Max. Field Acres	Min. Field Acres	ISSUES
Unit 1	565.12	30	37.62	6.75	heavy wildlife use, herbicide resistant weeds
Unit 2	536.75	31	46.45	6.22	heavy wildlife use, herbicide resistant weeds, UXO areas in Hampton Complex
Unit 3	563.92	32	57.82	3.96	heavy wildlife use, herbicide resistant weeds, long linear fields in bunker complex
Unit 4	567.54	28	48.92	4.91	heavy wildlife use, herbicide resistant weeds, long linear fields in bunker complex
Unit 5	525.74	22	53.84	6.88	heavy wildlife use, herbicide resistant weeds, long linear fields in bunker complex
Unit 6	550.66	28	40.03	4.74	heavy wildlife use, herbicide resistant weeds
Unit 7	588.74	31	62.92	5.06	heavy wildlife use, herbicide resistant weeds

Table 3. Summation from 2016 to 2020 (5 years) of row crop values at the Refuge by Row Crop Unit.

Overall Cost Summation from 2016 to 2020 (5 years) by Year									
Year	**Total Acres**	**No. Fields**	**GOV Share Value**	**Cover Crop Value**	**Remaining Balance**	**IKS**	**Rent**	**No. Cooperators**	**$/acre**
2016	3989.3	205	$127,558.51	$75,299.38	$29,157.58	$27,360.85	$450.12	7	$58.16
2017	3965.45	205	$158,337.10	$57,548.04	$69,233.16	$49,792.76	$18,643.78	7	$71.90
2018	3965.45	205	$159,688.15	$46,112.34	$68,818.97	$22,250.96	$38,211.29	7	$69.25
2019	3965.45	205	$102,327.50	$43,526.51	$40,538.49	$13,631.50	$27,179.99	6	$47.00
*2020	3905.14	201	$79,917.82	$64,102.82	$199,087.84	$5,025.41	$194,062.43	7	$87.86
Total	**-**	**-**	**$627,829.08**	**$286,589.08**	**$406,836.04**	**$118,061.48**	**$278,547.61**	**-**	**-**

GOV Share Value- is the sum value of the unit each year from 2016 to 2020 that was the government share for example, corn shares left in the field.
Cover Crop Value- The amount of cost associated with planting soybean fields to winter wheat.
Remaining Balance- This the balance the farmer is responsible for after deducting the cost associated with harvesting and hauling the Refuge shares in 2016 to 2019. In 2020, the Refuge converted from a priority system to a bid system and our shares were left in the field. So, for 2020 this amount is estimated what the value of corn and cover crops left on refuge would be.
IKS-Amount the farmer had deducted from their remaining balance to complete in kind services such as mowing, applying fertilizer, spreading gravel, and etcetera.
Rent- Amount the farmer paid to the Refuge after all deductions were complete.
$/acre-Average grazing value per acre based on the sum of GOV Share Value + Cover Crop Value + Remaining balance divided by total acres to get an estimate of the Refuge value per acre by year.
***Cells Highlighted in Yellow**- These cells were estimated to be able to compare to years in the priority system. The refuge went from a priority system to a bid system in 2020.

Table 4. CERCLA restriction acres of overlap by row crop field and unit. Please note current Illinois Ordnance Plant site wide restrictions state, "No production water wells shall be installed, and residential use and camping are prohibited."

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
1	**A-5-3**	YES	1.75	4840	AREA-2D	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
1	**A-5-3**	YES	1.47	4840	AREA-2B	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
1	A-5-4	NO	1.04	3725	AUS-061	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
1	**A-6-W-1**	YES	0.59	5799	AREA-2F	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
2	**A-32-2**	YES	6.84	2917	UXO 1800' Buffer	No Rx Burns, CERCLA consult, No soil disturbance, No soil removal w/o OSHA certified person, No digging, trenching, **No AG Uses**
2	**A-32-3**	YES	3.94	1958	UXO 1800' Buffer	No Rx Burns, CERCLA consult, No soil disturbance, No soil removal w/o OSHA certified person, No digging, trenching, **No AG Uses**

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
2	**A-32-4**	YES	13.98	4401	UXO 1800' Buffer	No Rx Burns, CERCLA consult, No soil disturbance, No soil removal w/o OSHA certified person, No digging, trenching, **No AG Uses**
2	**A-32-5**	YES	7.13	3040	UXO 1800' Buffer	No Rx Burns, CERCLA consult, No soil disturbance, No soil removal w/o OSHA certified person, No digging, trenching, **No AG Uses**
2	**A-32-7**	YES	11.47	3230	UXO 1800' Buffer	No Rx Burns, CERCLA consult, No soil disturbance, No soil removal w/o OSHA certified person, No digging, trenching, **No AG Uses**
2	**A-32-8**	YES	2.06	1556	UXO 1800' Buffer	No Rx Burns, CERCLA consult, No soil disturbance, No soil removal w/o OSHA certified person, No digging, trenching, **No AG Uses**
2	**A-32-9**	YES	0.35	933	UXO 1800' Buffer	No Rx Burns, CERCLA consult, No soil disturbance, No soil removal w/o OSHA certified person, No digging, trenching, **No AG Uses**
3	A-37-N-1	NO	10.26	5047	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-N-10	NO	8.12	3846	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
3	A-37-N-2	NO	20.38	7612	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-N-3	NO	18.45	8452	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-N-4	NO	16.43	7118	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-N-5	NO	14.98	5602	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-N-6	NO	5.06	4950	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-N-8	NO	7.83	4060	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
3	A-37-N-9	NO	3.96	1694	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-S-11	NO	5.45	2683	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-S-12	NO	7.53	3887	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-S-14	NO	16.97	8299	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-S-15	NO	12.35	6079	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-S-16	NO	14.11	5015	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
3	A-37-S-17	NO	3.95	4371	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-S-18	NO	4.35	2326	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	A-37-S-19	NO	23.75	9564	AREA-13	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
3	**A-38-2**	YES	0.47	4367	AREA-10	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
3	**A-38-6 & 7**	YES	0.05	13588	AUS-043	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
4	A-13-6	NO	15.60	6418	AREA-6	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
4	A-13-7	NO	13.34	6120	AREA-6	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
4	A-13E-7	NO	0.01	5983	AREA-6	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
4	**A-6-W-2**	YES	5.24	3635	AREA-2F	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
4	**A-9-1**	NO	2.75	4182	AUS-018	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
4	**A-9-4**	NO	5.65	4540	AUS-018	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
5	A-13-1	NO	11.10	3551	AREA-6	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
5	A-13-2	NO	13.43	4131	AREA-6	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
5	A-13-3	NO	9.23	3514	AREA-6	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
5	A-13-4	NO	14.34	4647	AREA-6	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
5	A-13-8	NO	10.25	4967	AREA-6	Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation
5	**A-6-W-3**	YES	1.74	5042	AREA-2P	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
5	**A-6-W-9**	YES	0.27	3195	AREA-2P	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
6	**A-25-1**	YES	0.49	7744	AREA-12	No Rx Burns, No Hunting, CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
6	**A-25-4**	YES	0.09	2743	AREA-12	No Rx Burns, No Hunting, CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
6	**A-25-5**	YES	3.01	4729	AREA-12	No Rx Burns, No Hunting, CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
6	**A-26-2**	YES	7.16	3474	UXO 1800' Buffer	No Rx Burns, CERCLA consult, No soil disturbance, No soil removal w/o OSHA certified person, No digging, trenching, **No AG Uses**
6	**A-26-2**	YES	3.15	4686	AUS-043	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
6	**A-27-E-4**	YES	1.88	8577	AREA-9 WEST	CERCLA consult for earthmoving activity, Mowing PPE, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
6	**A-27-N-4**	YES	0.31	10885	AREA-9 WEST	CERCLA consult for earthmoving activity, Mowing PPE, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**

Unit	Field No.	PPE	ACRES	PERIM.	LABEL	LUC
7	**A-22-4**	NO	3.45	5086	AREA-8 SOUTH	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
7	**A-23-16**	YES	0.04	4053	AREA-9 WEST	CERCLA consult for earthmoving activity, Mowing PPE, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
7	**A-23-17**	YES	3.36	3283	AREA-9 WEST	CERCLA consult for earthmoving activity, Mowing PPE, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**
7	**A-23-a-5**	NO	0.12	2403	AREA-8 SOUTH	CERCLA consult for earthmoving activity, Access restricted, No soil removal w/o OSHA certified person, Do not use soil for borrow material, No digging, trenching unless for facility operation, **No AG Uses**