Comprehensive Conservation Plan

Quivira National Wildlife Refuge

Kansas

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Approved by

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Quivira National Wildlife Refuge

Kansas

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Contents

Summary XI
Abbreviations XVII

CHAPTER 1—Introduction 1

1.1 Purpose and Need for the Plan 2

1.2 The U.S. Fish and Wildlife Service and the National Wildlife Refuge System 3
U.S. Fish and Wildlife Service 3
National Wildlife Refuge System 3
People and the Refuge System 4

1.3 National and Regional Mandates 4

1.4 Refuge Contributions to National and Regional Plans 5
Conserving the Future 5
Partners in Flight 5
North American Waterbird Conservation Plan 5
North American Waterfowl Management Plan 5
U.S. Shorebird Conservation Plan 6
Recovery Plans for Federally Listed Threatened or Endangered Species 6
Kansas State Wildlife Action Plan 6
Responding to Accelerating Climate Change 7

1.5 Landscape-Scale Conservation 7
Strategic Habitat Conservation 7
Landscape Conservation Cooperatives 8

1.6 The Planning Process 8
Coordination with the Public 9
State Coordination 11
Tribal Coordination 11
Results of Scoping 12
The Draft Plan 12
The Final Plan 12

CHAPTER 2—The Refuge 13

2.1 Establishment, Acquisition, and Management History 13
Establishment 13
Acquisition History 14
Management History 14

2.2 Purposes 14

2.3 Vision 16

2.4 Goals 16
Landscape Conservation Goal 16
Native Ecological Community Conservation Goal 16
Visitor Services Goal 16
Public Outreach Goal 16
Cultural Resources Goal 17
Visitor and Employee Safety and Resource Protection Goal 17

Administration Goal 17

2.5 Special Values 17
Rare, Diverse, and Quality Habitat 17
Wildlife Species 17
Species of Concern 17
Water Resources 17
Communities and People 17
Education and Visitor Services 17
Cultural Resources 18
Facilities and Infrastructure 18
Special Designations 18

2.6 Planning Issues 18
Water Quantity and Quality 18
Tree Management 19
Whooping Crane Closures 19
Prohibiting the Collection of Shed Antlers 19
Deer and Turkey Hunting 19
Increasing Public Use and Wildlife Compatibility 19

CHAPTER 3—Refuge Resources and Description 21

3.1 Physical Environment 21
Climate 21
Land Features 25
Soils 25
Water Resources 26
Air Quality 29

3.2 Biological Resources 29
Plant Communities 31
Wildlife Communities 40
Federally and State-Listed Species 45

3.3 Management Tools 46
Rest 46
Water Management 47
Prescribed Fire 47
Grazing 47
Mechanical Treatments 48
Chemical Treatments 48

3.4 Human History and Cultural Resources 48
Prehistoric Resources 48
Prehistoric Occupation 48
Protohistoric and Historic Native Americans 49
Historic Euro-Americans 49
History 50

3.5 Special Management Areas 52

3.6 Visitor Services 52
Hunting 52
Fishing 53
Wildlife Observation and Photography 53
Environmental Education 53
Interpretation 54
Other Uses 55
Special Events 55
Public Outreach 55

3.7 Partnerships 56

3.8 Socioeconomic Environment 56
Population, Ethnicity, and Education 57
Regional Economic Setting 58
Public Use of the Refuge 60
Visitor Levels 60
Economic Contributions of the Refuge 61

3.9 Operations 61
Funding and Staff 62
Facilities 62

CHAPTER 4—Management Direction 65

4.1 Management Focus 65

4.2 Overview of Goals and Objectives 66

4.3 Landscape Conservation Goal 66
Landscape Conservation Objective 1: Land Ownership and Collaboration 68
Landscape Conservation Objective 2: Habitat Fragmentation 70
Landscape Conservation Objective 3: Environmental Health and Climate Change 71

4.4 Native Ecological Community Conservation Goal 72
Native Ecological Community Conservation Objective 1: Wetlands 81
Native Ecological Community Conservation Objective 2: Grasslands 89
Native Ecological Community Conservation Objective 3: Woodlands 93

4.5 Visitor Services Goal 95
Hunting Objective 1 97
Hunting Objective 2 97
Fishing Objective 1 98
Fishing Objective 2 100
Wildlife Observation and Photography Objective 1 100
Wildlife Observation and Photography Objective 2 101
Environmental Education and Interpretation Objective 1 101
Environmental Education and Interpretation Objective 2 102
Environmental Education and Interpretation Objective 3 102
Environmental Education and Interpretation Objective 4 102
Environmental Education and Interpretation Objective 5 103
Environmental Education and Interpretation Objective 6 103
Other Uses Objective 103

4.6 Public Outreach Goal 104
Public Outreach Objective 1 104
Public Outreach Objective 2 105
Public Outreach Objective 3 105

4.7 Cultural Resources Goal 106
Cultural Resources Objective 106

4.8 Visitor and Employee Safety and Resource Protection Goal 106
Visitor and Employee Safety Objective 106
Resource Protection Objective 107

4.9 Administration Goal 108
Funding and Staff Objective 1 108
Funding and Staff Objective 2 108
Facilities Objective 1 109
Facilities Objective 2 110
Facilities Objective 3 110
Facilities Objective 4 110

4.10 Stepdown Management Plans 111
4.11 Monitoring and Evaluation 111
4.12 Plan Amendment and Revision 112

GLOSSARY 113

BIBLIOGRAPHY 213

APPENDIXES

Appendix A
Environmental Compliance 119
Appendix B
Compatibility Determinations 123
Appendix C
Intra-Service Section 7 Biological Evaluation 139
Appendix D
Public Involvement 147
Appendix E
Key Legislation and Policy 175
Appendix F
List of Preparers and Contributors 179
Appendix G
Species Lists 181
Appendix H
Grassland Fragmentation Assessment 207

FIGURES

Figure 1. Quivira National Wildlife Refuge and Great Plains Nature Center, Kansas 2
Figure 2. Basic strategic habitat conservation process 7
Figure 3. Great Plains Landscape Conservation Cooperative with Quivira National Wildlife Refuge, Kansas 8
Figure 4. Process steps for comprehensive conservation planning and associated environmental analysis 9
Figure 5. Water control structures, Quivira National Wildlife Refuge, Kansas 15
Figure 6. Playa Lakes Joint Venture region, Quivira National Wildlife Refuge, Kansas 23
Figure 7. Refuge soil map, Quivira National Wildlife Refuge, Kansas 27
Figure 8. Potential presettlement conditions, Quivira National Wildlife Refuge, Kansas 33
Figure 9. Vegetation cover types in 1954, Quivira National Wildlife Refuge, Kansas 36
Figure 10. Vegetation cover types in 2008 (NVCS), Quivira National Wildlife Refuge, Kansas 37
Figure 11. Public use facilities at Quivira National Wildlife Refuge, Kansas 63
Figure 12. Elevation at Quivira National Wildlife Refuge, Kansas 67
Figure 13. Land use and habitat outside the boundaries of Quivira National Wildlife Refuge, Kansas 69
Figure 14. Native ecological community conservation objectives for Quivira National Wildlife Refuge, Kansas, illustrated in a community profile schematic 80
Figure 15. Cropland and tree coverage planning at Quivira National Wildlife Refuge, Kansas 94
Figure 16. Location of woodland groves at Quivira National Wildlife Refuge, Kansas, in 2012 96
Figure 17. Proposed deer and turkey hunt area, Quivira National Wildlife Refuge, Kansas 99

FIGURES (CONTINUED)

Figure 18. The adaptive resource management process 112
Figure 19. Current grassland conditions at Quivira National Wildlife Refuge, Kansas. 211
Figure 20. Future grassland conditions at Quivira National Wildlife Refuge, Kansas 212
Figure 21. Current nonhostile grassland conditions at Quivira National Wildlife Refuge, Kansas 213

TABLES

Table 1. Summary of the Comprehensive Conservation Plan process for Quivira National Wildlife Refuge, Kansas 10
Table 2. Land acquisition history of the Quivira National Wildlife Refuge, Kansas 14
Table 3. Vegetation descriptions for Quivira National Wildlife Refuge, Kansas 31
Table 4. Hydrogeomorphic relationship of historical distribution of vegetation communities or habitat types to geomorphic surface, soils, and hydrological regime in the area of Quivira National Wildlife Refuge, Kansas 32
Table 5. Comparison of vegetation cover types between 1954 and 2011 on Quivira National Wildlife Refuge, Kansas. 38
Table 6. National Vegetation Classification System (NVCS) associations, Quivira National Wildlife Refuge, Kansas 39
Table 7. Observed woodland bird use at Quivira National Wildlife Refuge, Kansas 42
Table 8. Threatened and endangered species and species of concern, Quivira National Wildlife Refuge, Kansas. 46
Table 9. State and county population estimates in the area around Quivira National Wildlife Refuge, Kansas. 57
Table 10. Community population estimates in the area around Quivira National Wildlife Refuge, Kansas. 57
Table 11. State income, unemployment, and poverty statistics and county statistics in the area around Quivira National Wildlife Refuge, Kansas 58
Table 12. Community income, unemployment and poverty statistics in the area around Quivira National Wildlife Refuge, Kansas. 58
Table 13. Employment by sector in the area around Quivira National Wildlife Refuge, Kansas. 59
Table 14. Total visitor expenditures, expressed in dollars per person per day, for Quivira National Wildlife Refuge, Kansas. . .62
Table 15. Base staff budgeted in fiscal year 2012 and other staff stationed at Quivira National Wildlife Refuge, Kansas. 62
Table 16. Focal species by life event and habitat at Quivira National Wildlife Refuge, Kansas. 75
Table 17. Estimated greatest potential distribution of wetland habitat conditions (acres by unit and objective) for the proposed alternative for Quivira National Wildlife Refuge, Kansas 83
Table 18. Dominant nonwetland habitat types at Quivira National Wildlife Refuge, Kansas. 92
Table 19. Stepdown management plans for Quivira National Wildlife Refuge, Kansas. 111

Summary

© Mitch Werner

Kansas Sunflower

We, the U.S. Fish and Wildlife Service, manage the Quivira National Wildlife Refuge, which consists of 22,135 acres in Stafford, Rice, and Reno Counties in south-central Kansas. Our staff at the Quivira National Wildlife Refuge also manages the Great Plains Nature Center in Wichita, Kansas, in partnership with the Kansas Department of Wildlife, Parks and Tourism and the City of Wichita Department of Park and Recreation.

Quivira National Wildlife Refuge is located in the Great Plains. Its purposes are to provide migration, nesting, resting, and feeding habitat for migratory birds and to develop, advance, manage, conserve, and protect fish and wildlife resources.

The refuge also provides opportunities for the public to enjoy compatible wildlife-dependent public use activities including hunting, fishing, wildlife observation, photography, environmental education, and interpretation.

This document contains the comprehensive conservation plan for Quivira National Wildlife Refuge.

The Refuge

We developed a vision for Quivira National Wildlife Refuge that describes the focus of refuge management, including what will be supported and improved in the future. This is the essence of what we want to accomplish at the refuge by the end of the life of this CCP in 15 years.

We also developed a set of goals for Quivira National Wildlife Refuge to direct our work in achieving the vision and purposes of the refuge and to outline approaches for managing the refuge's resources.

Barry Jones/FWS

This dickcissel nest was found in the Hornbaker Unit of Quivira Refuge.

Vision Statement

The vision for Quivira National Wildlife Refuge is as follows:

Near the confluence of the Rattlesnake Creek and Arkansas River in central Kansas, water remains the great driver of a diverse complex of saltmarsh and unique native sand prairie community that is Quivira National Wildlife Refuge. The combination of these productive habitats as well as the refuge's midcontinent location continue to attract millions of birds needing to replenish essential reserves and to find protection in the mosaic of largely open grasses, sedges, rushes, and water. Through environmental education and outreach, we promote understanding and appreciation of the refuge's dynamic landscapes. For visitors, each moment is unique—the smell of moist earth and salty air, the primitive call of a crane, the whispering bluestem, the cacophony of geese, the early steps of a snowy plover chick, or the discovery of a subtle pattern or design in nature. In a land of recurring extremes, ongoing collaboration between refuge professionals, partners, and the public sustains a healthy system. Through land stewards transcending refuge boundaries, the integrity of these ecosystems are conserved with awe, respect, and appreciation of the gifts it offers for all to receive.

Goals

Our goals for Quivira National Wildlife Refuge are based on the National Wildlife Refuge System Improvement Act of 1997, the refuge's purposes, and the information we gathered during planning.

Landscape Conservation Goal

Actively protect, preserve, manage, and restore the functionality of the diverse ecosystems of the Rattlesnake Creek watershed.

Native Ecological Community Conservation Goal

Actively conserve and improve environmental conditions within refuge boundaries to promote sustainable, native ecological communities and support species of concern associated with this region of the Great Plains.

Visitor Services Goal

See that visitors enjoy quality, wildlife-dependent recreational opportunities.

Public Outreach Goal

Help visitors of all abilities understand, appreciate, and support our mission, the refuge's unique habitats, and the refuge's importance to migratory birds and other wildlife and plant species.

Cultural Resources Goal

Identify, value, and preserve the cultural resources and cultural history of the refuge and connect staff, visitors, and the community to the area's past.

Visitor and Employee Safety and Resource Protection Goal

Provide for the safety, security, and protection of visitors, employees, natural and cultural resources, and facilities of the refuge and the Great Plains Nature Center.

Administration Goal

Provide and support facilities, strategically fill approved positions and allocate staff, increase volunteer opportunities and partnerships, and effectively raise and use money to maintain the long-term integrity of infrastructure, habitats, and wildlife resources at the refuge and at the Great Plains Nature Center.

Management Direction

The comprehensive conservation plan directs the management of the Quivira National Wildlife Refuge to meet the purposes of the refuge and to address issues.

The plan is intended to be a broad umbrella of general concepts and specific objectives for the refuge over the next 15 years. As the plan is implemented, we will develop stepdown plans with details for carrying out actions needed to achieve objectives.

Concepts and Objectives for the Refuge

We will focus on restoring native communities and promoting the potential natural range of conditions on Quivira National Wildlife Refuge that help focal resources or focal species and their respective habitats and on increasing public use opportunities for hunting. We will increase our attention and understanding of the connectedness of habitats and the effectiveness of our management. To achieve this, we will make relatively minor changes to our current operations; inventory, monitoring programs, and research; staff; and infrastructure.

Rachel Laubhan/FWS

White Pelicans

Abbreviations

Administration Act	National Wildlife Refuge System Administration Act of 1966
AFY	acre-feet per year
BSM	Big Salt Marsh
CCP	comprehensive conservation plan
CFR	Code of Federal Regulations
cfs	cubic feet per second
DOI	U.S. Department of the Interior
EA	environmental assessment
EPA	Environmental Protection Agency
°F	degrees Fahrenheit
FWS	U.S. Fish and Wildlife Service
GIS	geographic information system
GPLCC	Great Plains Landscape Conservation Cooperative
GPNC	Great Plains Nature Center
Improvement Act	National Wildlife Refuge System Improvement Act of 1997
KDWPT	Kansas Department of Wildlife, Parks and Tourism
LSM	Little Salt Marsh
NEPA	National Environmental Policy Act of 1969
NWR	national wildlife refuge
NVCS	National Vegetation Classification System
NRCS	Natural Resources Conservation Service of the U.S. Department of Agriculture
Partners	Partners for Fish and Wildlife
PLJV	Playa Lakes Joint Venture
the refuge	Quivira National Wildlife Refuge
Refuge System	National Wildlife Refuge System

Region 6	Mountain-Prairie Region 6 of the U.S. Fish and Wildlife Service
Service	U.S. Fish and Wildlife Service
U.S.	United States
U.S.C.	United States Code
USGS	U.S. Geological Survey

A glossary of these and other terms follows chapter 4.

Chapter 1—Introduction

© Bob Gress

Black-necked Stilt

We, the U.S. Fish and Wildlife Service (Service or FWS) manage the Quivira National Wildlife Refuge (Quivira Refuge or refuge), which consists of 22,135 acres in Stafford, Rice and Reno Counties in south-central Kansas. Our staff at the Quivira Refuge manages the Great Plains Nature Center (GPNC) in partnership with the Kansas Department of Wildlife, Parks and Tourism (KDWPT), and the City of Wichita Department of Park and Recreation. To address the long-term management of the refuge and the GPNC, we have developed this comprehensive conservation plan (CCP).

This chapter introduces our process for development of the Quivira Refuge CCP. It describes our involvement as well as that of the public, our partners, the State of Kansas, and other interested parties and also describes conservation issues and plans that affect the refuge.

The chapters that follow contain information we used and the results of our analysis. These form the foundation of the plan:

Chapter 2 describes the refuge and planning issues.

Chapter 3 describes the physical, biological, and social environment of the refuge.

Chapter 4 describes objectives and strategies for all aspects of managing the refuge.

The refuge is part of the National Wildlife Refuge System (Refuge System), and is located in south-central Kansas (figure 1). The GPNC is a Service administrative site and an educational facility, but it is not a unit of the Refuge System.

We have developed this CCP to provide a foundation for the management and use of Quivira Refuge. The CCP specifies the necessary actions to achieve the vision and purposes of the refuge. Wildlife is the first priority in refuge management, and public use, including wildlife-dependent recreation, is allowed and encouraged as long as it is compatible with the purposes of the refuge. The CCP will serve as a working guide for management programs and activi-

ties throughout the refuge over the next 15 years. Although this document contains management direction for the refuge, greater detail will be provided in stepdown management plans as part of carrying out the final CCP.

1.1 Purpose and Need for the Plan

The purpose of this CCP is to define the role that Quivira Refuge will play in support of the mission of the National Wildlife Refuge System and to provide long-term guidance for managing programs and activities. The CCP will help us:

- communicate with the public and our partners in carrying out the mission of the Refuge System;
- establish a clear statement of direction for managing the refuge;
- provide refuge neighbors, refuge visitors, and government officials an understanding of our management actions on, and around, the refuge;

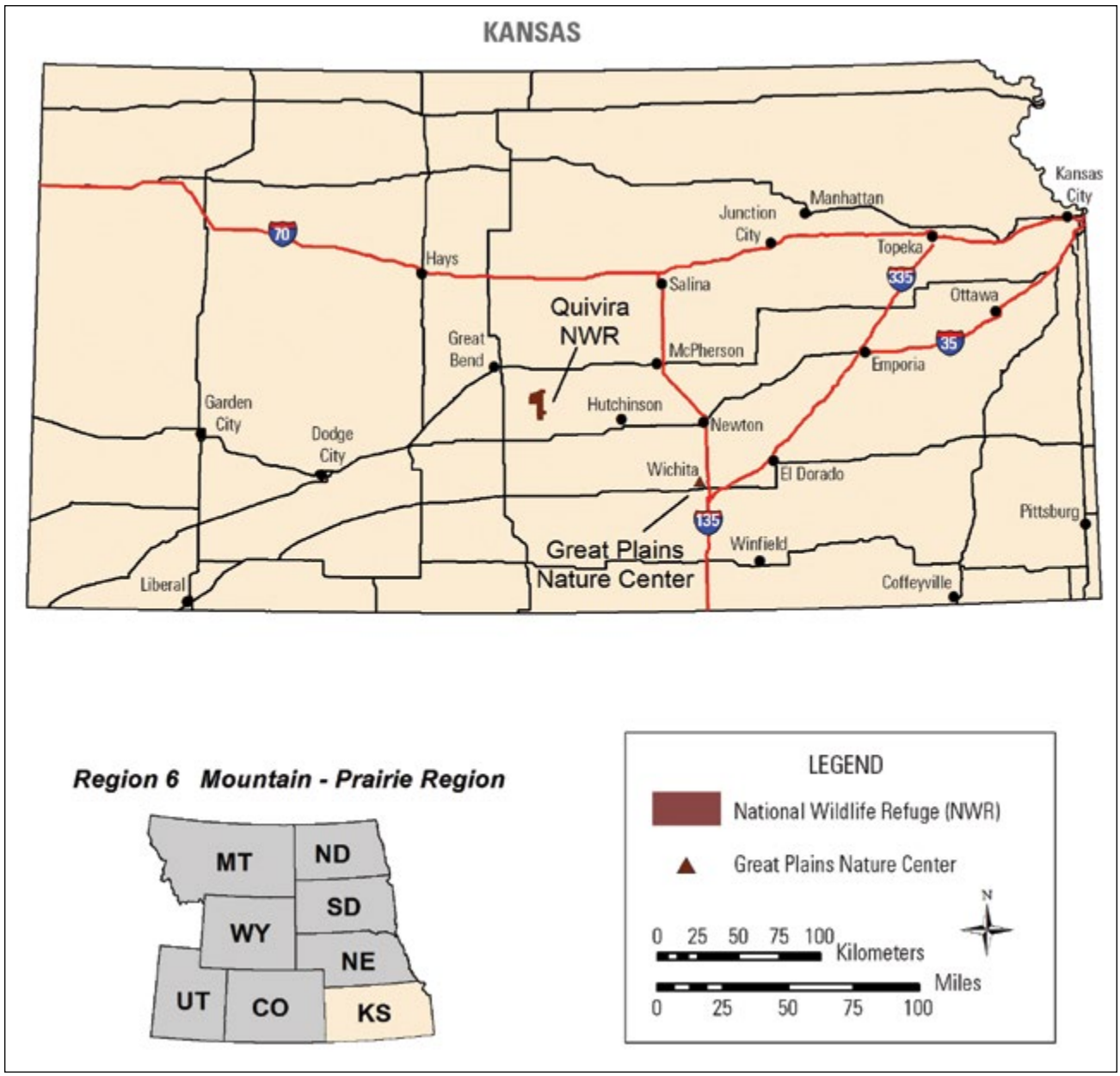

Figure 1. Quivira National Wildlife Refuge and Great Plains Nature Center, Kansas.

- make sure that our management actions are consistent with the mandates of the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act) (Public Law 105–57);
- make sure that our management of the refuge is consistent with Federal, State, and county plans;
- establish a basis for developing budget requests for refuge operation, maintenance, and capital improvement needs.

1.2 The U.S. Fish and Wildlife Service and the Refuge System

We are the principal Federal agency responsible for fish, wildlife, and plant conservation. The Refuge System is one of our major programs.

U.S. Fish and Wildlife Service

The mission of the U.S. Fish and Wildlife Service, working with others, is to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people.

In the late 19th and early 20th centuries, America's fish and wildlife resources declined at an alarming rate, largely because of unrestricted market hunting. Concerned citizens, scientists, and hunting and angling groups joined together and generated political will for the first significant conservation measures taken by the Federal Government. These actions included the establishment of the Bureau of Fisheries in the 1870s and, in 1904, passage of the first Federal wildlife law, the Lacey Act, which prohibited interstate transportation of wildlife taken in violation of State laws. Beginning in 1903, President Theodore Roosevelt created more than 50 national wildlife refuges across the Nation.

Over the next three decades, the United States ratified the Migratory Bird Treaty with Great Britain, and Congress passed laws to protect migratory birds, establish new refuges, and to create a source of money for refuge land acquisition. In 1940, we, the FWS, were created within the U.S. Department of the Interior (DOI), and several existing Federal wildlife functions, including law enforcement, fish management, animal damage control, and wildlife refuge management, were placed in our charge, under one organization, for the first time.

Today, we enforce Federal wildlife laws, manage migratory bird populations, restore nationally significant fisheries, conserve and restore vital wildlife habitat, protect and recover endangered species, and help other governments with conservation efforts. In addition, we administer a Federal aid program that distributes hundreds of millions of dollars to the States for fish and wildlife restoration, boating access, hunter education, and related programs across the United States.

National Wildlife Refuge System

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

In 1903, President Theodore Roosevelt designated the 5.5-acre Pelican Island in Florida as the Nation's first wildlife refuge for the protection of native nesting birds. This was the first time the Federal Government set aside land for wildlife. This small, but significant, designation was the beginning of the National Wildlife Refuge System.

One hundred years later, the Refuge System has become the largest collection of lands in the world specifically managed for wildlife, encompassing more than 150 million acres within more than 550 refuges and more than 3,000 small areas for waterfowl breeding and nesting. Today, there is at least one refuge in

every State including Puerto Rico and the U.S. Virgin Islands.

The Improvement Act established a clear mission for the Refuge System. It states that we must manage each national wildlife refuge to:

- fulfill the mission of the Refuge System;
- fulfill the individual purposes of each refuge;
- consider the needs of fish and wildlife first;
- include the development of a CCP for each unit of the Refuge System and to fully involve the public in the preparation of these plans;
- support the biological integrity, diversity, and environmental health of the Refuge System;
- recognize that wildlife-dependent recreation activities, including hunting, fishing, wildlife observation, photography, environmental education, and interpretation, are legitimate and priority public uses;
- allow our refuge managers to identify compatible public uses;

Besides the mission for the Refuge System, the wildlife and habitat vision for each unit of the Refuge System supports the following principles:

- Wildlife comes first.
- Ecosystems, biodiversity, and wilderness are vital concepts in refuge and district management.
- Habitats must be healthy.
- Growth of refuges and districts must be strategic.
- The Refuge System serves as a model for habitat management with broad participation from others.

Following passage of the Improvement Act, we began to carry out the direction of this new legislation including preparing CCPs for all national wildlife refuges. The Improvement Act says we will create CCPs with involvement from the public, and each refuge must have a completed CCP by 2012.

People and the Refuge System

The Nation's fish and wildlife heritage adds to the quality of American lives and is an integral part of the country's greatness. Wildlife and wild places have always given Americans special opportunities to have fun, relax, and appreciate the natural world.

Through birdwatching, fishing, hunting, photography, and more, wildlife recreation contributes millions of dollars to local economies. In particular, money generated from the taxing of sporting arms and ammunition and of fishing equipment, as authorized by the Pittman–Robertson and Dingell–Johnson Acts, respectively, has generated tens of millions of dollars. We distribute this money to the States to increase wildlife and fish populations, expand habitat, and to train hunters across the Nation. Our efforts to support national wildlife refuges also generate substantial economic help for communities that surround these refuges and wetland management districts.

Economists report that visitors to national wildlife refuges contribute more than $1.7 billion annually to local economies. They also enjoy the nature trails, auto tours, interpretive programs, and hunting and fishing opportunities found on refuges.

1.3 National and Regional Mandates

We manage national wildlife refuges to achieve the mission and goals of the Refuge System along with the designated purpose of each individual refuge as described in establishing legislation, Executive orders, or other establishing documents. The key concepts and guidance for the Refuge System are in the National Wildlife Refuge System Administration Act of 1966 (Administration Act), Title 50 of the Code of Federal Regulations (CFR), The "Fish and Wildlife Service Manual," and the Improvement Act.

The Improvement Act amends the Administration Act by providing (1) a unifying mission for the Refuge System; (2) a new process for determining compatible public uses on refuges; and (3) a need for each refuge to be managed under a CCP. The Improvement Act states that wildlife conservation is the priority of Refuge System lands and that the Secretary of the Department of the Interior will make sure that the biological integrity, diversity, and environmental health of refuge lands are kept. Each refuge must be managed to fulfill the Refuge System's mission and the specific purposes for which the refuge was established. The Improvement Act requires us to check

the status and trends of fish, wildlife, and plants in each national wildlife refuge.

Detailed descriptions of these and other laws and Executive orders that may affect a CCP or our carrying out of a CCP are in Appendix E—Key Legislation and Policy. Our policies for planning and the day-to-day management of refuges are in the Refuge System Manual and the "Fish and Wildlife Service Manual."

1.4 Refuge Contributions to National and Regional Plans

Quivira National Wildlife Refuge contributes to the conservation efforts outlined in the various State and national plans described here.

Conserving the Future

A 2011 report, "Conserving the Future, Wildlife Refuges & the Next Generation" (FWS 2011), is the culmination of a yearlong process by teams of our employees to evaluate the Refuge System nationwide. The report contains 42 recommendations packaged with three vision statements for wildlife and habitat, people, and leadership. This CCP incorporates all three vision statements. Our planning team examined the recommendations in this document for guidance during CCP planning.

Partners in Flight

The Partners in Flight Program began in 1990 to address the declining population levels of many migratory bird species. Its challenge is to support functional natural ecosystems in the face of human population growth. Partners in Flight worked to identify priorities for landbird species and habitat types. Their activity has resulted in 52 bird conservation plans covering the continental United States.

North American Waterbird Conservation Plan

The North American Waterbird Conservation Plan provides a contiguous framework for conserving and managing colonial-nesting waterbirds, including 209 species of seabirds, coastal waterbirds (gulls, terns, and pelicans), wading birds (herons and ibises), and marshbirds (certain grebes and bitterns). Geographically, the plan covers 28 countries, from Canada to Panama, as well as islands and near-shore areas of the Atlantic and Pacific oceans, the Gulf of Mexico, and the Caribbean Sea. As with Partners in Flight and other migratory bird plans, the North American Waterbird Conservation Plan has a goal to establish conservation action and to exchange information and expertise with other bird conservation initiatives. The plan also calls for establishment of "practical units for planning" for terrestrial habitats. Quivira Refuge is located within the Central Mixedgrass Prairie Bird Conservation Region in the Central Prairies Waterbird Conservation Planning Region.

North American Waterfowl Management Plan

Written in 1986, the North American Waterfowl Management Plan envisioned a 15-year effort to achieve landscape conditions that could sustain waterfowl populations. Specific plan objectives are to increase and restore duck populations to the average levels of the 1970s—62 million breeding ducks and a fall flight of 100 million birds (FWS and Canadian Wildlife Service 1986). Recognizing the importance of waterfowl and wetlands to North Americans and the need for international cooperation to help in the recovery of this shared resource, the United States and Canadian Governments developed a strategy to restore waterfowl populations through habitat protection, restoration, and enhancement. The innovative plan is international in scope and regional in its implementation. Its success depends on the strength of partnerships, called joint ventures, which involve Federal, State, Provincial, tribal, and local governments; businesses; conservation organizations; and individual citizens.

Joint ventures are regional, self-directed partnerships that carry out science-based conservation through a wide array of community participation. Joint ventures develop implementation plans that focus on areas of concern identified in the plan. Quivira Refuge lies within the Playa Lakes Joint Venture. We have considered The North American Waterfowl Management plan and the supporting efforts of the Playa Lakes Joint Venture throughout the planning process, and these will be supported and promoted within the CCP.

U.S. Shorebird Conservation Plan

In 2000, the U.S. Shorebird Conservation Plan began through a partnership between Federal, State, and nongovernmental conservation agencies and researchers mainly to sustain the quantity and quality shorebird habitat at local-to-hemispheric scales (Brown et al. 2001). The plan is meant to complement other conservation plans already developed for waterfowl, colonial waterbirds, and landbirds. The plan involves eleven regional groups, and Quivira Refuge is part of the Central Plains–Playa Lakes Region. Nearly all the 37 shorebird species listed for the region use Quivira Refuge during migration. At least six of those species have been reported nesting on the refuge, mostly common in occurrence.

Recovery Plans for Federally Listed Threatened or Endangered Species

We are responsible for administering the Endangered Species Act that requires development and implementation of federally endangered species recovery plans. Quivira Refuge contributes to the whooping crane and interior least tern recovery plans. Management actions identified in the plans are intended to recover and conserve species and their ecosystems to levels where protection under the Endangered Species Act is no longer necessary.

Kansas State Wildlife Action Plan

The Kansas Comprehensive Wildlife Conservation Plan (Wasson et al. 2005) is a strategic, habitat-based plan that considers 315 species of greatest conservation need living within the State. Regions are identified and key habitats are ranked within the plan according to the degree of threat to their well-being . The plan lists species of concern for each key habitat along with issues of concern and strategies to address them. Issues of concern include existing data gaps, extensive changes in habitat structure over the past century, ongoing fragmentation and conversion of habitat, the spread of invasive species, and effects of natural resource management on habitat conditions. In addition, information is lacking for many species in need. Criteria used to rank the relative importance of species conservation strategies were derived from species status and considered whether or not species were regionally endemic or were subject to commercial harvest but were not eligible for

Barry Jones/FWS

Windmill located in the Reno Unit of Quivira Refuge.

money from programs such as Federal aid. Quivira Refuge is part of the Central Mixed-grass Prairie Conservation Region where mixed and sand prairie are listed first and second in importance, respectively. We support the habitats and many associated species listed in The Kansas Comprehensive Wildlife Conservation Plan.

Responding to Accelerating Climate Change

The Service expects accelerating climate change to affect the Nation's fish, wildlife, and plant resources in profound ways (Staudinger et al. 2012). While many species will continue to thrive, some may decline and some may go extinct. Others will survive in the wild only through direct and continuous human intervention. In 2010, we completed a strategic plan to address climate change for the next 50 years. This strategic plan uses three key strategies: adaptation, mitigation, and engagement. In addition, the plan acknowledges that no single organization or agency can address climate change. Partnerships are necessary across the Nation and around the world. This plan is an integral part of the DOI's strategy for addressing climate change as expressed in Secretarial Order 3289 (September 14, 2009).

The Service will use the following guiding principles from the strategic plan to respond to climate change:

- priority setting—continually evaluate priorities and approaches, make difficult choices, take calculated risks, and adapt to climate change
- partnership—commit to a new spirit of coordination, collaboration, and interdependence with others
- best science—reflect scientific excellence, professionalism, and integrity in all of our work
- landscape conservation—emphasize the conservation of habitats within sustainable landscapes, applying our strategic habitat conservation framework
- technical capacity—assemble and use state-of-the-art systems to meet the climate change challenge
- global approach—lead national and international efforts to meet the climate change challenge

1.5 Landscape-Scale Conservation

In the face of escalating challenges such as land use conversion, invasive species, water scarcity, and refuge issues that have been amplified by accelerating climate change, we have broadened our vision from applying an ecosystem approach to conservation to looking at the interrelation of ecosystems across landscapes.

Strategic Habitat Conservation

The National Ecological Assessment Team, a cooperative effort between us and the U.S. Geological Survey (USGS), wrote a report outlining a unifying adaptive resource management approach for conservation (USGS 2006). It can be applied on a landscape scale and across the entire range of a focal species or across a suite, or guild, of species. This is strategic habitat conservation, a new way of thinking and doing business that uses biological goals for focal species populations, makes strategic decisions about needed work, and constantly reassesses (figure 2).

Figure 2. Basic strategic habitat conservation process.

Figure 3. Great Plains Landscape Conservation Cooperative with Quivira National Wildlife Refuge, Kansas.

Landscape Conservation Cooperatives

Strategic habitat conservation helps us to apply adaptive management across large landscapes. We used the framework of strategic habitat conservation to identify the first generation of landscape conservation cooperatives. These cooperatives are partnerships between us and Federal agencies, States, tribes, nongovernmental organizations, and universities. Designed to help planning and science, the cooperatives will help us conduct biological planning, conservation design and delivery, and monitoring programs and research.

Quivira Refuge lies within the Great Plains Landscape Conservation Cooperative (GPLCC) (figure 3). The GPLCC has grasslands, playas, saline lakes, prairie rivers, streams and riparian corridors, savannas, shrublands and sand dune habitats in parts of Kansas, Nebraska, western Oklahoma and Texas, eastern Colorado and New Mexico, and southeast Wyoming.

The GPLCC has identified priority species, which include the burrowing owl, black-tailed prairie dog, American bison, American burying beetle, mountain plover, long-billed curlew, lesser prairie-chicken, grasshopper sparrow, Cassin's sparrow, lark bunting, Harris' sparrow, prairie falcon, northern pintail, sandhill crane, least sandpiper, western sandpiper, long-billed dowitcher, whooping crane, snowy plover, Wilson's phalarope, interior least tern, piping plover, Bell's vireo, Arkansas River shiner, Arkansas darter, Topeka shiner, Pallid and shovelnose sturgeon, paddlefish, blowout penstemon, and sand dune lizard. Many of these species have been reported on the refuge, such as burrowing owl, grasshopper sparrow, Cassin's sparrow, lark bunting, Harris's sparrow, prairie falcon, Bell's vireo, Arkansas darter, and all the listed waterfowl, shorebirds, and cranes.

The GPLCC will serve as a convening body to bring all interested parties together to address existing and future issues related to climate change and landscape-scale conservation.

1.6 Planning Process

The Improvement Act requires that we develop a CCP for Quivira Refuge. This is the final plan, and it

will guide our refuge management for the next 15 years.

We prepared this plan in compliance with the Improvement Act and part 602 (National Wildlife Refuge System Planning) of the "Fish and Wildlife Service Manual." The actions described herein meet the needs of the Council on Environmental Quality regulations that implement the National Environmental Policy Act of 1969 (NEPA). Other requirements and guidance are contained in the Refuge System's planning policy, issued in 2000. This policy established needs and guidance for refuge and district plans, including CCPs and stepdown management plans, to make sure that planning efforts follow the Improvement Act. The planning policy identifies several steps for CCP and environmental analysis development (figure 4).

We began in September 2009 by creating a planning team comprised primarily of our staff from the Quivira Refuge and our Mountain-Prairie Region 6 of the U.S. Fish and Wildlife Service (Region 6) Division of Refuge Planning. Added teammembers included staff from some of our other divisions; staff from the KDWPT; and members of the Osage Nation. See Appendix F—List of Preparers, Consultation, and Coordination for a complete teammember list. During preplanning, we, the team, developed a mailing list and identified internal issues and qualities unique to the refuge. We then identified and reviewed the purposes of the refuge and current programs, compiled and analyzed relevant data.

Scoping for the public and our partners started with a notice of intent to prepare a draft CCP and environmental assessment (EA) that was published in the Federal Register on Wednesday, February 24, 2010. We informed about the plan's progress through news releases, the first planning update, and three public scoping meetings held between March 8 and 10, 2010, in Stafford, Great Bend, and Wichita, Kansas, between 4 and 7 p.m. Throughout the planning process we encouraged comment on, and added input to, the draft CCP and EA to comply with the public involvement needs of NEPA. Table 1 lists the specific planning steps taken to date for the preparation of this final CCP.

Coordination with the Public

The mailing list we use contains more than 270 names and has private citizens; local, regional, and State government representatives and legislators; other Federal agencies; and interested organizations.

Figure 4. Process steps for comprehensive conservation planning and associated environmental analysis.

Table 1. Summary of the Comprehensive Conservation Plan process for Quivira National Wildlife Refuge, Kansas.

Date	*Event*	*Outcome or purpose*
September 22–23, 2009	Preplanning meeting	Toured the refuge, formed into an initial planning team, started the mailing list, and discussed the planning schedule and data needs.
October 5, 2009	Work plan	Completed the work plan.
October 30, 2009	Planning team invitation letters mailed	Service Regional Director invited tribal nations and the KDWPT to be on the planning team.
February 2010	Planning update	Mailed the first planning update to those on our mailing list. The update described the planning process and announced upcoming public scoping meetings.
February 24, 2010	Notice of intent	Published the notice of intent to prepare a CCP in the Federal Register (volume 75, number 36, pages 8394–8395).
March 8–10, 2010	Public scoping meetings	Held public meetings in Stafford, Great Bend, and Wichita, Kansas. The public had an opportunity to learn about the CCP process and provide comments.
March 9–10, 2010	CCP kickoff and vision and goals meeting	Reviewed the refuge purposes, identified refuge qualities and issues, and developed a draft vision statement and goals for the refuge.
March 22–23, 2011	Hydrogeomorphic method analysis project update	Reviewed the progress and findings of the hydrogeomorphic analysis project.
November 2–3, 2011	Alternatives development planning meeting	Discussed management alternatives.
March 13–14, 2012	Environmental consequences and choosing proposed action workshop	Reviewed the environmental consequences for the alternatives, and to select a proposed action alternative.
May 1–2, 2012	Objectives and strategies work session	Developed objectives and strategies for the proposed action alternative.
May–June 2012	Draft plan preparation	Prepared the draft CCP and EA.
November 2012	Draft plan internal review	Team and other Service staff reviewed the draft CCP and EA and provided comments to help clarify the analyses and provide consistency.
January–March 2013	Draft plan preparation	Completed the draft plan for public review.
April 2013	Draft plan public review	The planning team completed the draft plan for distribution to the public for review.
April 2013	Planning update	Mailed the second planning update to those on our mailing list. The update announced upcoming public scoping meetings.
April–May 2013	Public scoping meetings	Public meetings were held in Great Bend, Stafford, and Wichita, Kansas.
June–September 2013	Public comments review	The planning team reviewed the public comments and determined needed changed for the final CCP.
October 2013	Decision on preferred alternative	The Regional Director selected the preferred alternatives and signed the finding of no significant impact.
November 2013–April 2014	Final Plan preparation	The planning team finished revising and editing the final CCP for printing and distribution.

See Appendix D—Public Involvement for more detail.

We mailed the first planning update using our mailing list, and we made updates available at the public scoping meetings. The update included information on the history of the refuge and on the CCP process. It included an invitation to attend the public scoping meetings and contained information on how to be placed on the CCP mailing list as well as on how to submit comments to us. Our planning team leader accepted emails at address: toni_griffin@fws.gov.

We held three public scoping meetings from March 8 to March 10, 2010. We used an open house format and set up stations tended by our staff to provide information and answer questions. Attendees were encouraged to ask questions and offer comments. We recorded verbal comments, and each person was given a comment form that could be used to submit added thoughts or questions in writing.

Written comments were due March 31, 2010. We received more than 80 comments orally and in writing during the scoping process. We received letters from 3 organizations (National Wild Turkey Federation, Defenders of Wildlife, Great Bend Convention and Visitors Bureau) and from 12 individuals. Each member of our team reviewed the comments, and we considered them throughout the planning process.

State Coordination

Our Regional Director for Region 6 of the Service sent a letter to KDWPT, inviting them to take part in our planning process. As a result, three of their representatives joined our planning team.

We mailed the first planning update to the offices of U.S. Representatives Lynn Jenkins, Jerry Moran, and Todd Tiahrt and U.S. Senators Sam Brownback and Pat Roberts for Kansas telling them of the planning process, inviting them to attend our public scoping meetings, and asking them to provide comments on issues to be addressed during the planning process. We also mailed planning updates to Kansas Governor M. Parkinson, to Kansas State senator Ruth Teichman, and to State representatives Mitch Holmes and Dennis Moore. We also invited these elected officials to attend our scoping meetings by phone.

Tribal Coordination

Our Regional Director for Region 6 sent a letter to tribes that have been identified as possibly having a cultural and historic connection to the Quivira Refuge area. The Citizen Potawatomi Nation, Kickapoo Tribe in Kansas, Kickapoo Tribe of Oklahoma, Kiowa, Osage Nation of Oklahoma, Prairie Band of Potawatomi of Kansas, Seneca–Cayuga Tribe of Oklahoma, Shawnee, and Wyandotte Nation of Oklahoma tribal councils all received this letter.

The Osage Nation tribal council responded to our letter, and they appointed Dr. Andrea Hunter, tribal historic preservation officer; James Munkres, archaeologist I; Rebecca Brave, Native American Graves Protection and Repatriation Act assistant; and Bradley P. Stumph, natural resource specialist, to represent them on our planning team. These tribal representatives attended two planning meetings, our vision and goals workshop and our hydrogeomorphic method analysis project update session. The Osage

Rachel Laubhan/FWS

Silky Prairie Clover

Nation reviewed the draft CCP and EA during internal review, and they provided comments.

Other tribal councils did not respond to the letter from our Regional Director, but we continued to invite their comments.

Results of Scoping

We used the comments, collected from scoping meetings and correspondence, in the development of a final list of issues that were addressed in the draft CCP and EA. We decided which alternatives could best address these issues. The planning process ensures that we resolve or give priority to issues with the greatest effect on the refuge resources and programs over the life of the final CCP. Chapter 2 contains the issues we identified, along with a discussion of effects on resources. In addition, we considered suggested changes to current refuge management presented by the public and other groups.

The Draft Plan

Availability of the draft CCP and EA for Quivira Refuge was announced in the Federal Register on April 22, 2013, and comments on this document were collected through May 31, 2013. Three public meetings to discuss this plan were announced in a planning update released in April 2013. These meetings were held from April 29 to May 1, 2013 in the local communities of Great Bend, Stafford, and Wichita, Kansas. Meeting attendees were given the opportunity to submit comments. Comments were also collected online, by email, and by mail.

The public commented on the draft CCP and EA during a review period. We recorded all comments, oral and written. The planning team then reviewed them. Some modifications were made to this final CCP based on the public review. Appendix D has more detail about our involvement with the public, including responses to substantive public comments on the draft CCP and EA.

Rachel Laubhan/FWS

Long-billed Dowitcher

The Final Plan

Approved by the Regional Director, this final CCP directs the management of the Quivira National Wildlife Refuge to meet the purposes of the refuge and to address issues.

The plan is intended to be a broad umbrella of general concepts and specific objectives for the refuge over the next 15 years. As the plan is implemented, we will develop stepdown plans with details for carrying out actions needed to achieve objectives.

Chapter 2—The Refuge

Dan Severson/FWS

Whooping Crane

This chapter explains the establishment, management history, purpose and special values of Quivira National Wildlife Refuge. Planning issues and a discussion of their effects on resources are also summarized here. Our planning process sought to resolve issues that have the greatest effect on refuge resources and programs, and it ranked these issues for further consideration over the life of the plan.

2.1 Establishment, Acquisition, and Management History

The following section describes the establishment, acquisition, and management history of Quivira Refuge.

Establishment

In May 1955, the Migratory Bird Conservation Commission approved the establishment of, and the processing of purchase agreements for, the "Great Salt Marsh National Wildlife Refuge" to recognize two unique, historic saltmarsh and salt flat areas, the Big Salt Marsh (BSM) and the Little Salt Marsh (LSM).

In 1958, the name of the refuge was changed to Quivira National Wildlife Refuge after the Spanish term for the area. Quivira Refuge has a mixed-grass sand prairie ecosystem that contains a diversity of grassland and wetland vegetation associations (Faber-Langedoen 2001) with a range of salinities, stream corridors, salt flats, sand dunes and hills, and agricultural lands.

Barry Jones/FWS

Boiling Springs

Acquisition History

After establishment, acquisitions were made to bring the refuge area to 21,820 acres by 1969. In August 1991, two Hornbaker tracts totaling 116 acres southwest of the refuge were acquired from the Farmers Home Administration. Approximately 200 more acres were bought from Richardson in 1998 in the BSM area. These acquisitions enlarged the refuge to 22,135 acres (table 2)

Management History

Water management has played a major role at the refuge. In 1957 we filed for a "senior" right to divert 22,200 acre-feet of water from Rattlesnake Creek to refuge wetlands (Estep 2000, Striffler 2011). In 1982, we filed a Notice of Proof of completion of work for water right permit #7571. In 1996, the Kansas Division of Water Resources certified a permit for only 14,632 acre-feet of water diversion from Rattlesnake Creek because we could not show that we had diverted 22,200 acre-feet during the period of proof.

The current Kansas Water Right for the refuge is 14,632 acre-feet per year not to exceed 300 cubic feet per second from Rattlesnake Creek. The actual quantity of water normally diverted from Rattlesnake Creek for refuge management is less than this water right, often because sufficient quantities are not available at the time water is desired to achieve refuge habitat goals and objectives. In years with below-average precipitation and heavy demands for agricultural irrigation, the refuge receives insufficient quantities to exercise all habitat management options. Water is not metered when it leaves the refuge mostly because water rights are absent downstream where it enters the Arkansas River.

Water control structures may be found in figure 5.

2.2 Purposes

Every unit of the Refuge System has one or more purposes for which it was established. They are the foundation on which to build all management programs, from biology and public use, to maintenance and facilities. No action that anyone takes may conflict with them. The purposes are found in the legislative acts or administrative orders under which lands are either transferred or acquired, or conservation easements are established, for a refuge unit. An individual unit may contain lands that have been acquired under a variety of transfer and acquisition authorities, which then gives the unit more than one purpose.

On May 3, 1955, Quivira Refuge was established under these authorities and for these purposes:

- Migratory Bird Conservation Act (16 United States Code [U.S.C.] § 715d)
  - for use as an inviolate sanctuary, or for any other management purpose, for migratory birds
- Fish and Wildlife Act of 1956 (16 U.S.C. § 742f(a)4)
  - or the development, advancement, management, conservation, and protection of fish and wildlife resources
- Fish and Wildlife Act of 1956 (16 U.S.C. § 742f(b)1)
  - for the benefit of the United States Fish and Wildlife Service, in performing its activities and services

The goals, objectives, and strategies identified in this CCP support these purposes

Table 2. Land acquisition history of the Quivira National Wildlife Refuge, Kansas.

Acres reserved from public domain	*Acres acquired by other Federal agency*	*Acres donated*	*Acres bought*	*Acres in agreement easement or lease*	*Total acres in refuge*	*Total cost of land acquisition*
0	116	199.2	21,820.1	0	22,135.3	$2,059,238

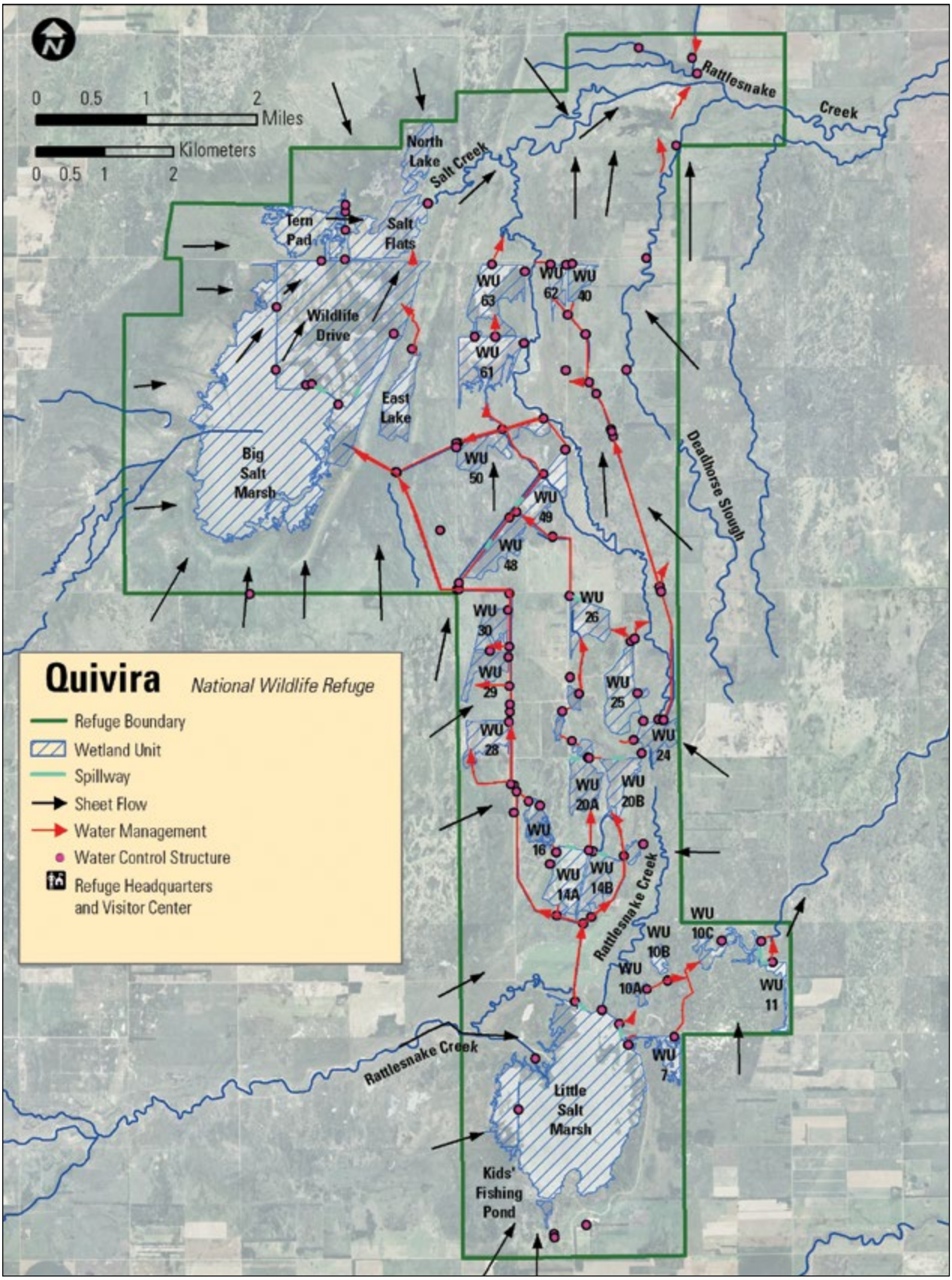

Figure 5. Water control structures, Quivira National Wildlife Refuge, Kansas.

2.3 Vision

We developed a vision for Quivira Refuge that describes the focus of refuge management, including what will be different in the future. This is the essence of what we want to accomplish at the refuge by the end of the life of this CCP in 15 years. The vision for Quivira Refuge is as follows:

Near the confluence of the Rattlesnake Creek and Arkansas River in central Kansas, water remains the great driver of a diverse complex of saltmarsh and unique native sand prairie community that is Quivira National Wildlife Refuge. The combination of these productive habitats as well as the refuge's midcontinent location continue to attract millions of birds needing to replenish essential reserves and to find protection in the mosaic of largely open grasses, sedges, rushes, and water. Through environmental education and outreach, we promote understanding and appreciation of the refuge's dynamic landscapes. For visitors, each moment is unique—the smell of moist earth and salty air, the primitive call of a crane, the whispering bluestem, the cacophony of geese, the early steps of a snowy plover chick, or the discovery of a subtle pattern or design in nature. In a land of recurring extremes, ongoing collaboration between refuge professionals, partners, and the public sustains a healthy system. Through land stewards transcending refuge boundaries, the integrity of these ecosystems are conserved with awe, respect, and appreciation of the gifts it offers for all to receive.

2.4 Goals

We also developed a set of goals for Quivira Refuge based on the Improvement Act, the refuge's purposes, and the information we gathered, with help from the public, during planning. These goals will direct our work in achieving the vision and purposes of the refuge, and they outline approaches for managing the refuge's resources.

Landscape Conservation Goal

Actively protect, preserve, manage, and restore the functionality of the diverse ecosystems of the Rattlesnake Creek watershed.

Native Ecological Community Conservation Goal

Actively conserve and improve environmental conditions within refuge boundaries to promote sustainable, native ecological communities and support species of concern associated with this region of the Great Plains.

Visitor Services Goal

See that visitors enjoy quality, wildlife-dependent recreational opportunities.

Public Outreach Goal

Help visitors of all abilities understand, appreciate, and support our mission, the refuge's unique habitats, and the refuge's importance to migratory birds and other wildlife and plant species.

© Mitch Werner

Prickly Pear

Cultural Resources Goal

Name, value, and preserve the cultural resources and cultural history of the refuge and connect staff, visitors, and the community to the area's past.

Visitor and Employee Safety and Resource Protection Goal

Provide for the safety, security, and protection of visitors, employees, natural and cultural resources, and facilities of the refuge and the GPNC.

Administration Goal

Provide and maintain facilities, strategically acquire and allocate staff, increase volunteer opportunities and partnerships, and effectively raise and use money to support the long-term integrity of infrastructure, habitats, and wildlife resources at the refuge and at the GPNC.

2.5 Special Values

The public helped us to name the special values of Quivira Refuge, which are the characteristics and features that make it special, valuable for wildlife, and worthy of national wildlife refuge status. Special values can range from unique biological features to something as simple as "a quiet place to see a variety of birds and enjoy nature."

Naming the special values for Quivira Refuge, listed below, helps us to recognize its worth and to make sure that these values are preserved, protected, and enhanced through planning.

Rare, Diverse, and Quality Habitat

Quivira Refuge contains unique systems, including inland saltmarsh and native sand prairie. The saltmarsh and alkali flats support a diverse range of wildlife species that use the refuge for migration and nesting. The refuge contains quality grassland habitat that is complimented by a grassland buffer that surrounds the refuge and creates large blocks of contiguous habitat for grassland-dependent species, including prairie-chicken. The refuge has large areas of wetland habitat that supports many wildlife species and has the potential for moist soil management.

Wildlife Species

Quivira Refuge is located in a transition zone providing habitat for both eastern and western migratory bird species. Large numbers and concentrations of these birds occur on the refuge, and a variety of rail species are also present. The refuge also supports a diverse population of reptiles and amphibians, as well as a prairie dog town.

Species of Concern

The refuge provides critical habitat for the federally listed whooping crane and State-listed western snowy plover. Bald eagles winter and nest on the refuge, and federally listed interior least terns also nest here.

Water Resources

Quivira Refuge has senior water rights, approximately 14,000 acre-feet per year, and water management capability on the refuge is good because of a strong network of infrastructure that has water control structures and dikes.

Communities and People

Local, regional, and international communities support Quivira Refuge. It has a Friends group and boosts the economies of surrounding, rural communities. Less than 3 percent of Kansas' lands are owned by the public, and the refuge makes up a large part of that. In addition, the refuge feels little urban encroachment.

Education and Visitor Services

Quivira Refuge offers many opportunities for wildlife-dependent recreation, including hunting, fishing, wildlife observation, photography, environmental education, and interpretation. Forty percent

of the refuge, or approximately 9,000 acres, is open to hunting. All of the refuge is open to fishing and to foot traffic for wildlife observation and photography year round, except when temporary closures are necessary for events like eagle or tern nesting. Quivira Refuge also comanages the GPNC in Wichita, which complements and supports its purposes.

Cultural Resources

The area is rich in Native American history, as generations of people came here for both food and water. As such, the potential exists for cultural resources to be found on Quivira Refuge.

Facilities and Infrastructure

There is good access to, and within, Quivira Refuge. Directions to the refuge are well signed, and many sites within the refuge are accessible to persons with disabilities.

Special Designations

Quivira Refuge has many special designations including: Ramsar Site, as identified by Wetlands of International Importance; Western Hemisphere Shorebird Reserve Network contributor; one of the Eight Wonders of Kansas; and Important Bird Area, as identified by the National Audubon Society. We have also designated the Santana Research Natural Area on the refuge.

2.6 Planning Issues

Based on an analysis of comments collected from the public, input from our staff, and a review of the needs of the Improvement Act and NEPA, we identified several key issues for Quivira Refuge. These were used to create alternatives for future management and are summarized below.

Water Quantity and Quality

Agriculture dominates the area, oil production is common, and water rights have been overappropriated within the water management district. These water resource and land use trends relate to additional concerns of current and future characteristics of water quality. Future water availability and quality may not be assured, yet adequate water quantity and chemistry are critical factors of refuge saltmarsh and wetland communities. Substantial declines in the

FWS

White-tailed Deer

water table would also likely affect grassland and meadow habitats.

Tree Management

There are differences of opinion about tree management on Quivira Refuge. Prairie restoration, with a reduction in current tree coverage, is generally understood and supported. Yet, some would prefer that we keep tree coverage at a higher level for a variety of reasons.

Whooping Crane Closures

When whooping cranes, which are federally listed as endangered, are present, Quivira Refuge closes to hunting to avoid disturbing them and to prevent accidentally shooting them. Whooping crane arrivals and departures are unpredictable, which makes it difficult for hunters to plan ahead. Public lands for hunting in Kansas are also limited, which exacerbates their frustration. And yet, while disappointing hunters, whooping cranes do attract birders.

We at the refuge have received many requests to reconsider our refuge-wide closures. At the nearby Cheyenne Bottoms Wildlife Area, KDWPT has successfully protected whooping cranes by using partial area closures. This may prove to be effective for us as well.

Prohibiting the Collection of Shed Antlers

Deer population density on Quivira Refuge is relatively high, and those who have an interest in shed antler collection do not support our decision to prohibit this activity on all refuges in Kansas. However, collecting or taking of any plant, wildlife or parts thereof from a national wildlife refuge without a permit is specifically prohibited under Title 50 CFR Part 27.61.

Deer and Turkey Hunting

Deer and turkey hunting have never been approved as a public use activity or management strategy on Quivira National Wildlife Refuge, but there is interest in allowing these hunting activities in the future. Populations of these species continue to increase, and research suggests that effective population management may require a control of some sort both on and off refuge lands.

Rachel Laubhan/FWS

Eastern Racer

Increasing Public Use and Wildlife Compatibility

We are aware of potential benefits and harm to natural resource conservation brought on by an increasing interest in birding and ecotourism. Whooping cranes and rare birds quickly attract many birders and photographers when they appear on the refuge. According to the National Wildlife Refuge System Compatibility Policy, these wildlife-dependent recreational use activities are welcome as long as they are found not to interfere with, or detract from, the fulfillment of the Refuge System mission or the purposes of the refuge.

Chapter 3—Refuge Resources and Description

© Bob Gress

Pectoral Sandpiper

This chapter describes the environment found at Quivira Refuge that will be affected by the actions we choose to enact as a result of the planning process contained in this CCP. The environment has physical and biological parts and elements that have been created by humans, such as cultural resources, special management areas, visitor services, operations and socioeconomics.

3.1 Physical Environment

The following sections describe aspects of the physical environment of the refuge. Physical characteristics include climate, climate change, air quality, geography and physiography, water resources, and soils. Many regional descriptions of the physical environment have been completed and may be reviewed for more detail, such as a report on the Rattlesnake Creek Subbasin available through the Kansas Department of Agriculture (2006).

Climate

The refuge climate is dry sub humid, lying along the transition boundary between the rain shadow of the Rocky Mountains and the warm, moist air currents of the Gulf of Mexico. Regional weather patterns depend on the interaction of these two air masses (Sophocleous and Perkins 1992).

Refuge habitat conditions are influenced greatly by climate and management strategies, and prescriptions are adjusted based on seasonal and annual fluctuations in precipitation, temperature, and evaporation. Weather data have been recorded from a station in Hudson, Kansas, about 8 miles west of

the refuge, since at least 1941. Based on this historical data, the coldest month is January, with average low and high temperatures of 20 and 41 °F, respectively, and the warmest month is July, with average low and high temperatures of 68 and 95 °F, respectively. Annual precipitation varies between 13 and 41 inches, with a long-term average of 24–25 inches. It rains an average of 74 days per year in Stafford County and 71 percent of the precipitation falls during the growing season, which averages 185 days between April and September. Mean snowfall is 20 inches per year, yet substantial accumulations seldom occur. The average annual free-surface evaporation is about 64 inches (Sophocleous et al. 1997), with rates being highest during the summer months (Latta, 1950).

Because of its location at a climatic boundary prone to multiple air masses, Kansas is also vulnerable to strong thunderstorms, especially in the spring months. Many of these storms become super cell thunderstorms. According to statistics from the National Climatic Data Center, Kansas has reported more tornadoes (for the period January 1, 1950 through October 31, 2006) than any state except Texas, and it averages more than 50 tornadoes annually (NOAA, 2006). Prevailing winds are from the southeast during the summer months, May through September. Northeast winds are common throughout the winter months, October through April. Average wind velocities are moderately strong in all seasons and reach their greatest velocities during the spring. The mean, 0.02-mile (30-meter) wind speeds for Quivira Refuge range from 13.4 to 14.5 miles per hour (Kansas Corporation Commission 2008).

Climate Change

Climate change is the preeminent issue for conservation in the future. Over the next two decades, a warming of about 0.36 °F per decade is projected for the planet as a whole. Warming is expected to continue for centuries, even if greenhouse gas emissions are stabilized, because of the substantial time lags of climatic processes (Christensen et al. 2007).

Along with this projected warming, atmospheric moisture transport and convergence is projected to increase, resulting in a widespread increase in annual precipitation over most of the continent, except the south and southwestern part of the United States (Christensen et al. 2007). This increased precipitation is more likely to occur in winter and spring months, rather than in the summer (Christensen et al. 2007). It is also considered likely that extreme weather, such as heat waves and flooding, will become more frequent. Increases in annual precipitation may be partially offset by increases in evaporation. Moisture availability, rather than just precipitation, is an essential resource for plants and animals.

Such changes will influence many environmental factors that will affect our management of Quivira Refuge, such as the balance of water inflows and outflows, water runoff patterns, the rate and extent of erosion, aquifer recharge rates, water quality parameters, and species abundance and distributions. However, climate change predictions are generally applied at large spatial scales, and much uncertainty remains about the use of this information at local scales (Weins and Bachelet 2010). Thus, it is difficult to plan for specific management changes on the refuge based on our current understanding.

While finding specific management actions to address climate change are not possible at this time, a report on the potential effects of human-caused climate change was prepared for the Playa Lakes Joint Venture (PLJV) region with a focus on habitats (Matthews 2008) (figure 8). This report synthesized much of the relevant information available at the time, including works of the Intergovernmental Panel on Climate Change and many peer-reviewed publications. The author notes that while global and regional shifts in climate are natural, adapting to recent changes is different because of landscape modifications like habitat fragmentation, invasive species, and water quality degradation. Species most vulnerable to climate change have restricted ranges, specialized habitat needs, and are largely migrants. Predicted potential climate change effects on habitat within the PLJV region cited in this report are summarized in the list below. It is important to note differences in climate change predictions at various scales of the PLJV region, such as overall, southwest, and northeast, though all scales are important considerations in the management of natural resources that occur on the refuge. The author also qualifies predictions with the understanding that local variations in weather patterns, like the amount and intensity of precipitation, are a continuing characteristic of the region.

Predicted Potential Effects of Climate Change at the Scale of the Playa Lakes Joint Venture Region

- decreasing annual precipitation in contrast to the larger Great Plains region
- increasing winter temperatures causing less snow, or frozen, precipitation and less ice cover and more rain, with precipitation falling later and melting earlier
- decreasing water volume in wetlands in fall and winter leading to more shallow habitat

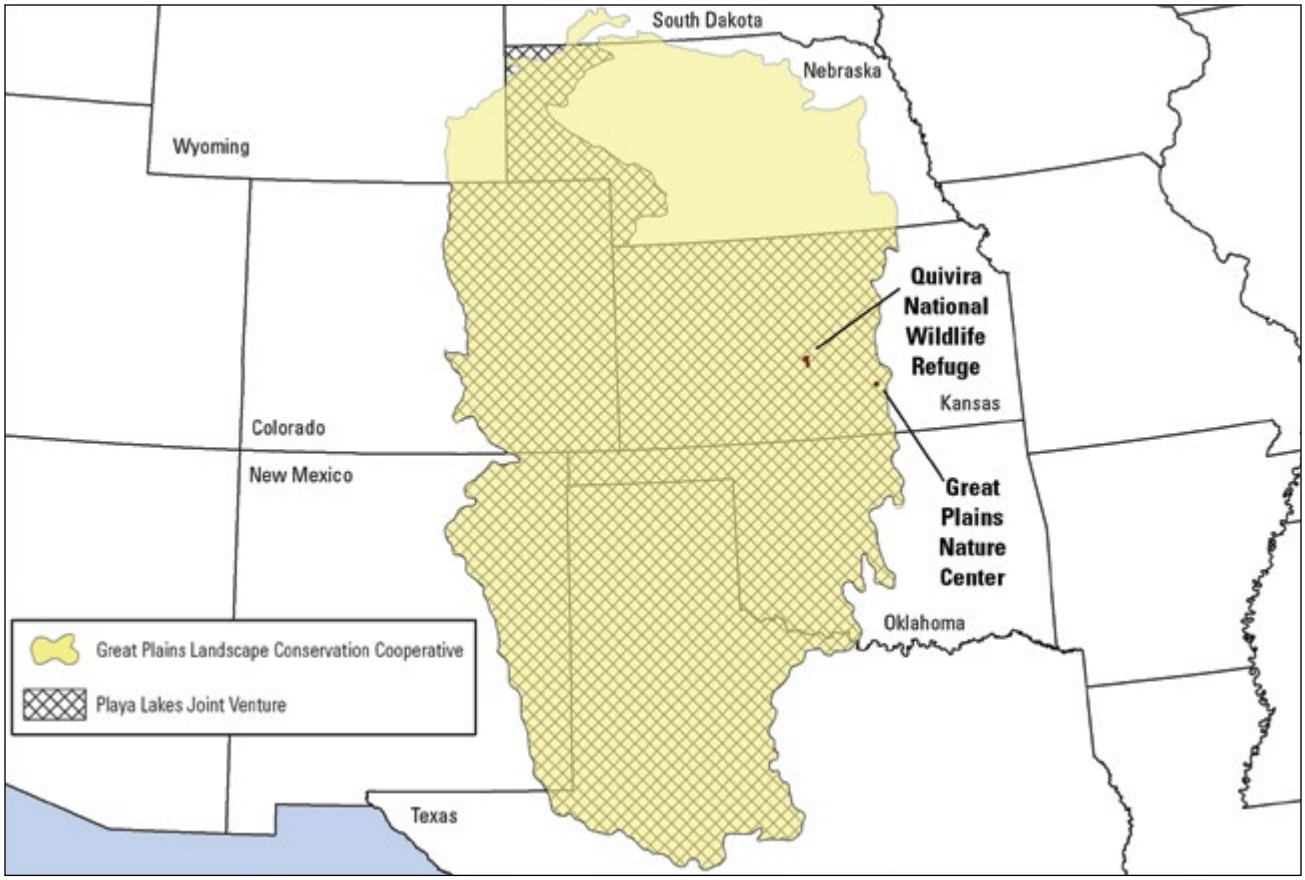

Figure 6. Playa Lakes Joint Venture region, Quivira National Wildlife Refuge, Kansas.

- decreasing presence of flooded, or functioning, wetlands, especially more ephemeral and shallow types—which compose most of the wetlands in the PLJV region—or those that respond quickly to changes in precipitation and evaporation, like playas, warm-water sloughs, floodplain marshes, and wet meadows, resulting in decreased cooler, deeper water during warm periods, particularly in the summer and early fall
- increasing rate of increase in summer temperatures
- changing plant species productivity, abundance, and ranges across all habitat types and partly related to the differences in their tolerance levels or adaptation strategies to events like drought, flooding and fire
- changing distribution of wetlands across the landscape
- decreasing connectivity among wetlands by ground water or by periods of high precipitation and flooding
- increasing likelihood of disease transmission because of higher concentrations of waterfowl in limited habitat areas, higher winter temperatures, and more
- changing species composition, or abundance, of fish
- changing water column turnover cycles for larger, deeper wetlands that leads to the reduced overall productivity of open-water habitat
- decreasing sensitivity and increasing resiliency of sandhill wetlands, or those influenced by ground water—not playas, or wetlands dependent on precipitation and with no, or limited, connectivity to ground water—to temperature and precipitation extremes during the next one to two decades or longer with changes in erosion rates possibly causing sandhills to move
- sustaining local populations of specialized arthropod species in saline wetlands may be affected by persistent dry conditions and

sustaining bird species with great dependence on saline wetlands could be negatively affected by more extreme flooding and drying events

- increasing drought frequency
- increasing abundance of fully flooded playas, or temporary, seasonal wetlands, in the spring
- increasing abundance of fast runoff events
- increasing sedimentation rates
- decreasing food availability for birds with shifts in the quality and state of wetlands, such as moving from a water condition that is dominated by plants large enough to be seen by the human eye, which results in oxygen-rich water, to one that support a dense growth of algae that depletes oxygen
- likely increasing generalist invasive exotic species
- decreasing overall water quality
- eastern shifting of the central United States and Canada migratory flyway
- decreasing sensitivity to climate changes by larger catchments and watersheds with more permanent flowing water relative to smaller catchments and watersheds with less permanent flowing water
- altering flow regimes for rivers and streams in the PLJV region, with lower flows occurring in later summer and early fall and higher flows occurring in the winter and spring and with low-order streams being more directly affected by winter and spring flooding events than the middle, and lower, reaches of rivers
- emerging economic and political trends and resultant changes in land use patterns, such as agricultural strategies and practices, urbanization, and fire suppression, will decide natural resource effects
- shifting distribution—moving north and east into the PLJV region—of nematodes, insects and other arthropod species that are native to North America but exotic to region
- increasing grassland productivity with the increased rates of spring precipitation, while increasing levels of atmospheric carbon dioxide and other complex feedback mechanisms may affect the duration of this trend
- accentuating thermal effects on grassland habitats by insects, notably plant pollinators and herbivores will affect associated predator–prey relationships and influence species abundance and phenologies, like the timing of breeding, migration, and other life events
- increasing fire on the landscape to help most grassland habitats, while creating uncertainty about what grassland types and conditions will follow burns over the long term
- affecting prairie dog communities, but how is not known, with one study suggesting that prairie dog herbivory might support their resilience to climate change

Predicted Potential Effects of Climate Change on Areas within the PLJV Region:

- An increasingly extreme annual precipitation gradient between the southwestern and northeastern parts of the PLJV region will develop—uncertainty makes drawing clear boundaries extremely difficult. It is likely that, by midcentury, areas farther north, perhaps to Nebraska, will be similar to the current thermal regime of the southern high plains.
- For northern and eastern parts of the PLJV region, including the refuge area, there may be an increase in annual precipitation of less than 10 percent by 2100 and uncertainty about specific changes in hydrologic patterns, like timing. This precipitation trend is in contrast to that at a PLJV scale and more consistent with trends at a Great Plains scale.
- For northern and eastern parts of the PLJV region, current trends suggest that ephemeral wetlands could shift to more permanent types. However, some models suggest that summers could become warmer in these areas and increase evaporation rates.
- For the southwest area of the PLJV region, increasing drought frequency and severity could turn semiarid regions into deserts.

Collectively, the potential effects of climate change described above inform us on how environmental conditions may change in the future, as well as how the roles, and relative importance, of natural resources that occur on the refuge might change within the context of the PLJV region. Many strategies used in traditional refuge management may also be used to address challenges related to climate change, like the control of invasive species, the support of native communities, the control or reduction of habitat fragmentation, the manipulation of water levels, and the periodic assessment of conservation goals and objectives, but new strategies may also have to be developed.

Land Features

Quivira Refuge is located in the Great Bend Lowland, or Prairie, which is part of the Arkansas River Lowlands section of the larger Central Lowland physiographic province (Schoewe 1949). Following the large, northward bend of the Arkansas River in central Kansas, the Great Bend Lowland is an alluvial plain, with sediment originally deposited by flowing water that has local, gently rolling hills. Refuge lands range in elevation from about 1,700 to 1,800 feet above sea level (Schoewe 1949) and are only slightly higher in elevation than the Arkansas River (Hathaway et al. 1978). Arbogast and Johnson (1998) refer to the Great Bend (Sand) Prairie as a "mosaic of sand sheets and dune fields," with dune orientations that are mostly northwesterly and southwesterly. Surface materials are mostly easily erodible sands and gravels of Quaternary Dunes (Schoewe 1949, Zeller 1968) that are generally of Rocky Mountain origin deposited from laterally shifting channels of the ancestral Arkansas River (Fent 1950). The Rattlesnake Creek is a mostly perennial tributary that meanders northeasterly through the Great Bend Lowland and flows through Quivira Refuge about 15 miles from its confluence with the Arkansas River.

Thin, unconsolidated, or undifferentiated, alluvium that is less than 20 feet thick and more-recent Eolian sand deposits are common in the area of the refuge (Arbogast 1995, Arbogast and Johnson 1998, Sophocleous 2003). The alluvial materials are poorly sorted sand, silt, and clay broadly described as silty sand, sandy loam, or loess, whereas, sands are well sorted. Poorly sorted materials are less porous, have poor drainage when compared to well-sorted materials, and are commonly associated with local depressions like wetlands. In contrast, well-sorted deposits are characteristic of higher sand dune sites and often occur in areas of ground water recharge or springs. Particle size of deposits also influence soil and water properties, which partly determine plant and wildlife communities. Dune sands generally are very fine-to-fine-sized particles, and those of the beach ridge occurring along the east and southeast side of the BSM, which were derived from a Wisconsin-age lake, are fine-to-medium sized (Arbogast and Johnson 1998, Heitmeyer et al. 2012). More detailed soil descriptions and their relationships with different communities on the refuge are provided in the soils section of this chapter.

A broad description of the geologic stratigraphy of the Quaternary alluvium in the area of the Quivira Refuge, in order from surface to bedrock, is as follows: (1) sand dunes; (2) relatively continuous near-surface silt–clay bed from a loess deposit; (3) alternating sequences of sandy silt–clay, sand, and gravel lenses; (4) basal sand and gravel beds of fluvial origin; and (5) bedrock (Latta 1950, Macfarlane et al. 1993, Fader and Stullken, 1978, Kansas Department of Agriculture 2006). The type, relative age, and position of parent material greatly influence soil formation, hydrology, and resulting plant communities. The Permian bedrock, many feet below the relatively more permeable surface materials, is up to 350 feet thick in the area of the refuge (Macfarlane et al. 1993, West et al. 2010). Fader and Stullken (1978) state that the Permian bedrock underlying the refuge is primarily associated with the Salt Plain Formation, although an area along the east boundary of the refuge is associated with the Harper Sandstone Formation. In other reports, these two Permian bedrock formations are collectively called the Harper Salt Plain Formation or "red beds." Materials in these formations consist of reddish-brown sandstone, siltstone, shale, salt, gypsum, anhydrite, and limestone, which are a source of saline water that is characteristic of the refuge (Rubin et al. 2001, Kansas Geological Survey and Kansas State University 1997). At various depths between the surface and bedrock zones are clay lenses or layers that create separation between saltwater of the bedrock aquifer and fresh water of the higher alluvium aquifer of Cretaceous bedrock (Latta 1950, Sophocleous and Ma 1998, Sophocleous 2000, Rubin et al. 2001). More detailed descriptions of geology and hydrology of the area may be found in the Water Resources Inventory and Analysis Report (Striffler 2011) and hydrogeomorphic method analysis report (Heitmeyer et al. 2012) prepared for the refuge.

Soils

Soils are diverse (figure 7) and they differ with respect to texture, moisture and nutrient retention capacities and salinities. Such differences influence

plant and wildlife community distribution and composition. Refuge lands are comprised of the following soil subgroups: 37 percent Subirrigated; 22 percent Saline Subirrigated; 17 percent Sands, choppy and subirrigated; 14 percent Aquolls; 10 percent Sandy; and less than 1 percent each of Loamy Clay and Clay Upland (Soil Survey Staff 2010). Ecological site characteristics and State transition models are described by the National Vegetation Classification System (NRCS) for each soil subgroup (Soil Survey Staff 2010), Heitmeyer et al. 2012).

Water Resources

Hydrology is one of the most important factors influencing ecosystem structure and function. Consequently, hydrology also is of primary importance in planning our refuge management activities. However, hydrology involves complex relationships that exist at multiple spatial scales that are difficult to characterize in a CCP and EA. Therefore, a review of the Water Resources Inventory and Analysis Report (Striffler 2011) and the hydrogeomorphic method analysis report prepared for the refuge, as well as models and reports that provide detailed descriptions of water resources in the Rattlesnake Creek basin, is recommended. For purposes of this CCP and EA, a more general description of water resources is provided below.

Regional Context

Refuge lands occur within the Rattlesnake Creek watershed, which is approximately 95 miles long and 18 miles wide and encompasses parts of 10 counties (Basin Management Team 2010). Within the watershed, Quivira Refuge is located at lower elevations in the eastern part of the watershed and Big Bend Ground-Water Management District No. 5 (USGS 2012b, Sophocleous and McAllister 1987, Rattlesnake Creek/Quivira Partnership 2000). Refuge resources and management are dependent on surface water from the Rattlesnake Creek, but surface and ground water interactions are common, most noticeably in the form of seeps, springs, and underflow.

Surface Water

The drainage area of the watershed is 1,047 square miles, but the upstream area that actually contributes runoff to the area of the refuge is only 519 square miles, as identified by the contributing drainage area for USGS Zenith gaging station #07142575 (USGS 2012d). Rattlesnake Creek flows are checked continuously at the Zenith station, a distance of about 2 aerial miles before entering the southwest boundary of the refuge.

Traditionally, total annual flows in the creek are positively correlated with annual precipitation amounts. However, data from the Zenith gauge show a declining trend in average annual streamflow during recent years that is related to an increased use of ground water for irrigation coupled with reduced precipitation (Striffler 2011). But of equal or greater, importance are the observed changes in the timing of within-year flows. In part because of land use activities upstream from the refuge, water often has been unavailable when needed during the growing season to manage plant communities or to provide habitat for wildlife.

Ground Water

The Rattlesnake Creek watershed overlies the Great Bend Aquifer, which is part of the High Plains Aquifer. In general, ground water flow at a regional scale is eastward (Hathaway et al. 1978), but local variation occurs (figure 5). Near the refuge, the depth to ground water is generally 1–4 feet (Sophocleous 2003, Hathaway et al. 1978). Ground water pumping is a primary water source for irrigated crops, including small grains such as wheat and some corn. In general, most farmland presently lies west of the rangeland and woodland tracts that are next to the refuge boundary.

Water Quality

Major factors affecting water quality in the Rattlesnake Creek Subbasin include complex interactions between aquifers and soil stratigraphy (Sophocleous and Ma 1998, Rubin et al. 2001), irrigation practices (Hathaway et al. 1978, Rubin et al. 2001), and oil and gas activities (Rubin et al. 2001). While mineral composition varies within the watershed, northeastern Stafford County—of which the refuge area is a part—is referred to as a mineral intrusion area. Here, water in the aquifer has contact with salt-bearing Lower Permian bedrock, causing chemical reactions of dissolved solids and the natural occurrence of sodium chloride-type salts (Hathaway et al. 1978). As a result, saline and sodic soils and waters are produced, depending on soil drainage capacities and evaporation patterns (Hathaway et al. 1978, Rattlesnake Creek/Quivira Partnership 2000). High rates of ground water pumping in the Rattlesnake Creek corridor may disrupt the natural discharges of saltwater because of decreased surface flows and increased saltwater entry into the freshwater aquifer (Rubin et al. 2001). Differences in the conductance of water occurs throughout the water-

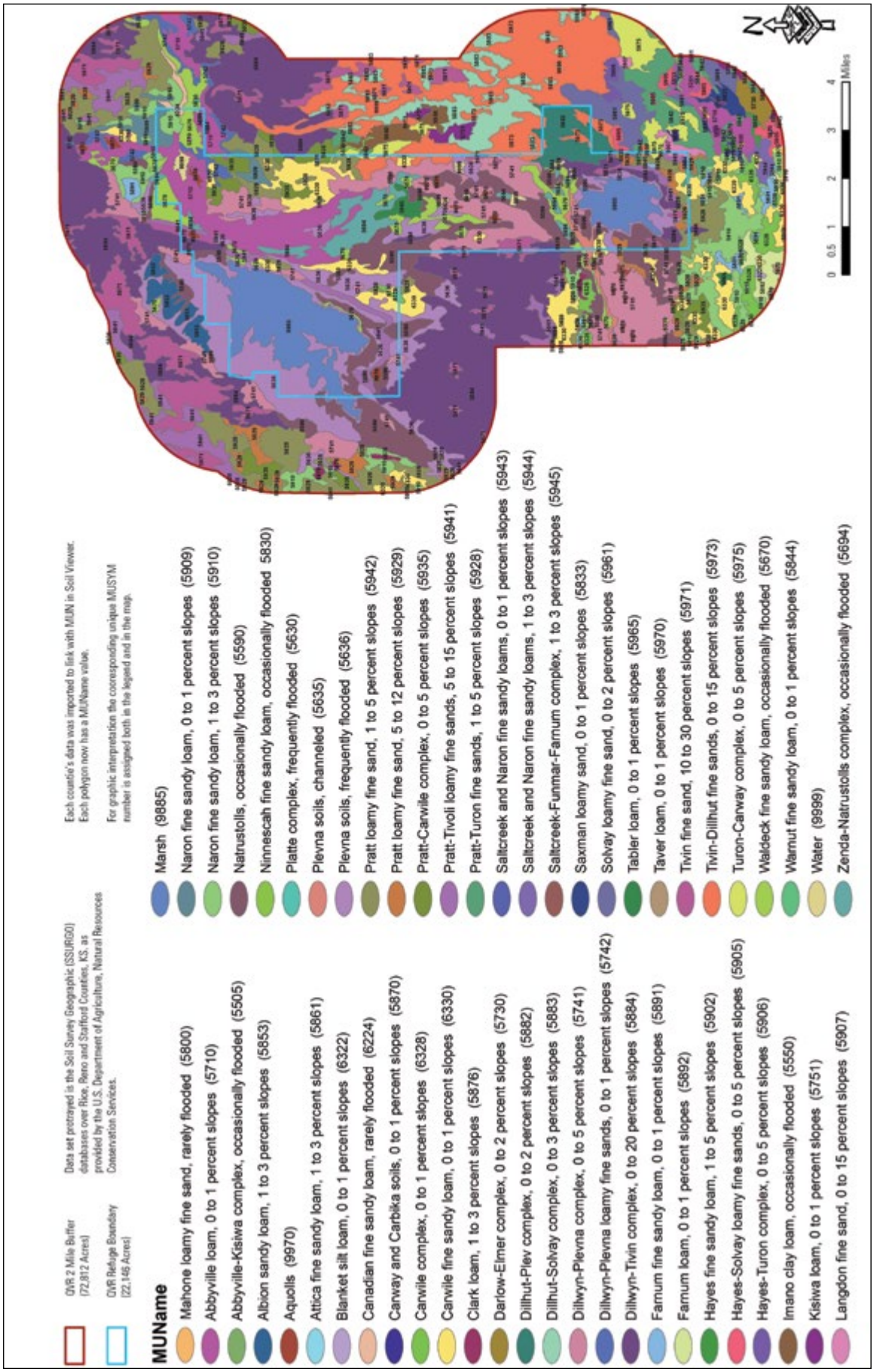

Figure 7. Refuge soil map, Quivira National Wildlife Refuge, Kansas. *Source: Soil Survey Staff 2010.*

shed, with wide ranges possible in the area of the refuge (less than 750, 750–2,250, and up to greater than 2,250 micromhos) (Hathaway et al. 1978). More well test results of chemical quality data sampled at certain points in time in the Great Bend Prairie may be found in a report by Hathaway et al. (1978).

Abnormally high nutrient levels in different states, such as nitrates found in oxygenated conditions, may have adverse ecosystem effects (Christensen 2001). Nitrate concentrations in the Great Bend Prairie aquifer are commonly affected by irrigation well density, subsurface clay lenses, and land use practices. Land managers who use grazing or who manage herbivores in areas of high nitrate concentrations, especially when using more intensive grazing in drought conditions, are often concerned about differential effects to forage plants. For example, cornstalks may hold more nitrates than some bluestem grasses, and the lower 6 inches of a plant may have the highest nitrate concentrations. Land managers adjust strategies to decrease, or prevent, potential adverse effects, such as toxicity and poisoning that can lead to cattle asphyxiation. Nitrate levels reported before in the Great Bend Prairie aquifer are relatively high, often greater than 0.000083454 pound per gallon (10 milligrams per liter), compared to many other samples of uncontaminated ground water collected throughout the United States, which average less than or equal to 0.000025036 pound per gallon (3 milligrams per liter) (Townsend and Young 1995). Based on 42 samples of ground water collected in Stafford County, Townsend and Young (1995) reported that nitrate nonpoint-source contamination was more evident in shallow wells typically used for domestic and stock, with a mean (range) depth of well equal to 60.04 (28.87–93.83) feet (18.3 [8.8–28.6] meters), compared to deep wells typically used for irrigation, with a mean (range) depth of well equal to 83.99 (41.99–135.17) feet (25.6 [12.8–41.2] meters). Nitrate–N values had a mean (range) of 0.00005508 (0.000010849–0.000095972) pound per gallon (6.6 [1.3–11.5] milligrams per liter) for shallow wells and 0.000032547 (0.000011684–0.000079281) pound per gallon (3.9 [1.4–9.5] milligrams per liter) for deep wells. There were no substantial differences in nitrate–N concentrations between sandy and loamy soils or flood versus center-pivot irrigation methods. A thicker clay layer above well screens was positively associated with lower nitrate concentrations in the study. Results of this research may be used in evaluating the potential effects of existing wells in a given area, or considered, when planning the addition or removal of wells on refuge lands.

Rachel Laubhan/FWS

Rattlesnake Creek flows into Little Salt Marsh on Quivira Refuge.

Recent Trends in Water Quantity

Recent regional trends in water quantity that are important in refuge planning include: (1) the encroachment of woody vegetation into open prairie, which likely has resulted in higher water use when compared to the natural plant communities that occurred before human settlement (Striffler 2011, Heitmeyer et al. 2012); and (2) declines in the ground water table and streamflows that are inadequate to meet refuge management needs (Sophocleous 1997, Rattlesnake Creek/Quivira Partnership 2000).

Water Rights and Management

Refuge hydrology is complex, largely because of dynamic precipitation and flow patterns, surface–ground water interaction, and a highly altered landscape that uses extensive ground water pumping within the watershed. Overall, the main sources of surface water entering the refuge are precipitation, ground water discharge, and Rattlesnake Creek surface inflows. Primary surface outflows are evaporation, plant transpiration, ground water recharge, and surface drainage outflows. As discussed above, short- and long-term shifts in the water balance occur in response to precipitation patterns and land use activities within the watershed.

The refuge senior water right [Permit #7571] allows quantities of 14,632 acre-feet per year (AFY) and flows of 300 cubic feet per second (cfs). This water right seems adequate for current refuge management except that often the refuge does not receive water sufficient to meet our water right and water is not always available at a time when it is most critical for refuge management. The refuge waterflow system, or infrastructure, allows various levels of control in flooding, dewatering, and moving water among more than 30 water units (figure 5, Striffler 2011).

In high flow years, excess water may be transferred downstream or used to support desirable water depths in water units, such as impoundments or wetland areas. Sediment and water chemistry may be altered through the periodic flushing and draining of water through the refuge water conveyance system. Occasional dewatering of wetlands is desired to promote the nutrient cycling required for supporting the long-term productivity of wetland systems and for the management of plants with different germination and growth needs (Mitsch and Gosselink 2003). Water depths are often regulated to increase the availability of food resources or structural conditions for waterbirds that have different nutritional needs and adaptations used in acquiring resources.

Air Quality

The Clean Air Act requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (EPA 2011a). In accordance with this need, the EPA has set standards for the following six pollutants to protect the health of humans and the environment: carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution, and sulfur dioxide. Other primary functions of EPA are to provide regulatory authority and technical help to State and local control agencies, as well as to conduct programs that research many different aspects of air science and technology (EPA 2011b). Of particular interest to natural resource managers is current EPA research linking air quality to ecosystem exposure (EPA 2011c), which may provide new insights about the relative importance of sustaining natural resources to improving air quality and interactions between air quality and ecosystem health.

The Kansas Department of Health and Environment's Bureau of Air is the agency that checks, regulates, and reports air quality in Kansas and sends data to the EPA's Air Quality System. Cold winters, warm dry summers, and high winds cause ozone and particulate matter to be criteria pollutants of particular concern in Kansas, especially during events of blowing soil and surface inversions (Kansas Department of Health and Environment 2010). Because of the remoteness of Quivira Refuge, it is presumed that farming and burning activities that affect air quality are of most concern for the refuge. However, the refuge is mostly in Stafford County, where the population density is in the 6,000–9,000 category, and is not included in any Kansas Department of Health and Environment monitoring area or in any designated statistical area. Hutchinson, Great Bend, and Salina are cities close to the refuge that are listed as Micropolitan Statistical Areas, but the Kansas Department of Health and Environment only operates monitors in the Salina Micropolitan Statistical Area, which covers Ottawa and Saline Counties. Salina is downwind of Wichita and is a proposed ozone monitoring site for the next 5 years.

Thus, based on available information, air quality is not a current issue near the refuge, but it may be a consideration in the near future, depending on activities at a larger landscape scale.

3.2 Biological Resources

Evaluating refuge lands in the appropriate ecological context is needed for developing management

goals and objectives that will best meet the purposes of the refuge and optimize contributions to the conservation of biological resources at larger spatial scales. Among the factors that contribute to the diversity and abundance of refuge flora and fauna is the refuge's central location within the mixed-grass transition zone where characteristically short western and tall eastern grasses meet, northern cool-season grasses and southern warm-season grasses converge, and many species range distributions overlap. Thus, depending on shifting short- and long-term environmental conditions, biological resources of the refuge are dynamic within, and among, years. In addition, wetland habitats that tend to be fewer and less reliable in this geographic region attract some species that rely on both wetland and grassland resources for life events. For example, dry shoreline and salt flat habitat provides nesting sites for waterbird species, such as interior least tern, western snowy plover, black-necked stilt, and American avocet. Also, the complex of upland and wetland habitats produces a high abundance and diversity of plants, invertebrates, and vertebrates and, therefore, is an attractive source of food for species associated with both communities. Collectively, these factors contribute to a diverse flora and fauna, because the distributions of many western and eastern wildlife and plant species overlap, such as with the presence of both the eastern and western meadowlark and kingbird.

Quivira Refuge supports a diversity of wetland types that each provide resources like invertebrates, plant foods, and cover in unique combinations that are important for meeting the life requisites of focal species. In addition, each wetland provides multiple plant communities simultaneously, such as tall emergent and wet meadow, and plant communities tend to change temporally in response to abiotic factors like bare mudflats in spring that can be colonized by annual emergent vegetation later in the same year.

Within created wetlands, the partial drawdown or flooding of a unit and brief periods of inundation during the spring has resulted in sparse vegetation interspersed with expanses of mudflats that provide suitable foraging habitat for spring and fall migrating shorebirds. If partial drawdown or flooding is prolonged through the summer, bare mudflats next to shallowly flooded habitats have provided shorebird nesting habitat. Conversely, if water is maintained on units for longer periods, perennial emergent vegetation tends to colonize sites. Local interspersion of emergent herbaceous wetland cover and open water is reported to benefit a high diversity of marshbirds, provided long-term wetland cycling is sustained (Weller and Spatcher 1965, Bolenbaugh et al. 2011), and wetland size is a reported influential factor of habitat use for some waterbirds (Brown and Dinsmore 1986). Depending on the type of perennial vegetation, suitable nesting and foraging habitat has been provided for grebes and bitterns (cattail or bulrush) or rails and phalaropes (sedge or rush). In addition, semipermanent units that support emergent vegetation interspersed with open water have offered suitable breeding habitat for amphibians and thermal cover for waterfowl during early winter.

In grasslands, differences in species niche selection allow cohabitation within the same community. Bird habitat selection differs largely based on behavioral interactions and needs of various life activities, such as for foraging, mating, nesting, brooding, or protection from weather or predators (Wiens 1973, Cody 1985a, Cody 1985b). In general, sand prairie grassland for this region has been described as being dominated by grasses with lesser amounts of forbs and woody vegetation (Küchler 1974, Natural Resource Conservation Service 2010). Ecological site descriptions report potential woody coverage of less than 5–15 percent on some soil associations and up to about 30–40 percent on others, with amounts changing largely dependent on management history. Some shrub cover exists as a natural part of the grassland community to provide valuable wildlife food and different types of cover for nesting, resting, escape, and thermal protection. During winter, a combination of grassland and shrub habitat contributes to bird use diversity and abundance, including focal species (Davis 2001). However, some woody vegetation has been managed to conserve native grassland communities because, for example, extensive tall, dense shrub cover is avoided by some breeding grassland birds (Cooper 2009) and has been associated with higher rates of predation (Klug et al. 2009, 2010).

All biological resources of the refuge are dynamic within, and among, years, depending on short- and long-term environmental conditions. Therefore, evaluating the potential contribution of refuge lands to wildlife is complex and requires consideration of short- and long-term community dynamics relative to the status and importance of species and communities at various spatial scales.

Populations of many species native to the area have declined because of habitat loss and degradation caused by factors such as land use changes, the spread of invasive species, habitat fragmentation, urbanization, and management actions that affect the quantity and quality of water resources. The importance of each of these factors depends on the scale considered. In this planning process, we examined several plans and documents at scales ranging from local to national that were relevant to the purposes and goals of Quivira Refuge. These included our lists of species of management and conservation concern (FWS 2008a) that consider various national and international bird conservation plans and other locally important status reports, or designations.

The descriptions of plant and wildlife communities that follow are not comprehensive.

Plant Communities

This sections includes details on the various plant communities found on Quivira Refuge

Landscape Context: Status and Trends of Plant Communities

Saltmarsh and sand prairie are two distinct ecological communities of Quivira Refuge and the western Great Plains that are of importance at both the global and State scale (Kansas Natural Heritage Program, Kansas Biological Survey 2008). Based on the Natural Plant Communities of Kansas status list dated October 9, 2003, saltmarsh is globally ranked as an imperiled community because of its rarity or its vulnerability to extinction, but is now not able to be ranked at a State level because of the lack of, or conflicting, information. Sand prairie, on the other hand, is a secure community at a global level, but is State listed as imperiled because of its rarity and vulnerability to extirpation in Kansas.

More than 97 percent of lands in Kansas are in private ownership, and most are highly altered from conditions that occurred before European settlement. For example, an evaluation of land cover maps and remotely sensed data shows that current plant community alliances differed substantially from before settlement times—or before about 150 years ago, and more recent times of about 5 years ago (Peterson et al. 2004). Changes in land use from the historical period include 48 percent of lands cultivated in Kansas, and a dramatic reduction in the area of native short, and tall, grass communities. Recent changes in land use affected less than 20 percent of Kansas lands and included conversion of grassland to cropland—greater than 2,471,053 acres (1,000,000 hectares)—and woodland, as well as the conversion of cropland to grassland. The latter can be attributed to enrollments in the Conservation Reserve Program, rather than to the reconstruction, or restoration, of native grassland conditions that occurred historically (Heisler et al. 2003, Briggs et al. 2005).

Rachel Laubhan/FWS

Insects thrive in Quivira Refuge plant communities.

Presettlement Conditions

Küchler (1974) characterized potential natural vegetation for Kansas at a landscape scale. Based on that report, Quivira Refuge's potential natural vegetation includes: saltmarsh (saltgrass–seepweed), floodplain vegetation (cottonwood–willow) and prairie cordgrass, and sand prairie (bluestem–sandreed). While historical surveys vary with respect to the presence of little, or no, woody vegetation, there seems to be agreement that woody vegetation was not a dominant feature, and trees were generally cottonwood and willow (Wilcox 1870, Gates 1937, Thompson 1871, unpublished refuge reports on file at Quivira Refuge headquarters, Stafford County, Kansas).

Küchler's vegetation descriptions, relevant to refuge lands, are provided in table 3. More detail on ecological site potentials are provided by the soil survey staff (2010), which were used to describe potential presettlement conditions of refuge lands in figure 8 and table 4 (Heitmeyer et al. 2012).

Table 3. Vegetation descriptions for Quivira National Wildlife Refuge, Kansas.

Küchler's classification	*General description*	*Major plants*	*Other characteristic parts*	*Location (Kansas and landscape)*
Saltmarsh	Dense to open stands of short-to-medium-tall grasses, few forbs	*Dominants*: saltgrass, seepweed *Local Codominants*: spikerush, three-square, prairie bulrush, prairie cordgrass, alkali sacaton	Wood bluegrass, western ragweed, prairie dogbane, white heath aster, woolly-fruit sedge, Canada wildrye, foxtail barley, inland rush, plains bluegrass, tall or yellow knotweed, drooping bulrush, sea purslane	Alkaline, periodically flooded depressions in central and north-central Kansas

Table 3. Vegetation descriptions for Quivira National Wildlife Refuge, Kansas.

Küchler's classification	*General description*	*Major plants*	*Other characteristic parts*	*Location (Kansas and landscape)*
Floodplain vegetation (western and central Kansas)	*Savanna*: tall, medium-tall, and low broadleaf deciduous scattered trees and shrubs with "impoverished" bluestem prairie understory *Freshwater marsh*: dense stands of tallgrasses with forbs common but not prominent	*Dominants*: cottonwood, peachleaf willow, and, in eastern Kansas, black willow and American elm *Codominant in western Kansas*: sandbar willow *Dominants*: prairie cordgrass	Nearly 30 species and combined species found in eastern and western Kansas *** Wood bluegrass, big bluestem, rice cutgrass, whitegrass, Michigan lily, Virginia bunchflower, switchgrass, cup plant or squarestem rosinweed, hardstem and softstem bulrush, Indiangrass, eastern gamagrass, broadleaf or common cattail	Floodplains and streambanks with permanent and intermittent flooding (note differences in eastern and western Kansas) *** Shallow depressions of floodplains, periodically flooded or with high water table; common in eastern Kansas and in bluestem prairie
Sand prairie	Medium dense stands of grasses that are medium-tall to tall, forbs common	*Dominants*: big bluestem, little bluestem, sandreed, switchgrass	Sand bluestem, field sagewort, sand milkweed, sideoats grama, sandbur, sand lovegrass, umbrella plant, field snakecotton, flaxflowered gilia, prairie sunflower, golden aster, roundhead lespedeza, fourpoint evening primrose, sand paspalum, chickasaw plum, hardstem and softstem bulrush in wet spots, sand dropseed, and broadleaf or common cattail in wet spots	Sandy sites in south-central Kansas

Source: Küchler 1974.

Table 4. Hydrogeomorphic relationship of historical distribution of vegetation communities or habitat types to geomorphic surface, soils, and hydrological regime in the area of Quivira National Wildlife Refuge, Kansas.

Habitat type	*Geomorphic surface*	*Major soil types*	*Flood frequency**
Sandhills	Dune sands	Tivin	OP
Sandy grassland			
(Beach ridge)	Beach ridge	Pratt–Tivoli	OP
Saltmarsh	Alluvial or lacustrine depressions	Soil survey geographic database marsh	SGD, ROB
Saltgrass	Depression fringes	Plevna	SGD, ROB
Seasonal herbaceous	Alluvium depressions	Aquoll, Waldeck	Seasonal surface
Riparian creek corridors	Rattlesnake Creek corridor	Varied, sand	Continual creek flow
Subirrigated saline grassland	Alluvium	Abbyville, Natrisols	SGD, OP
Subirrigated nonsaline grassland	Alluvium	Dillhut–Plevna, Hayes–Solweg, Dillwyn, Zenda	GD, OP
Upland sandy grassland	Dune sands	Canadian, Carwille, Naron, Pratt, Tivin–Dillhut	OP
Upland clay or loam Grassland	Dune loess, loam	Farnum, Tabler	OP

* OP—mostly onsite precipitation; SGD—saline ground water discharge; GD—ground water discharge with low salinity; ROB—Rattlesnake Creek overbank and backwater surface flows; Seasonal surface—mostly seasonal surface water runoff and minor creek overbank flooding, relatively fresh or slightly brackish water; Continual creek flow—sustained flows in Rattlesnake Creek.

Sources*:* relationships were found on land cover maps prepared for the Government Land Office survey notes taken in the late 1800s, historical maps and photographs, current and historical U.S. Department of Agriculture soil maps (Dodge et al. 1978, NRCS 2010), geomorphology maps, region-specific hydrology data (Fader and Stullken 1978, Sophocleous 1997, Jian 1998, Estep 2000, Striffler 2011), and various botanical accounts and literature (NRCS 2010, Ungar 1961).

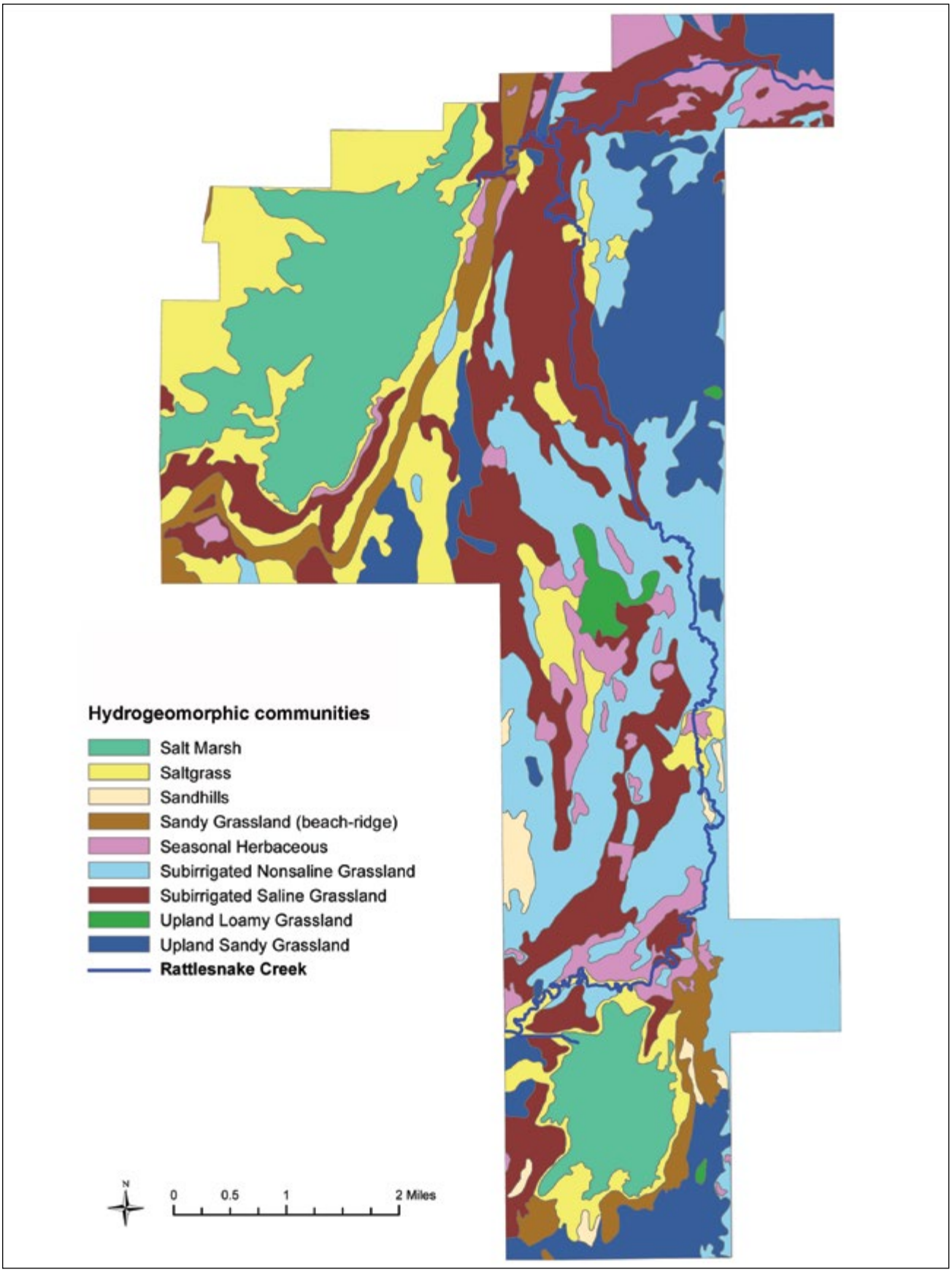

Figure 8. Potential presettlement conditions, Quivira National Wildlife Refuge, Kansas. *Source: Heitmeyer et al. 2012.*

Historical biological information on the saltmarshes of Quivira Refuge is extremely limited. There are a few aerial photos, drawn maps, and miscellaneous notes in published and gray literature. However, hydrologic inputs to the LSM historically occurred only from periodic overbank flooding of Rattlesnake Creek and from precipitation. It was not until the late 1920s–early 1930s that a ditch was constructed to divert Rattlesnake Creek flows directly into the LSM. Likely, this essential hydrologic change generated various short- and long-term transformations of the marsh ecosystem, such as water quantity and quality changes and the introduction or increased presence of carp. For example, at the time of refuge establishment, notes in Quivira Refuge's master plan suggest that the estimated size of the LSM was about 640 acres and its greatest depth was 4 feet. However, a comparison of aerial photographs ranging from the 1920s to today shows that the historical size of the marsh was much smaller (Heitmeyer et al. 2012).

During the 1958–1960 growing seasons, an intensive ecological study of vegetation in, and around, the BSM was conducted by Ungar with emphasis on salt tolerance and its resulting effects on plant distribution (1961, 1964, and 1965). At the time, the marsh covered parts of 12 sections, and water depths rarely reached 2–3 feet, partly because of constructed ditches that had been dug to control drainage before the refuge's establishment.

Seasonal fluctuations in water depth and quality in the BSM were because of characteristic sporadic rains and drying in July and August. The main source of salts in the BSM was found to be sodium chloride. Water and soil samples collected in 1959 and 1960 found similar monthly changes in chloride ion concentration and total salinity, and variability occurred among sampling sites. The lowest salinities occurred in the adjacent prairie and the highest salinities occurred in the barren salt flats, with a general increase in salinity values as the marsh dried in July. In the water, the chloride ion concentration range was equal to 0.008–1.65 percent, and the total salinity range was equal to 0.02–2.96 percent. In the soil surface from 0–3.94 inches (0–10 centimeters), the chloride ion concentration range was equal to 0.001–2.34 percent, and the total salinity range was equal to 0.003–2.96 percent. Salts were greater at the surface, from 0–3.94 inches (0–10 centimeters), than in the soil subsurface, from 23.62–27.56 inches (60–70 centimeters). Soil salinity had more of an effect on the distribution of rooted plants than water salinity, and extremes in salinities—where survival was equal to, or greater than, 1-percent salinity—were most limiting to plant distribution, when compared to averages. Ungar's research and other biological studies conducted since (Reinke 1981, Harris 1999) have identified many unique features of Quivira Refuge's inland saltmarsh systems.

Fine-scale descriptions of lands where created wetlands now occur are limited, however, the following observations were noted from Quivira Refuge's original master plan (FWS 1962):

- In general, refuge infrastructure development was intended to increase the availability of water, such as coverage, depth, and duration, by converting temporally and seasonally flooded areas to more permanently flooded wetland types to help resources of concern at the time, which were primarily migratory waterfowl during migration.

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Prairie cordgrass is an important component of meadows on Quivira Refuge providing relatively taller conditions for wildlife.

- Unit 7 was a low sump area of about 15 acres fed from the LSM.
- Drainage from unit 11 went northeast through a natural channel.
- Units 14a and 14b occurred along an old creek channel, and dominant plants were alkali sacaton and saltgrass.
- Unit 16 was a natural sump dominated by alkali sacaton and saltgrass flats.
- Unit 21 was a natural low area in an old creek channel.
- Units 22 and 23 were natural ponds and depended on surface runoff for water, and both had a good history of waterfowl use, including dabbling and diving ducks.
- Unit 24, or Darrynane Lake, was an existing 16-acre impoundment on Rattlesnake Creek, part of an old hunting club property that had a washed concrete spillway.
- Unit 25 was a natural, low saltgrass–sacaton area between sand knolls.
- Unit 26 contained about 90 acres of good farmland.
- Unit 28 was surrounded by tallgrass to the south and east.
- Unit 34 was in a low area in a tallgrass pasture.
- The plan for Unit 44 was to have it drain into scattered sump areas on the flats to the north.
- Units 47 and 55 were saltgrass flats that characteristically flooded in spring and were used by 50,000 ducks in 3–4 inches of water.
- Units 48 had 75 surface acres and unit 49 had 100 surface acres.
- Unit 50 was an old hunting club property.
- Unit 57 was a natural lake called McCandless or East Lake.
- Unit 60 had a history of heavy duck use in late winter, indicating that it had some deep water and remained ice free longer than other wetland habitats.
- Unit 62 was covered by a dense stand of prairie cord grass.
- Dead Horse Slough was an existing slough at the time.
- The BSM was unit 72, and it was planned to be the storage unit for habitat area in the northwestern part of the refuge that was attractive to diving ducks like scaup, redhead, and canvasback.

Current Conditions

Since presettlement times and refuge establishment in 1955, more environmental changes have occurred on refuge lands (Heitmeyer et al. 2012). In 1954, a reconnaissance map of the area was completed that described cover types, associated dominant plants, and miscellaneous notes of vegetation conditions for the purpose of assessing property values before acquisition of lands by the Federal Government. Our refuge staff recently recreated the hand-drawn map of 1954 in a geographic information system (GIS) (figure 9) and recoded cover types to use as a general baseline cover map to facilitate its comparison with a recent vegetation map of refuge lands made in 2011 (figure 10). While important shifts in plant communities mapped in 1954 and 2008 are evident (table 5), results should be viewed with caution partly because of differences in the purposes for which the two maps were developed; methodologies, such as observer bias, minimum mapping unit, equipment, and technology; and environmental conditions occurring at specific points in time, such as certain days, months, years during relatively wet and dry periods.

Some of the more notable differences include: (1) an increase in the occurrence of nonnative and invasive species in both grassland and wetland communities; (2) an increase in the coverage of shrubs and trees, especially in uplands and riparian zones; (3) the establishment and spread of Phragmites and cattail in wetlands; (4) the extensive development of artificial infrastructure; (5) an increase in the area of surface water; and (6) indications of a decline in shortgrass species. However, the 1954 appraisal and other refuge reports described much of the refuge land area as being overgrazed at the time of establishment, and this grazing regime likely favored shortgrass over tallgrass species, as reported by Aldous (1935) in central Kansas.

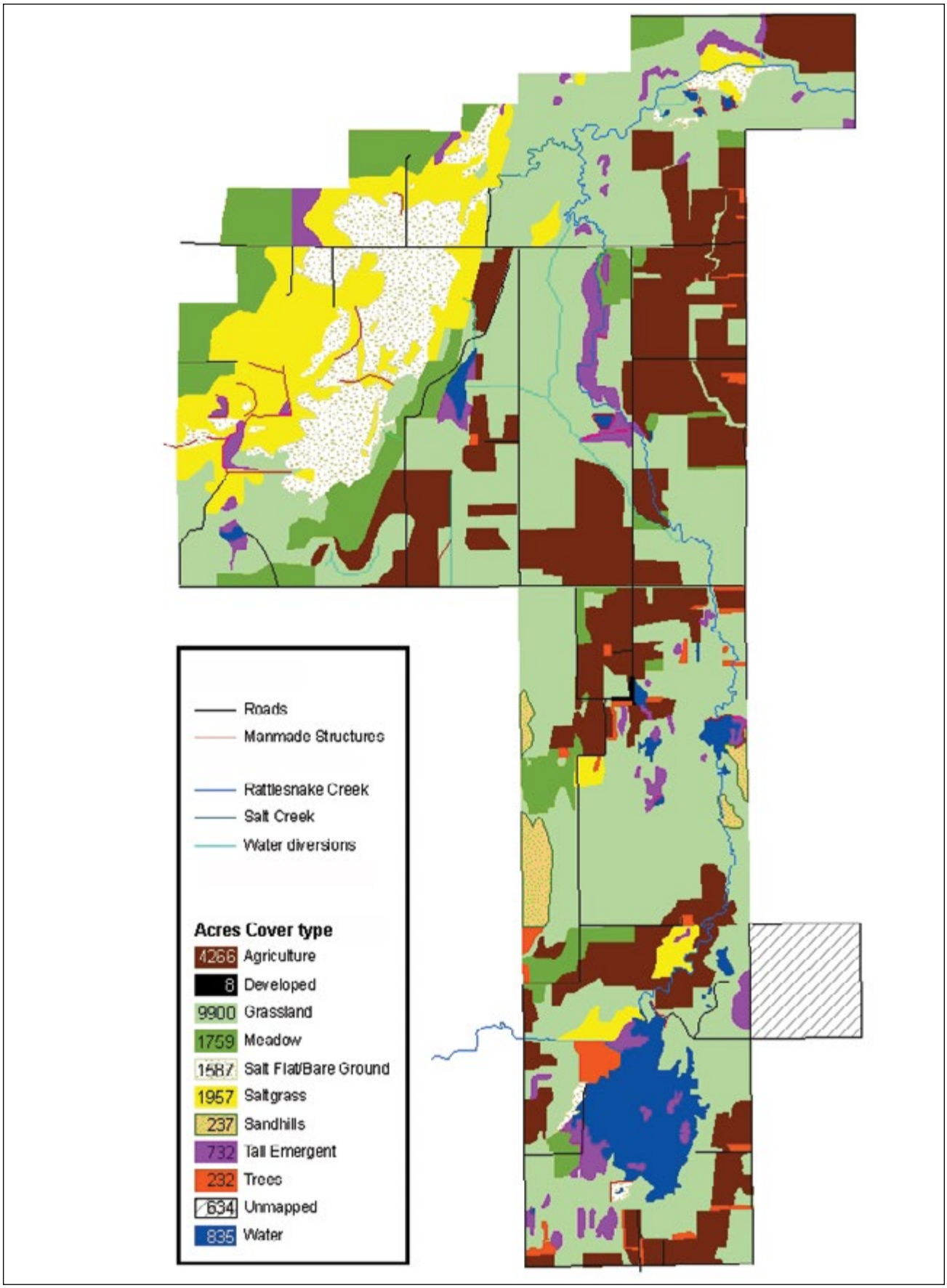

Figure 9. Vegetation cover types in 1954, Quivira National Wildlife Refuge, Kansas.

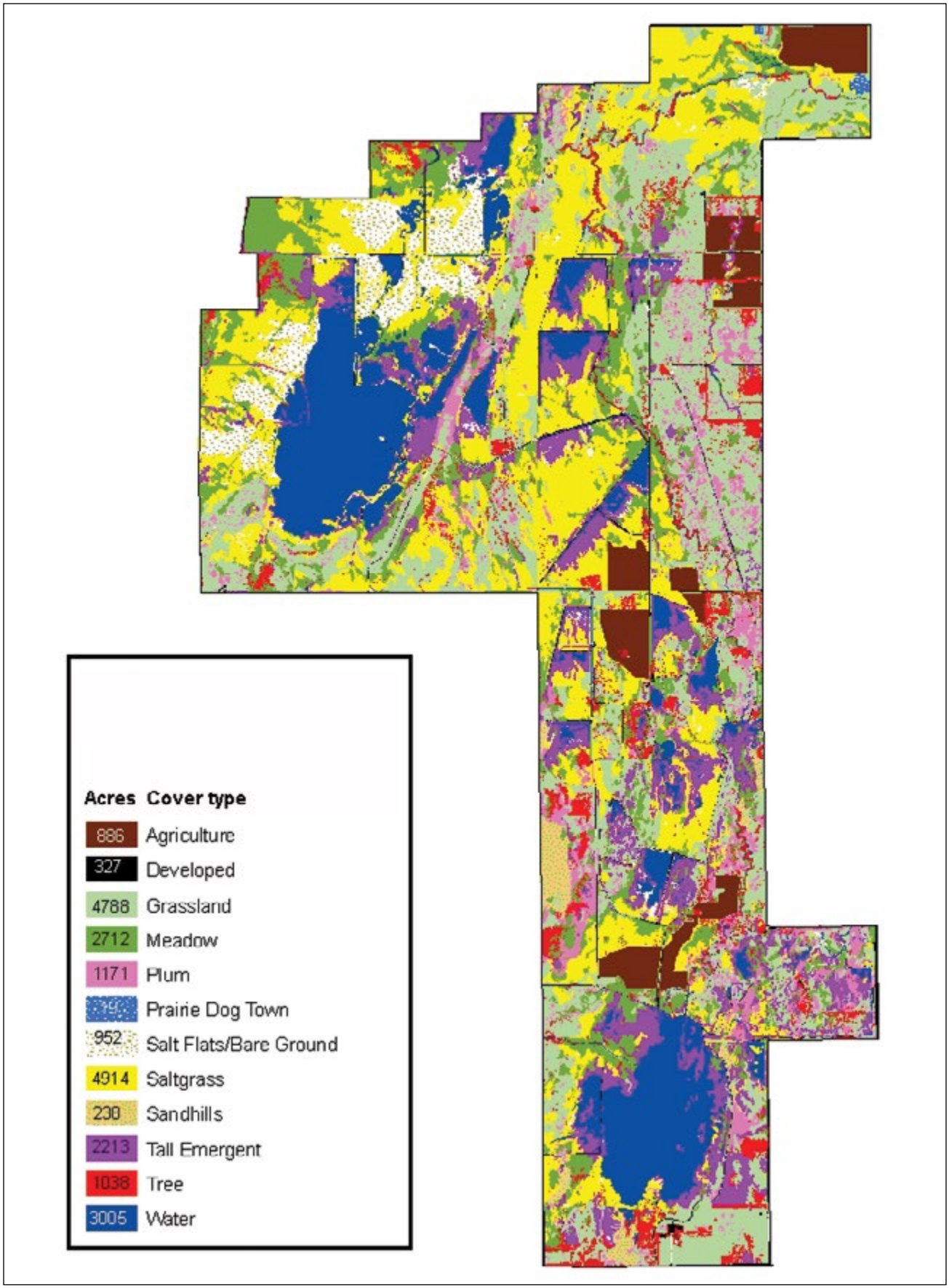

Figure 10. Vegetation cover types in 2008 (NVCS), Quivira National Wildlife Refuge, Kansas.

Table 5. Comparison of vegetation cover types between 1954 and 2011 on Quivira National Wildlife Refuge, Kansas.

Cover type	*Map**	*Descriptions (dominant plant species)*
Grassland	1954	big and little bluestem, switchgrass, Indiangrass, sand lovegrass, buffalograss, blue grama, sideoats grama, three-awn, sand dropseed, wild barley, wild rye, bluestem wheatgrass, panic grass, saltgrass (G1 and G2 symbols on original map)
	2011	big and little bluestem, switchgrass, Indiangrass, and less of other prairie grasses and forbs (sometimes lesser amounts of meadow species present)
Sandhills	1954	Sandhills with carrying capacity of >5 acres of cow and calf for 6 months because of low vegetation density. Based on our soil survey geographic database soil map, this is most of the Tivin fine sand with 10––30% slope sites on Quivira Refuge. (G3 symbol on original map is comprised of the Sandhills and Saltgrass cover types)
	2011	unmapped areas, polygons with >50% Tivin fine sand with 10–30% slopes (figure 7)
Saltgrass	1954	Saltgrass (G3 symbol on original map includes Sandhills and Saltgrass cover types)
	2011	Saltgrass
Salt flat, bare ground	1954	bare soil, mostly with alkaline salts (white) on surface (Af symbol on original map)
	2011	bare ground areas, some with alkali and sparse cover of saltgrass
Meadow	1954	little bluestem, Indiangrass, three-square, sedges, rushes (H symbol on original map, "wild hay")
	2011	Medium-short emergent plants, primarily prairie cordgrass, three-square, sedges, rushes (not tall bulrushes, sometimes lowland prairie grasses mixed in this cover type)
Tall emergent	1954	three square bulrush, hardstem bulrush, nutgrass [*Scirpus paludosus*], sedges, rushes (M symbol on original map; for Marsh, fresh; in swales and depressions and next to wetland areas)
	2011	cattail, Phragmites, tall bulrushes (mostly softstem bulrush)
Water	1954	surface water (W symbol on original map)
	2011	surface water
Trees	1954	mostly shelterbelt strips or groves near buildings and cultivated fields. One site with saltcedar on the delta where Rattlesnake Creek enters the LSM. Several groves of open, mixed oaks scattered in the "grazing type" (B, T symbols on original map)
	2011	black locust, tamarisk, cottonwood, Russian olive, Siberian elm, and some tall shrubs that were not plum
Plum	1954	not included in map description
	2011	sand plum with little coverage (<5%) of American plum and other shrubs
Agriculture	1954	farmed areas and few small sites that were primarily forbs (weeds)
	2011	farmed areas
Prairie dog towns	1954	not included in map description
	2011	active prairie dog towns

*The 1954 map was adapted to improve visual clarity. The current map used 2008 aerial photos that were ground truthed in 2010 and 2011 and was completed in 2011. Of note, descriptions of certain cover types are similar but not exactly the same for the 1954 and current maps. For instance, current "tall emergent" plant types are taller than what occurred in the past.

A recent inventory of refuge vegetation was completed in 2011, and approximately 22,262 acres of refuge lands were mapped to plant association classes. The inventory excluded a small tract of refuge land that occurs a few miles west of the main refuge boundary, but includes at least parts of boundary road areas, which accounts for the seeming discrepancy in refuge acreage. Protocol largely followed National Vegetation Classification System (NVCS) standards (Federal Geographic Data Committee 2008) and other guidance. The minimum mapping unit of the aerial photos was 0.5 acre, but ground truthing only included plum stands 0.2 acre or greater. Ground truthing used 2008 aerial photographs and was conducted in 2010, which was relatively wet, and 2011, which was relatively dry. Thus, it is presumed that certain plant species were more conspicuous under wetter conditions and other species were more conspicuous under dry conditions. A plant key was used to classify different combinations

of 20 herbaceous, 5 shrub, and 15 tree-dominant plant species into suitable categories, which resulted in the identification of 43 vegetation associations (table 6) (Farr and Laubhan 2011).

Based on this inventory and on estimates from summed GIS acreage data, Quivira Refuge is comprised of the following association types: 48.6 percent (10,819 acres) herbaceous wetland zones, 13.5 percent (3,005 acres) open water, 22.0 percent (4,898 acres) grassland, 6.6 percent (1,469 acres) shrubland, and 3.9 percent (868 acres) riparian area and upland woodland categories combined. It is important to understand that this coverage estimation is scale dependent. For instance, shrub associations were only classified as such if stands were equal to, or greater than, 0.2 acre and shrub coverage was equal to, or greater than, 50 percent. This minimum mapping unit was chosen because it was reasonable for both mapping and for our management planning and implementation. Therefore, smaller shrub stands may exist that are mapped as grassland. Similarly, existing ephemeral or seasonal wetlands measuring less than 0.2 acre were classified as different herbaceous and woodland associations of which they were a part. The most abundant plants for each association type were: saltgrass, cattail, and three-square in wetlands; little bluestem, switchgrass, and Indiangrass in grasslands; plum and saltcedar—also considered a small tree—in shrubland; and locust, Russian olive, and cottonwood in forest or woodland.

Table 6. National Vegetation Classification System (NVCS) associations, Quivira National Wildlife Refuge, Kansas.

Vegetation associations	*Acres*	*Hectares*
Boxelder woodland	0.3	0.1
Agriculture vegetation	885.9	358.5
Tree-of-heaven forest	7.8	3.1
Big bluestem–helianthus herbaceous vegetation	551.2	223.1
Big bluestem–western Great Plains herbaceous vegetation	426.4	172.6
Sand bluestem herbaceous vegetation	62.5	25.3
Bare ground	18.9	7.6
Black-tailed prairie dog town grassland complex	18.9	7.6
Cheatgrass seminatural herbaceous vegetation	82.1	33.2
Northern catalpa forest	11.9	4.8
Hackberry woodland	0.6	0.3
Roughleaf dogwood shrubland	22.7	9.2
Inland saltgrass herbaceous vegetation	4926.1	1993.5
Russian olive woodland	29.2	11.8
Spikerush fascicularis herbaceous vegetation	329.3	133.3
Green ash forest	3.1	1.3
Kentucky coffeetree forest	16.2	6.6
Eastern redcedar seminatural forest	85.4	34.5
Osage orange woodland	5.6	2.3
Mullberry woodland	8	3.3
Switchgrass vegetation	431.8	174.8
Switchgrass–Indiangrass vegetation	1245	503.8
Common reed western North American temperate seminatural herbaceous vegetation	72.5	29.3
Plains cottonwood–black willow forest	389.5	157.6
Plum shrubland	1231.1	498.2
Fragrant sumac shrubland	28.1	11.4
Riverine sand flats–bar sparse vegetation	936.3	378.9
Black locust or honeylocust forest	253.8	102.7
Sandbar willow or mesic graminoids shrubland	57.1	23.1
Soapberry woodland	1.6	0.6

Table 6. National Vegetation Classification System (NVCS) associations, Quivira National Wildlife Refuge, Kansas.

Vegetation associations	*Acres*	*Hectares*
Little bluestem–sideoats grama western Great Plains herbaceous vegetation	2058.8	833.2
Common threesquare herbaceous vegetation	1107.6	448.2
Softstem bulrush semipermanently flooded herbaceous vegetation	167.9	68
Softstem bulrush–cattail herbaceous vegetation	366.9	148.5
Prairie cordgrass –spikerush and sedge herbaceous vegetation	1293.6	523.5
Saltcedar seminatural temporarily flooded shrubland	126.4	51.2
Cattail Great Plains herbaceous vegetation	1615	653.6
American elm woodland	1.9	0.8
Siberian elm woodland	50.6	20.5
Para grass herbaceous vegetation	2.8	1.1

The Boiling Springs has an artesian well and an associated freshwater habitat of small streams and pools that form a few acres. In the area of the artesian well, water cress is abundant as well as a source population of State-threatened Arkansas darters. All of our alternatives in this CCP and EA suggest the need to further evaluate potential future management to support the Arkansas darters. Besides mapped vegetation associations, other important factors to consider include the current existence of a pipe where water from the spring flows to the surface and increasing woody vegetation. The pump remains from an oil well that has been removed, and it is unknown if the removal of the pipe would result in more springs or if habitat suitability would increase for the Arkansas darter. Increasing woody vegetation in the area may also create changes in water quality or habitat use. A beaver downed one large tree in 2011, creating a dam in the area where Arkansas darters live. Casual observations suggest that larger pools in the area would encourage use by predator fish, such as the green sunfish, and that would likely adversely affect Arkansas darter populations.

Wildlife Communities

This sections includes details on the various wildlife communities found on Quivira Refuge

Status and Trends of Wildlife Communities

While national wildlife refuges are managed for wildlife first, a particular refuge cannot be managed for all associated wildlife every year. Habitat conditions constantly change over time generally favoring a broad diversity of wildlife species. Thus, planning that evaluates trade-offs in management effects on wildlife at various spatial and temporal scales may better sustain native communities.

As part of this process, various regional and national conservation plans and species of concern lists are considered collectively within the context of the refuge bird list and other relevant local conservation factors such as: (1) the refuge purposes and relevant policies and mandates; (2) a species native or nonnative status; (3) species population trends; (4) species range distribution in relation to refuge location; (5) species current and potential occurrence on refuge lands; (6) species tolerance of grassland fragmentation, urbanization, and agricultural activities; and (7) the availability and condition of habitat outside refuge boundaries. A detailed analysis of species tolerance of grassland fragmentation is presented in appendix H. Collectively, these considerations helped us to develop a list of priority management species we call focal species (table 3).

Presettlement Conditions

Consideration of changes in wildlife since presettlement is important for understanding the full range of native habitat conditions and for evaluating current management potential. For instance, knowledge of native species life needs and behavior may be used to describe what the environment used to look like and how it functioned. Many native herbivores and predators that were an inherent part of the historical natural system no longer occur on refuge lands or in the region, and, consequently, their absence likely has altered fundamental ecosystem processes. For example, grazing or browsing by bison, pronghorn, elk, and prairie dogs in central Kansas used to variably influence many indigenous prairie plants and wildlife

that have unique adaptations, and now their roles or functions are only partially replaced by domestic cattle, sheep, or goats.

Similarly, the use of prescribed fire and artificial manipulation of hydrology do not completely mimic the historical frequency, intensity and magnitude of historical fires and water movement on the landscape. Thus, complete restoration of historical processes and associated native plant and wildlife community will not be possible regardless of the alternative we select in this CCP and EA, however, the extent to which restoration will occur differs among the alternatives. In managing for wildlife, strategies may be used for various purposes, including compensating for one, or more, of the many long-term, or permanent, imbalances that have been created in the landscape.

Conditions of wildlife communities since refuge establishment have not been summarized, but have been recorded in the refuge master plan, annual narratives, and other files and documents. Of particular relevance to our alternatives, the deer count on the refuge at the time of establishment was less than 20, and turkey were not present. Also, the master plan showed our intention to manage habitat to encourage use by greater prairie-chickens, noting their former occurrence on refuge lands and their absence in the early 1950s. Because birds are a primary focus of the Refuge System and changes in communities have been many and complex, it is worth referring those interested in more details to a discussion by Johnsgard (2009) of the changes in bird communities and range distributions over the past three decades.

Current Conditions

The refuge is recognized nationally and internationally for its importance in wildlife conservation. Quivira Refuge is a Ramsar Wetland of International Importance, a Western Hemisphere Shorebird Reserve Network site, and a Globally Important Bird Area. The most current inventory of Quivira Refuge wildlife is provided in appendix G, but some highlights are described below.

Birds

More than 300 species of birds are thought to use Quivira Refuge. Some main attractions for visitors to the refuge are spring and fall bird migrations that include hundreds of thousands of geese and ducks, more than 30 species of shorebirds, many sandhill cranes, and the occurrence of rare species, such as the whooping crane, interior least tern, and snowy plover. Quivira Refuge wetlands provide migration and wintering habitat used by large populations of Canada geese, greater white-fronted geese, and, increasingly in recent years, snow geese. From 2009 to 2010, more than 11,000 ducks, 300,000 Canada geese, 402,500 white-fronted geese, and 425,000 snow geese were estimated to visit the refuge on independent, bimonthly survey dates. More than half of the fall surveys in 2009–2010 and 2008–2009 showed use by more than 20,000 geese, and three of the fourteen 2009–2010 surveys each reported more than 30,000 sandhill cranes. From 2002 to 2006, an annual average of more than 30,000 shorebirds were counted on Quivira Refuge during biweekly migration surveys (Hands 2008). In 2010, biweekly data counted 55,491 shorebirds on the refuge during the migration periods surveyed. With Cheyenne Bottoms Wildlife Management Area only about 30 miles away from the refuge and with high local variation in weather patterns, many birds rely on both areas to acquire necessary life resources. It has been suggested that these areas, combined, often hold more than 90 percent of the world's population of such species as stilt sandpipers and white-rumped sandpipers.

While many rare birds may be observed at Quivira Refuge, some receive much more attention than others. Whooping cranes are usually observed in small family groups during migration on Quivira Refuge. In recent years, the highest recorded season total for whooping cranes observed using areas on and near the refuge is 91 in the spring and 112 in the fall. Thus, the relative importance of the refuge to whooping cranes during migration is substantial, considering that the population in recent years has ranged from approximately 250 to possibly 300 during the winter of 2011–2012. Whooping cranes may stay on the refuge for up to 5 to 6 weeks in the fall, but spring migration stays are typically shorter and last from several days to weeks. Bald eagles are also a common wintering attraction, with a high of 204 eagles reported on the Quivira Refuge during the Christmas Bird Count in 2010. Only recently has one bald eagle pair been reported nesting on the refuge,

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Harris' sparrow, reported on Quivira Refuge, has been identified as a priority species by the Great Plains Landscape Conservation Cooperative.

and they successfully fledged two young annually during 2010 and 2011. Quivira Refuge is one of the few sites in Kansas with nesting black-necked stilt, interior least tern, snowy plover, and various rail species. Production of interior least tern on Quivira Refuge fluctuates, but colonies of equal to, or greater than, 10 nesting pairs are common, and young raised to flight stage has been as high as 36 to 40 individuals. More information on threatened and endangered species and other species of concern may be found in the appendixes.

Quivira Refuge is primarily a migration refuge, but, as shown above, many birds use habitat for nesting as well. Of the birds reported nesting on Quivira Refuge, 23 species are considered Birds of Management Concern (FWS 2008a). Of these, 13 species are Birds of Conservation Concern in Region 6, and 11 species are Birds of Conservation Concern in Bird Conservation Region 19, Central Mixed-grass Prairie (FWS, Mountain–Prairie Region 2008a). For a comparison, the total number of birds listed as Birds of Conservation Concern for Region 6 and Bird Conservation Region 19 include 43 and 16 breeding species, respectively. Based on available published information on how climate affects bird breeding in the region, most nesting activities begin in April and extend to August. But, bird use and timing of different breeding events vary within, and among, community types. Because management of wooded habitat is a current topic of interest in considering alternatives, it is important to note that many nesting bird species associated with wooded habitat on the refuge are generalists that have not exhibited population declines and may occur in more than one habitat type or have benefited from the expansion of urban and residential areas or constructed habitats like bridges, nest boxes, and farmland.

The presence of upland grassland passerines on Quivira Refuge is often overshadowed by the more easily identifiable and popular wetland-associated birds. However, many of these species are adversely affected by increasing woody vegetation, and refuge management has traditionally struggled with successfully reducing trees and shrubs to levels more characteristic of natural prairie. Some of the more common native passerines that characteristically breed on the refuge include: upland sandpiper, both eastern and western meadowlark, bobolink, dickcissel, grasshopper sparrow, field sparrow, lark sparrow, and brown-headed cowbird.

Many of the species associated with woodlands on refuge lands have benefited from human modifications to the landscape (table 7).

Table 7. Observed woodland bird use at Quivira National Wildlife Refuge, Kansas.

Bird species	*Woodland units*												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
wood duck		X											1
wild turkey		X							X				2
great blue heron					X								1
green heron		X											1
yellow-crowned night-heron									X				1
Mississippi kite									X				1
bald eagle											X		1
Cooper's hawk									X				1
red-tailed hawk											X	X	2
American kestrel					X								1
mourning dove												X	1
yellow-billed cuckoo	X	X		X					X			X	5
eastern screech owl	X	X					X		X				4
great horned owl		X		X	X		X						4
barred owl	X				X				X				3
chuck-will's widow									X				1
chimney swift					X								1
red-headed woodpecker												X	1
red-bellied woodpecker	X	X			X			X	X				5
downy woodpecker	X	X		X	X		X	X	X				7

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Egrets and Ibis

Table 7. Observed woodland bird use at Quivira National Wildlife Refuge, Kansas.

Bird species	*Woodland units*												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
hairy woodpecker	X	X			X			X	X				5
northern flicker		X					X	X	X				4
eastern wood-pewee	X							X	X			X	4
great crested flycatcher	X	X	X	X	X	X	X	X	X	X			10
western kingbird												X	1
eastern kingbird												X	1
Bell's vireo											X		1
warbling vireo	X	X			X	X		X		X	X	X	8
red-eyed vireo	X	X							X				3
blue jay		X							X			X	3
American crow									X				1
black-capped chickadee	X	X							X				3
white-breasted nuthatch	X	X			X				X				4
Carolina wren	X				X				X				3
house wren	X	X	X			X	X	X	X	X		X	9
blue-gray gnatcatcher	X	X			X	X	X	X	X				7
eastern bluebird	X	X		X		X		X	X				6
American robin		X	X						X	X		X	5
gray catbird	X												1
northern mockingbird						X							1
brown thrasher	X		X						X	X		X	5
yellow warbler	X	X		X				X			X	X	6
field sparrow				X					X				2
Northern cardinal	X	X		X	X		X	X	X	X	X	X	10
indigo bunting	X	X		X	X				X				5
common grackle												X	1
orchard oriole				X				X				X	3
Baltimore oriole		X		X				X	X	X	X	X	7
American goldfinch						X		X				X	3
Total species	21	24	4	11	15	7	8	15	29	7	7	18	49

Mammals

There are many information gaps about mammal populations and habitat use on the refuge. However, casual observations, limited refuge studies, and available literature were used to develop a refuge species list—which may be found in appendix G—and to gain knowledge of refuge habitat–mammalian community relationships. For example, while small mammals are widely known as an important prey base for many birds characteristic of the prairie, certain species have unique associations with open, sandy environments, such as the plains pocket gopher, eastern mole, plains pocket mouse, and Ord's kangaroo rat.

Prairie dogs are well-known associates of Great Plains grasslands, especially in shortgrass and mixed-grass prairie, and there are two prairie dog towns on Quivira Refuge (figure 11). The expansion of prairie dog towns on the refuge is limited by the high ground water table. Roads, canals, and other artificial infrastructure factors likely influence ground water conditions in certain areas of the refuge, thereby restricting the prairie dog colonies to an area that is likely smaller than what occurred historically.

There are various species associated with habitat in and around wetlands, such as beaver and muskrat. The least and short-tailed shrew are often found in mesic, or lowland, prairie here. With increasing coverage of woody vegetation, it is likely that the mammal community has shifted from what historically occurred in this area. The nine-banded armadillo is one obvious addition since refuge establishment, though the population seems to be low. The various potential effects to the sand prairie system resulting from mammalian community shifts are largely unknown, but it is presumed that supporting species characteristic of this unique environment would also promote important functions, such as soil disturbance, plant dispersal, burrow production as habitat for various wildlife, and food web interactions.

In the early to mid-1800s, deer in Kansas generally occurred along wooded parts of streams and in large, timbered areas in the eastern part of the State (Sexson et al. 1985a). Deer were considered extirpated in Kansas in 1904, and were still largely absent in 1933. By refuge establishment in the mid-1950s, it was estimated that there were easily less than 20 deer in the area of the refuge. In other words, it was an extremely rare event, and exciting, to see a deer on refuge lands in the mid-1950s. Since refuge establishment, legal harvest of deer has not been permitted on the refuge. In 1960, it was noted that, "An occasional white-tailed deer was seen on the refuge area, deer observations were becoming more frequent, and that the manager saw three deer between January and April." (from refuge narrative on file at the refuge). By 1971, deer sightings were described as common, and about 100 deer were estimated to be using the refuge area during the summer months, with a buck-to-doe ratio of 1:3. By 1980, deer were described as being "frequently seen throughout the refuge" (from refuge narratives on file at the refuge). Results of a statewide, 1984–1985, landowner deer survey showed deer populations were increasing throughout Kansas (Sexson et al. 1985b). Results of spotlight surveys conducted on Quivira Refuge between 1989 and 2005 found continued, substantial increases in the deer population (Althoff et al. 2006). While hunting was occurring on private lands next to the refuge, the numbers of deer counted during the prerifle season were not greater when compared to numbers counted during rifle season and after. No data were collected that could be used to definitively explain the results. Researchers noted evident browse lines in wooded areas and concurrent declines in the percentage of does with twins, which is commonly linked to poor herd health. Recent and ongoing distance sampling documents extremely high deer densities in areas of the refuge—19 groups per square kilometer, or 41 individual deer per 0.39 square mile (1 square kilometer), (Blecha et al. 2011). However, preliminary results of a September 2011 assessment found sampled deer—5 bucks and 5 does from ages 1.5 to 7.5 years—were healthy.

Although deer numbers on the refuge at the time of establishment were less than 20, relatively intense studies of white-tailed deer have occurred on the refuge in recent years because of their increasing population. Among many findings, some, in particular, are worth noting for planning purposes: (1) surveys show high, localized densities of both groups—19 groups per square kilometer—and individuals—41 deer per 0.39 square mile (1 square kilometer), (2) doe survival rates are relatively high compared to bucks because of poaching and hunting; (3) deer prefer existing woodland canopy and canopy edge; (4) use of private land is substantially higher during fall and winter; (5) male deer use private land more than females during winter and summer; and (6) during winter, male deer are in closer proximity with other males, in comparison to female-to-male or female-to-female associations, (Blecha et al. 2011).

Observations and preliminary data from a deer health assessment conducted on Quivira Refuge in 2011 suggest the population is now healthy. However, woodland canopy edge and food plots and fields where deer congregate could be key habitats for potential future chronic wasting disease transmission (Blecha et al. 2011). Method of spread is unknown. Frequent contact between younger males suggests that management actions targeting that age class might cause reductions in contact rates and lessen the chance of disease transmission. Because

Barry Jones/FWS

Tiger Salamander

deer within the Quivira Refuge population extensively use private lands, researchers believe that management of deer would be most successful if conducted on both private and refuge lands.

Reptiles and Amphibians

Reptiles and amphibians, or herptile species, recently documented as occurring on Quivira Refuge include three toads, four frogs, one salamander, six turtles, two lizards, and 13 snakes; see appendix G. Other herptile species have reported distributions in the area, but have not been documented on Quivira Refuge. Of significance to us, many herptile species may spend their entire lives on refuge lands. Thus, our refuge management actions could substantially alter metapopulation dynamics —or the spatially separate populations—of these species.

Furthermore, changes in herptile communities may effectively show how our management affects them, depending on the objectives. For instance, amphibians are often used in research and monitoring programs as sensitive indicators of water quality. At the same time, observing herptiles is not always easy, because many species spend considerable time underground, or have active periods that vary seasonally or that occur at night.

Like many birds and mammals, several herptiles have associations with open prairie, loose sandy soils, and wet environments that are characteristic of Quivira Refuge, such as Great Plains and Woodhouse's toads, yellow mud and spiny softshell turtles, lesser earless and prairie lizards, Graham's crayfish snake, western plains garter, and eastern and western hognose snakes. The six-lined racerunner and ornate box turtle are particularly abundant in sand or open prairie, and the latter is commonly observed on the refuge. The western massasauga is only abundant in a few locations in Kansas, one, of which, is the refuge.

Fish

Management of fish communities on the refuge is largely constrained by the species that enter it via Rattlesnake Creek. Those who frequently fish the LSM report that carp and channel catfish are common. A published survey of Rattlesnake Creek fish that included areas on, and near, the refuge found that the upper parts of the stream with low chloride concentrations supported communities dominated by red shiners or common carp; and lower, more saline, parts of the stream supported communities dominated by plains killifish (Eberle et al. 1996). Fathead minnows and sand shiners were other common species found in samples.

Arkansas darters were documented in the area of the Boiling Springs. The presence of a healthy source population of Arkansas darters at the Boiling Springs area was confirmed through observations of many fish of different ages by local experts in 2011. Casual sampling of Quivira Refuge creek and spring habitat by local experts in 2011 also found river carpsucker, mosquito fish, black bullhead, green sunfish, bluegill, and one goldfish.

Other

There are 10 species of crayfish reported to occur in Kansas (Ghedotti 1998). The northern crayfish is distributed throughout Kansas and is the most commonly observed species in streams (Ghedotti 1998). A baseline survey of crayfish species is unknown for Quivira Refuge, but crayfish and their burrows are a common occurrence. Various birds, fish, reptiles, amphibians, and mammals, eat crayfish, and many of them also compete with crayfish for food. Crayfish have been reported as a potential food item of whooping cranes (Armbruster 1990) and various waterbirds (Huner 2000). Reptiles and amphibians use crayfish burrows as shelter (Collins et al. 2010).

Other wildlife, such as butterflies, are listed in appendix G. Past refuge inventories of other wildlife are incomplete or nonexistent, and efforts to expand inventories have occurred in recent years. However, much remains to be learned of these species and associations on Quivira Refuge.

Federally and State-Listed Species

Quivira Refuge habitats support Federal and State threatened and endangered species, Federal candidate species, and State Species in Need of Conservation, including those species with designated critical habitat on the refuge and those that most commonly depend on refuge resources (table 8).

Table 8. Threatened and endangered species and species of concern, Stafford County, Kansas.

Species	*Federal status*	*State status*
Whooping crane*	endangered (CH)	endangered (CH)
Interior least tern*	endangered	endangered (CH)
Eskimo curlew	endangered	endangered
Piping plover	threatened	threatened (CH)
Arkansas darter *	Federal candidate species	threatened (CH)
Lesser prairie-chicken	Federal candidate species	
Sprague's pipit	Federal candidate species	
Western snowy plover *		threatened (CH)
Eastern spotted skunk		threatened
Plains minnow		threatened

* Those species that most commonly depend on refuge resources

CH indicates species with designated critical habitat on Quivira Refuge lands.

State Species in Need of Conservation that occur in Stafford County include: black rail, black tern, bobolink, Chihuahuan raven, eastern and western hognose snake, ferruginous hawk, glossy snake, golden eagle, long-billed curlew, mountain plover, short-eared owl, southern bog lemming, and whip-poorwill. In general, habitat conditions on Quivira Refuge should be suitable for most of these species, though several are not known to regularly use the area.

The KDWPT (2011) periodically updates descriptions and State distributions of species that are State listed or are of management concern. Information on status and occurrence of these species on the refuge are available in appendix G. Additional information is available on listed species and associated information for Stafford County (FWS 2012c, KDWPT 2011).

3.3 Management Tools

We use prescribed treatments to manage habitat primarily to promote the long-term sustainability of native wildlife and their associated ecosystems.

Native prairie vegetation and wildlife of the Great Plains evolved with periodic ecological disturbances from herbivory in the form of grazing, fire, flooding, drought, wind, ice, and other natural forces. In other words, long-term ecosystem sustainability is dependent on periodic disturbance. Landscapes, increasingly, have not incurred their characteristic, historical disturbances largely because land uses have been altered and concerns of human safety have arisen as human populations have grown. For example, wildfires generally do not grow large and burn across millions of acres of prairie, huge herds of bison do not migrate across the plains, and streamflow peaks and lows are relatively less dynamic.

A primary purpose of management uses on refuges is to conduct strategies that produce effects similar to historical disturbances to support, or restore, ecosystems. Quivira Refuge uses various management strategies to accomplish goals and objectives that promote a diverse plant community dominated by native vegetation that supports many different migratory and resident wildlife species. Management uses carried out in recent years include combinations of rest; water management; prescribed grazing and fire; mechanical treatments such as mowing, haying, farming, or tree cutting; and chemical use for control of exotic or invasive species (FWS 1994).

But, human-caused landscape changes and our management affect how uses are carried out. For example, some disturbance types are used more frequently than what occurred historically to control invasive plants or nonnative plants that have different tolerance thresholds than native species. Flooding is highly controlled on the refuge to regularly provide required resources for waterbirds and other wildlife, and wetlands have been created and altered. Brief overviews of primary refuge management uses are provided below.

Rest

For planning purposes, rest is a product of management decisions related to disturbance frequencies. In this case, we use this term to refer to the time when we choose not to graze, flood, drain, burn, or otherwise directly affect an area using an active form of management. It is important to recognize rest as a management use because community responses to prairie stressors, such as grazing, burning, and climate, are inherently variable in space and over time (Helzer 2010). Thus, management actions may produce changes in communities that last years, even during "rest," while natural forces also continue to occur. As referenced throughout the document, allowing many years of rest from disturbance in Great Plains grasslands runs contrary to natural ecosystem processes and may lead to adverse habitat conditions, such as the invasion by woody species and

an excessive accumulation of standing dead plant material that inhibits new plant growth.

Water Management

Water management on Quivira Refuge has been used to provide food and different types of habitat for waterbirds and other wetland-dependent wildlife throughout the year. Even before the refuge's establishment, water was impounded by various duck clubs to promote the area's use by waterfowl. Development of refuge infrastructure has occurred over decades, generally following the original refuge master plan.

Water management involves an extensive system of impoundments and dikes, canals, and associated control structures (figure 5). Maintaining water control infrastructure is essential for us to manage the refuge efficiently, and system operations, such as manipulating water levels, can be time-consuming and planning intensive.

Prescribed Fire

Historical prairie fires of the central Great Plains have been described as occurring about once every 3–4 years in tallgrass areas and once every 5–8 years in mixed-grass prairie, and they ranged in size from less than 0.25 acre to millions of acres (Helzer 2010). Fire characteristics and its resulting effects are dependent on fuel, weather, and topographic conditions at the time and place of ignition, and, historically, there were few natural fuel breaks in the open prairie and no suppressions by humans. Fire influences environmental conditions, such as light, moisture, and nutrients, that affect plant competition and wildlife use and promotes biodiversity and health, such as through increased nutrient cycling, the reduction in the amount of residual and woody vegetation, and by decreasing the potential effects of certain insects and of certain diseases caused by moisture and nutrient stress.

Over the past century, aggressive wildland fire suppression and the lack of prescribed fire implementation in the prairie have resulted in unnaturally altered habitats. Fire exclusion and the substantial increase of agricultural land uses are two major factors that are undoubtedly responsible for the declining abundance of some wildlife species.

Prescribed fire is now used in all major habitat types on the refuge to achieve fire program objectives involving both hazardous fuel reduction and habitat management. Prescriptions require specific procedures that set priorities for human safety, and, therefore, particular environmental and fire-behavior parameters regulate when burning may, or may not, occur to accomplish habitat objectives. In recent years, prescribed fire has been conducted on about a third of the refuge each year. There are 15 predefined fire treatment units, several, of which, may be further subdivided into 2–4 smaller units, using natural and constructed features to decide boundaries, such as water units and roads. For individual prescribed burns, boundaries may also be adjusted based on changing conditions, such as moisture, vegetation, and adjacent treated areas, to meet our refuge management objectives and to maximize safety and efficiency considerations associated with the prescription.

Because most of the available fuel within the refuge is grass, fires consume the fuel and go out quickly. Overall, fuel load varies by soil type and disturbance history, often ranging from 2,500 to at least 8,000 pounds per acre. Grass and forb responses vary because of the time of year, intensity, and duration of the fire, but they most often reestablish in place of woody vegetation. Other fuel types are present on the refuge, but they are seldom contiguous enough to be the primary carrier of fire. Between mid-October and mid-May, fuel in the form of dead grass and marsh vegetation is present in amounts that are greater than 2 tons per acre, or 4,000 pounds per acre. While fire generally results in little wildlife mortality, a large wildfire during drought conditions or occurring late in the growing season could reduce cover and forage availability for wildlife to the point that would increase mortality, especially if cover and forage are limited in the larger landscape, a situation that seldom occurs. All wildfires occurring on the refuge are now suppressed.

Grazing

Prescribed grazing on Quivira Refuge, usually involving cattle, consists of the clipping and removal of plant parts and soil disturbance caused by associated hoof action. As with other treatments, the main parts of grazing are timing and intensity. Its effects vary by timing in relation to climate influences on plants, the frequency and duration that plants are exposed to grazing, the number and type of livestock involved, environmental conditions, management history of the site, and infrastructure such as fence configuration and the distribution of water sources.

Specific plans are developed for each grazed area of the refuge, but they may change annually, or more frequently, depending on conditions. Traditionally, grazing occurs on the refuge between April and Sep-

tember or October, but it may occur earlier to control cattail growth or cheatgrass. Maintenance grazing periods typically last 5–7 consecutive days. More intensive, restoration grazing may occur onsite, such as when controlling large, dense stands of cattail.

Mechanical Treatments

A variety of mechanical treatments are used on Quivira Refuge.

Haying, Mowing, Tree cutting

These management uses are used to remove the buildup of residual vegetation in grasslands and wetlands or to manage the coverage of invasive woody vegetation. As with other mechanical activities, guidance and policy is appropriately followed to help avoid disturbing breeding birds. Timing and other considerations are made to encourage our desired plant species and habitat conditions and to discourage undesirable plant species.

Farming, such as Plowing, Disking, Planting, and Harvesting, and Restoration Activities

Many acres on the refuge were farmed before its establishment. Afterward, farming on poorer soils was retired, and those acres were replanted with native seed. In the 1960s, during the time of refuge development, there were about 2,500 acres under cultivation on the refuge to primarily provide supplemental grains and browse foods for migrating waterfowl. For decades, cropland management consisted of cooperative farmers conducting a winter wheat–milo–fallow crop rotation using strips 50–1,000 feet wide. Traditionally, a quarter-to-one-third of the total crop shares have been either sold or left in the field as the refuge crop shares. Even in the 1980s, it was estimated that refuge grain fields provided less than 10 percent of foods needed to support waterfowl use and that surrounding lands were a much greater source of grain and browse foods for wildlife.

There are 885.24 acres of refuge lands dryland farmed through cooperative agreements with local farmers. Acreage of farmed land on the refuge has been gradually decreasing, partly because of the low productivity of crops. Also, since establishment, there has been a shift in the understanding and need of refuge crops to supplement wildlife food resources. As refuge lands are retired from farming, management starts activities, such as the treatment of noxious weeds and the seeding of desired plants, to encourage the restoration of native vegetation. Genetically modified crops have never been used on the refuge, but current policy allows for the future use of such crops to reestablish native plants.

Disking of Wetlands

Disking is sometimes used in dry wetlands to stimulate the germination and growth of desired plants during subsequent flooding, or to manage undesirable conditions, such as cattail growth.

Chemical Treatments

The application of chemicals is used to effectively manage undesirable plants, such as exotic, noxious weeds. Use of chemicals on the refuge follows required guidance and policy with an approved integrated pest management plan and with annual pesticide use proposals that provide specific guidance on the use of herbicides.

3.4 Human History and Cultural Resources

This section describes what is known about the human history and cultural resources of the refuge.

Prehistoric Resources

Available archaeological studies used certain methods to date artifacts that suggest native people first occupied the south-central Kansas region 10,000 to 12,000 years before the present (Buller 1976). These people had a highly mobile lifestyle that depended largely on big game hunting. About 9,000 years before the present, regional patterns of human use began to change in response to regional climate fluctuations and increasing populations of people. Archaeological evidence suggests that these changes included more localized, less mobile, population centers and a greater diversity of tools.

Prehistoric Occupation

Certain dating methods suggest that by about 3,000 years before the present, larger campsites that

received repeated use occurred along floodplains of the Arkansas River and, presumably, Rattlesnake Creek. Inhabitants of the area collected wild plants, hunted large and small animals, and created chipped and ground tools. Human populations in south-central Kansas continued to increase and, by about 2,000 years before the present, small villages were established, and there is evidence that early agriculture was present along some waterways.

Protohistoric and Historic Native Americans

When the Spanish explorer Don Francisco Vasquez de Coronado reached the region in 1541, several Native American groups were present in central Kansas, including the Pawnee, Wichita, Plains Apache, Kansa, Kiowa, and Osage (Grajeda 1976, Wedel 1942). Throughout recorded early history, native people were attracted to the Quivira Refuge region because of the presence of salt, camp sites on higher elevation sandhills and uplands, and abundant wildlife. Although many tribes moved in and out of the region, the influx of European settlers was prevalent by the mid-1800s and, by the late 1870s, most tribes had been relocated to Oklahoma.

Historic Euro-Americans

The Spanish word "Quivira" is a form of the Native American name "Kirikuru," which is what local people called themselves when Coronado visited the region in search of the fabled Seven Cities of Cibola. After following the course of what is now the Arkansas River into the central Great Plains, the Coronado expedition spent several months encamped with the native peoples in a semipermanent village. The precise location of this village is not known, but it is believed to be northeast of the present-day Quivira Refuge. Thereafter, only a few trappers and

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A member of the Wichita Tribe posing for famed photographer Edward S. Curtis sometime around 1927.

explorers visited the area until the mid-1800s (Dolin 2010).

The first European definitively known to visit the Great Bend region of Kansas after Coronado was the French explorer Etienne de Bourgmont in 1724. Western explorers and fur trapping expeditions traveled through the Great Bend region in the mid- and late 1800s, and the Santa Fe Trail was established within 12 miles of the current refuge boundary (Cutler 1883, Blackmar 2002).

From May through July 1843, Captain Nathan Boone led an expedition of Army dragoons from Fort Gibson, Oklahoma. The route looped through south-central Kansas, and mentioned several prominent landmarks, including Salt Creek, a large salt lake, and the Arkansas River. Boone's journal provides a decent glimpse of the landscape from that period, including descriptions of the area both near, and within, present-day Quivira Refuge, including the following excerpts:

- June 10th: "after travelling 5 miles S.W. came to the Arkansas river at a point where for miles up and down, not a tree was growing." The crossing is believed to be near present-day Alden.

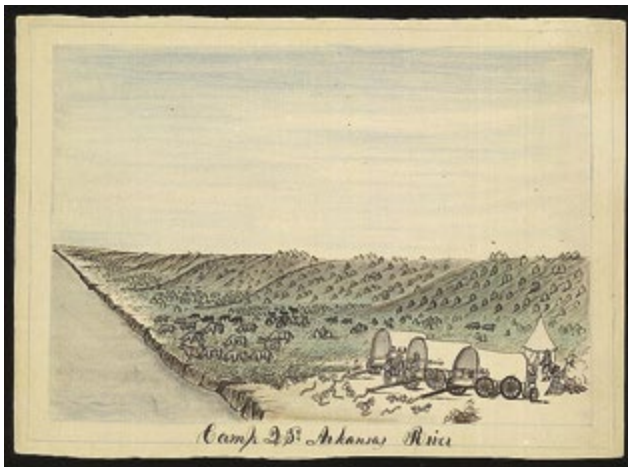
- June 11th: "Their first 4 miles were through Sand hills or drifting sand and in one place, a lake near a mile long of salt water." This is thought to be the BSM.

- June 11th: "Near 200 elk seen within 10 miles of camp and plenty of buffalo S.W. within 5 miles beyond a range of sand hills." The location of this camp is estimated to be directly north of present-day Quivira Refuge along the Arkansas River.

- June 22nd: "Started at 7 A.M. and marched 15 miles S. 3o W. and en-camped on open prairie on the head of the Creek, supposed to be the creek [a branch of present-day Rattlesnake Creek] on which we encamped on the 4th of June. No timber in sight since we left the river. Saw some buffalo, and passed some of the largest buffalo roads bearing to the E.S.E. probably to the salt in that region."

History

The General Land Survey was conducted in this region in 1871. The following year, surveyors for the



Library of Congress

A drawing by Daniel A. Jenks depicts his party's encampent on the Arkansas River in 1859 near present-day Great Bend, Kansas.

Santa Fe Railroad explored and documented a wide swath across Kansas, describing every other section of land along their route. Detail can often be found in the journals, field notes, and maps from both surveys. Below are excerpts from the Railroad Survey:

- April, 1872; section 33, T21S, R11W [For all but the S.E. 1/4, this is the BSM.] "embraces an area of some five Sec and has the appearance of a shallow lakebed—the top soil all being gone makes it about a foot lower than the adjacent land—Its surface to the subsoil is a light or whitish color and seems to be impregnated with alkali."

- Section 17, T22S, R11W [Entire section, 2 miles west of what is now the Migrants Mile area] "All pure sand without any vegetation. All hills and hollows. Constantly drifting. Worthless." It is important to note that, for the survey, land was being evaluated for farming, grazing, or other uses.

- E 1/2, section 13, T22S, R11W [Just southeast of present-day Migrants Mile]. "Dog village over most of both quarters."

- E 1/2, section 1, T23, R11W [East half of the section on which the present-day headquarters is located] "Surface mostly covered with drifting sand. In some small basins, good grass is found."

The first European settlement in Stafford County occurred in the 1860s, and, by 1876, a few people located near the BSM on Quivira Refuge (Cutler 1883, Ogle and Company 1904, Steele 1953). A company was organized for the purpose of manufactur-

ing salt, which was soon found to be unprofitable, and the homesteaders began using the marshes and adjacent grasslands for pasture, hayland, and cattle production (Sheridan 1956). The artesian wells, seeps, and springs near the BSM were relished by people in the area and believed to have health benefits. Early settler accounts from the region commonly speak of the abundance and desirability of wild haylands next to the BSM basin (Hay 1890). By the early 1900s, some upland areas at Quivira Refuge had been converted to small grain agriculture and some native prairies were modified with the introduction of non-native species.

Besides agriculture expansion in the Quivira Refuge area, the saltmarshes were used for commercial and recreational waterfowl hunting after the turn of the 20th century. Private hunting clubs, including the Hutchinson Gun and Hunting Club, Stafford Gun Club, Ellinwood Club, Park Smith Club and the McGuire Club either owned or leased much of the marsh lands, and, in the late 1920s or early 1930s, they dug a permanent ditch to connect, and divert, water from Rattlesnake Creek to the LSM. Other wetland areas along Rattlesnake Creek were also partly impounded by hunting clubs with small dikes and ditches, such as the 16-acre Darrynane Lake (Unit 24) impoundment.

By the 1930s, many upland areas on, and next to, Quivira Refuge had been converted to cropland and pasture. By 1954, about 4,266 acres of what is now Quivira Refuge were in agricultural production (figure 9).

Library of Congress

George Spangerberger's Privy

Library of Congress

This barn is on George Spangerberger's farmstead located in South Hutchison, Kansas.

3.5 Special Management Areas

We established the Santana Research Natural Area on Quivira Refuge in 1967 to preserve 347 acres of native bluestem prairie—classified as K–74, Bluestem Prairie—which includes 15 acres of a century-old cottonwood timber claim. Research natural areas are intended to represent the full array of North American ecosystems with their biological communities, habitats, natural phenomena, and geological and hydrological formations. As with designated Wilderness Areas, natural processes are allowed to predominate without human intervention.

Under certain circumstances, deliberate manipulation may be used to support the unique features for which a research natural area was established. This is the case with Santana Research Natural Area, as the 1984 management plan for the area described a current and future need to control woody vegetation, specifically listing cottonwood, black willow, Russian olive, sand plum, dogwood, and skunkbush as potential invading species. Our activities to support the habitat and biological communities here include prescribed fire, grazing, mowing, and cutting woody plants to prevent their spread.

Activities such as hiking, birdwatching, hunting, fishing, wildlife observation, and photography are permissible, but not mandated, in research natural areas. These special areas also may be closed to all public use if such use is found to be incompatible with primary refuge purposes. The Santana Research Natural Area on Quivira Refuge is open to the public but is not within the hunting area, and no fishing opportunities are available. Because our intent is to not alter or disrupt the characteristic bluestem grasslands found here, no trails or facilities have been, or will be, established in the area.

3.6 Visitor Services

Visitors can enjoy a variety of wildlife-dependent activities, such as hunting, fishing, wildlife observation, photography, environmental education, and interpretation. Most who come use the 14-mile auto tour route. Brochures containing area maps, public use regulations, bird species, and general information are available. Our refuge office is open Monday–Friday, 7:30 a.m.–4:00 p.m. The auto tour route and the rest of the refuge are open from 1 and one-half hours before dawn to 1 and one-half hours after dusk, except during hunting season when hunters are allowed a reasonable amount of time to access hunting areas before dawn and to leave after dusk.

No fees or registration are required for visiting the refuge. There are many access roads, and several county and township roads pass through the refuge. Therefore, attempts to estimate visitation present a challenge for our refuge staff. Visitors are asked to sign the guest register at the headquarters visitor center, but registration is not mandatory. Nonhunting use is estimated each year based on the guest register, head counts of education and interpretation groups, and estimates of visitors on the tour route during various seasons. Current annual visitation is estimated to be 65,000.

Visitors also make use of educational and interpretive activities in the classrooms and auditorium at the GPNC's large visitor center building as well as on the adjacent grounds.

Traditional tribal uses are also allowed on the refuge with a special use permit.

Hunting

Currently, about 8,062 of the refuge's 22,135 acres are within the hunting area. Hunting is permitted for ducks, geese, quail, pheasant, squirrel, rabbit, snipe, and rail. Hunting is not allowed for deer, turkey, or cranes. Hunting season runs from September 1 to February 28, with specific seasons within this period coinciding with State seasons. An accessible hunting blind is available by reservation in Unit 30.

Hunting rules, such as licensing needs and daily possession limits, follow applicable Federal and State regulations. Refuge-specific regulations include:

- Persons possessing, transporting, or carrying firearms on national wildlife refuge lands must comply with all provisions of State and local law. Persons may only use, or discharge, firearms in accordance with refuge regulations—50 CFR 27.42 and specific refuge regulations in 50 CFR Part 32. Discharge of a firearm is prohibited for any reason other than for the taking of game animals in legal hunting areas.

- Hunting is not permitted outside of the public hunting areas or from across roads, trails, or parking areas.

- Vehicle travel and parking is restricted to roads, pullouts, and parking areas.

- Steel shot, bismuth, or other nontoxic shot is required in all gauges when hunting any game on the refuge. The possession of lead shot in the field is prohibited.

- Trapping and baiting are prohibited.
- Retrieving game from areas closed to hunting is prohibited.
- The use of dogs for hunting and retrieving is encouraged. Dogs and other pets must be under their owners' control. From March 1 through August 31, all dogs and other pets must be leashed.
- Portable devices or temporary blinds of natural vegetation are permitted, though we encourage preventing the spread of nonnative invasive vegetation. Permanent blinds or pits may not be constructed. All equipment and blinds must be removed daily.

Many lands next to, or near, the refuge boundary are leased for private hunting. Thus, hunting activities are quite prevalent in the area.

Hunting on the refuge will expand and change as a result of this CCP, see chapter 4 for details.

Fishing

Fishing is allowed on all refuge waters in accordance with State fishing regulations, however, access is generally restricted to the LSM, the Kids' Fishing Pond, and a few points on Rattlesnake Creek. Accessible fishing piers are located at the north end of the LSM and at the Kids' Fishing Pond. The Kids' Fishing Pond is open for kids up to 14 years, although adults may fish there if they are accompanying a youth. Only one fish may be taken per person per day.

Fish species listed in the State fishing regulations may be taken. All other wildlife species, including turtles, frogs, and snakes are protected and may not be disturbed or removed from the refuge. Fishing with trotlines and setlines is prohibited. The use of seines for taking bait is not permitted. Fishing from water control structures and bridges, and the use of live bait is prohibited.

Fishing is also allowed at Chisholm Creek Park near the GPNC, managed and maintained by the City of Wichita.

Wildlife Observation and Photography

Quivira Refuge is a premiere birdwatching site in Kansas, and one of the top sites in North America. Birders travel to the refuge from across Kansas, as well as the United States, and many return to Quivira Refuge on a regular basis. Peak birder visitation usually coincides with the peak shorebird and waterfowl migration seasons in the spring and fall.

Besides birders, Quivira Refuge is popular with more general wildlife observers who visit to view deer, beaver, bald eagles, and the considerable amount of geese, ducks, and cranes that regularly visit during the same period.

The 40-plus miles of public roads within, or alongside, refuge boundaries include a 14-mile tour road that features a 4-mile Wildlife Drive through the BSM. There is an accessible observation tower, equipped with a spotting scope and seating, at the LSM, and a similar scope and seating are located at a viewpoint along the Wildlife Drive. Photo blinds, available on a first-come, first-served basis, are located at the LSM and on the Migrants Mile Trail. Horseback riding and bicycling on established roads, not hiking trails, are also allowed along with dogs that are under their owner's control and that are leashed during the nesting season of April 1 to August 15.

A large percentage of visiting birders and general wildlife enthusiasts are also photographers. Many professional and experienced photographers use the refuge on a regular basis.

Environmental Education

Whereas general school field trips formed most school visits in the past, educational programs have been increasingly focused on topics that help schools and other educational organizations by matching State curriculum-based standards. Several curricula have been developed and used for topics such as bird migration, prairie studies, animal communication, and shorebirds. New curricula are continually under development to offer a variety of subjects to a wider spectrum of grade levels.

Programs are presented either at the refuge or at schools. For onsite visits, Quivira opened a remodeled and modernized environmental education classroom in 2010 to better accommodate and focus on children's education. The facility, designed to hold a class of up to 45 persons, has built-in audiovisual equipment and a large variety of classroom supplies. It serves as the refuge's primary indoor class space, but also as a center for outdoor education activities associated with the nearby Migrants Mile Trail. As an alternate, or added, educational space, the headquarters' conference room, is occasionally used. Virtual geocaching is also allowed to enhance environmental education on the refuge.

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The Butterfly Blossoms Pathway native prairie wildflower interpretive trail at Quivira Refuge was made possible through a partnership with The Friends of Quivira.

The emphasis at the GPNC is on providing an opportunity for people of all ages to learn about the natural resources of the Great Plains, to develop an appreciation of the beauty and value of this region, and to become stewards of the natural resources. Environmental education, a learning process that increases knowledge and awareness about the environment and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action, is one tool used with school groups to achieve our stated goals. On average, the GPNC's staff conducts nearly 1,800 presentations and programs to school groups; community organizations, such as civic, church, and Scouting groups; organized recreation groups from places like city recreation centers and day camps for latchkey children; and casual visitors. Staff provides educational programs both on, and off, site; and programs are conducted year round. With a variety of wildlife available for their use under permit, staff is able to use live animals to help make connections with their audiences.

Interpretation

We lack a current refuge visitor services plan and a primary interpretive theme to provide guidance for our refuge management and staff. However, interpretation has been a vital part of Quivira Refuge's operations for many years. Primary themes have included birds and bird migration, refuge management, fire management, and endangered species. The primary method to present interpretive information to the public is via displays and signs, programs and workshops, brochures, and by Web and other social media. Interpretive displays are available at the headquarters. Topics in permanent displays include bird migration, saltmarshes, Quivira Refuge area history, endangered species, and refuge habitats. Other displays, either temporary or permanent, are added to augment knowledge about our refuge management, flora, and fauna. Displays are also present along the refuge tour road. Nine information kiosks are situated along the route, with maps and information about refuge habitats and hunting. The tour road also features eight different wayside exhibits featuring refuge wildlife and management activities. In addition, the Migrants Mile Trail, Quivira Refuge's premier hiking trail, has many interpretive signs along its length featuring wildlife and wildlife habitat.

Our refuge staff presents interpretive programs and workshops whenever possible, either by request or by scheduling through area schools or community organizations; see the outreach section in this chapter for more details. These are topic-oriented talks, slide shows, or guided walks and auto tours.

Both our refuge-general brochure and our bird checklist were revised and reprinted in 2011. Brochures about other topics, such as whooping cranes, common wildlife, and grasses have also been devel-

oped and printed. Our headquarters also has a rack featuring brochures of other nearby sites of interest, as well as other Service topics.

Quivira Refuge's Web site, in the content management system as of 2012, has long been popular as a source of information. Quivira Refuge was one of the first sites in the content management system. The current Web site has become diverse and detailed, offering interpretive information about subjects such as birds, mammals, reptiles and amphibians, and refuge habitats. Special features include separate pages dedicated to providing a variety of information about the endangered whooping crane, climate influences on refuge plants, and changes in the refuge environment throughout the year. Especially popular are the listings of recent bird observations and road conditions. During the most recently recorded period, March 2010 through February 2011, Quivira Refuge's Web site had 38,185 total visitors and 983,667 total visitor hits. Also during this period, there was an average of 107 visitors to the Web site per day.

In 2011, Quivira Refuge also began using Facebook and Flickr to showcase refuge wildlife, wildlife management, and current happenings; see the outreach section in this chapter for more detail.

Other Uses

Quivira has more than 2 miles of supported hiking trails, including the mile-long Migrants Mile Trail, which is a popular destination. Other activities that have been found to be compatible with the priorities of the refuge include bicycling and horseback riding only on established roads and, depending on the time of the year, bringing dogs on leashes. A national and well-publicized bicycling route passes through the center of the refuge on NE. 140th Street.

Activities that are prohibited on the refuge because of conflicts with wildlife include camping, boating, picnicking, canoeing, fires, the use of all-terrain vehicles, and the collecting of plant, animal, mineral, or any other natural materials.

See appendix B for more details.

Special Events

Annual events, such as Kids' Fishing Day in June, Monarch Mania in September, and Refuge Week Celebration in October, are held by refuge staff with the support of The Friends of Quivira. The Friends of Quivira and Friends of the Great Plains Nature Center are reciprocal partners and, as such, support each other's special events as needed and as time permits.

Public Outreach

Our mission—that of the Refuge System and Quivira Refuge—is an important focus topic for the refuge's environmental and interpretive programs and is also a priority for all outreach activities. It is a goal for all programs to include at least basic information on these missions. Programs that focus on refuge management are regularly given to area communities through civic organizations, churches, public libraries, and schools. Other than these programs, the primary outlets for outreach include the Kansas State Fair, refuge special events, and the Web and other social, or online, media.

Quivira Refuge is the lead partner in the operation of our booth at the annual Kansas State Fair in nearby Hutchinson, Kansas. The primary purpose of the booth is to teach others about our mission, to showcase Kansas refuges, and to educate about various wildlife-oriented topics and programs, our Ecological Services Division, Partners for Fish and Wildlife (Partners), and other operations. Our staff from Quivira Refuge and other offices in the State are on hand to help and educate fair visitors during the 10-day event.

Several special events are held annually, all in partnership with the Friends of Quivira. Some, such as Kids' Fishing Day in June and Monarch Mania in September, each have their own recurring annual themes, such as fish for the fishing day and butterflies for the monarch day, and often involve a combination of activities, education, and, in some cases, refreshments for the participants. Others, such as the Great Migration Rally in May and the Refuge Week Celebration in October, feature topics and activities that vary each year.

Quivira Refuge's Web site, updated several times a week, is also an important outlet for public information about the refuge's mission and objectives. Regular features include new happenings around the refuge, such as improvements, construction, and management; road conditions; schedules for special events; and bird observations. The Web site also has hunting and fishing regulations and bird count tallies. Refuge staff also regularly reports similar information on its official Facebook site, which is updated several times a week. Unusual bird observations, whooping crane sightings, and road conditions are also posted on the Kansas Listserv, used by many birders statewide.

3.7 Partnerships

Quivira Refuge and the GPNC collaborate with educational, regulatory, and research institutions that support refuge goals and objectives. Our refuge has formal and informal partnerships with Fort Hays State University, Sterling College, Kansas State University, Emporia State University, Friends University, Wichita State University, and others to work on research and educational projects. These working relationships involve, among other things, offering summer classes for educators to obtain continuing education credits, offering board memberships for the GPNC, and offering students working opportunities through AmeriCorps or internships.

The refuge is part of the Rattlesnake Creek Partnership, which seeks to resolve water rights issues in Groundwater Management District 5. The refuge partners with the KDWPT on a variety of wildlife-related projects, including avian influenza surveillance, chronic wasting disease and deer health programs, fish stocking, breeding shorebird surveys, and educational and interpretive programs. Quivira Refuge is a member of the Wetlands and Wildlife National Scenic Byway's planning committee, and Quivira staff regularly attends planning meetings about the Byway and the local Byway communities.

Partnerships with Ducks Unlimited over the years have resulted in many habitat improvement projects on the refuge, and these will continue.

Quivira Refuge staff partners with the Friends of Quivira to plan and present educational programs and annual events. The Friends of Quivira operate a nonprofit bookstore in the refuge visitor center.

Barry Jones/FWS

School kids from the local community learn about issues affecting the wildlife in their area at the Stafford County, Kansas, Conservation Day.

The GPNC operates under a memorandum of agreement with the City of Wichita and the KDWPT. Together, they have partnerships with many corporate sponsors like The Coleman Company, Koch, and Spirit AeroSystems and with educational institutions like Wichita State University and Friends University. This partnership also often works informally with other universities and colleges to provide work experience for interns when available.

The GPNC is supported by the Friends of the Great Plains Nature Center, who operate a bookstore in the nature center, support educational programming at the nature center, and provide pay for six employees, including a full-time naturalist who presents environmental education programs in schools and locations throughout the Wichita metropolitan area. The Friends of the Great Plains Nature Center naturalist helps in educational programming for both the GPNC and Quivira Refuge.

The refuge and the GPNC are always open to establishing new partnerships where possible that help wildlife and habitat conservation. The refuge is looking to establish a partnership to control invasive species in the Rattlesnake Creek watershed, such as saltcedar, and a partnership with neighbors to prevent the continued encroachment of invasive woody species, such as eastern red cedar and Russian olive.

With the addition of a Partners biologist to the staff at Quivira Refuge and a new focus area that is comprised of Quivira Refuge and Cheyenne Bottoms, new partnerships should continue to be developed.

3.8 Socioeconomic Environment

Quivira Refuge is open for the compatible, wildlife-dependent uses of hunting, fishing, wildlife observation, and photography. These recreational opportunities attract visitors and bring dollars to the community. Associated visitor activity, such as spending on food, gasoline, and overnight lodging in the area, provides local businesses with extra income and increases the local tax base. Our refuge management decisions about public uses, the expansion of services, and habitat improvement may either increase or decrease visitation to the refuge and affect visitor spending in the local economy.

As part of the development of this CCP, we hired a contractor to prepare a socioeconomic study for the Quivira Refuge (USGS 2012c). This study provides the basis for the sections that follow, including population and employment, public use of the refuge, and baseline economic activity.

For the purposes of an economic impact analysis, a region (and its economy) is typically defined as all counties within a 30–60 mile radius of the impact area. Only spending that takes place within this regional area is included as stimulating changes in economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. Quivira Refuge is located in south-central Kansas. Most of the economic activity related to the refuge is located within the five-county area of Stafford, Rice, Reno, Barton and Pratt Counties, therefore, these counties compose the local economic region for this analysis. The Refuge is also a partner in the establishment and daily operations of the GPNC located 90 miles from the refuge. While the GPNC lies outside the local economic region, connections with refuge activities will be discussed.

Collectively, the 5-county area has a population of approximately 116,000 people and covers a total area of 4,431 square miles (U.S. Census Bureau 2010). Within the five-county area, the cities of Ellinwood, Great Bend, Hutchinson, Larned, Lyons, Pratt, Stafford, Sterling and St. John are economically significant to the refuge and, as such, are additional areas of focus for the regional economic setting.

Population, Ethnicity, and Education

Table 9 lists population estimates and trends for the 5-county area and table 10 lists population estimates for the nine communities near the refuge. In 2010, the counties accounted for approximately 4 percent of the State's population (U.S. Census Bureau 2010). While Kansas has experienced an increase in the number of residents since 2000, 4 of the counties have experienced a decline in residents, with only Pratt showing a slight, 0.1-percent increase (U. S. Census Bureau 2010a). Ellinwood, Larned, Sterling and St. John have experienced declining populations, with St. John showing the greatest decline, losing more than 20 percent of its population since 2000.

Though Kansas is expected to grow in population, population decline is expected to continue in all five of the counties surrounding the refuge (The University of Kansas Institute for Policy and Social Research 2012). Barton and Stafford are expected to show the greatest decline, losing more than 20 percent of their populations by 2040, while Pratt is expected to show the least decline, with an expected loss of 9 percent. The overall decline in population may be due to an aging population as well as to migration to more urban areas. This trend can be observed across many of the rural counties in Kansas (Wichita State University 2011).

Table 9. State and county population estimates in the area around Quivira National Wildlife Refuge, Kansas.

	Residents (2010)[1]	*Persons per square mile (2010)*[1]	*Percent population change (2000–2010)*[2]
Kansas	2,853,118	34.9	6.8
Barton	27,674	30.9	–1.9
Pratt	9,656	13.1	0.1
Reno	64,511	51.4	–0.4
Rice	10,083	13.9	–6.3
Stafford	4,437	5.6	–7.4

Source: [1]U. S. Census Bureau 2012b. [2]U. S. Census Bureau 2010a.

Table 10. Community population estimates in the area around Quivira National Wildlife Refuge, Kansas.

	Residents (2010)[1]	*Persons per square mile (2010)*[1]	*Percent population change (2000–2010)*[2]
Ellinwood	2,131	1,966	–1.5
Great Bend	15,995	1,505	4.2
Hutchinson	42,080	1,994	3.2
Larned	4,054	1,745	–4.3
Lyons	3,739	1,736	0.2
Pratt	6,835	922	4.0
Stafford	1,159	1,233	7.8
Sterling	2,328	1,640	–11.9
St. John	1,036	575	–20.7

Source: [1]U. S. Census Bureau 2012b. [2]U. S. Census Bureau 2010a.

While the percentage of the State population with at least a bachelor's degree is higher than the national average (29.3 percent compared to 27.9 percent), each county within the 5-county area has lower than both the State and national averages (ranging from a low of 18.8 percent in Reno to a high of 22.7 percent in Pratt). Each of the nine communities surrounding the refuge also fall below State and national averages, with Stafford and Lyons having the lowest (13.2 percent) (U. S. Census Bureau 2010a).

In 2010, more than 87 percent of the population of Kansas self-identified as white, not of Hispanic or Latino origin (U. S. Census Bureau 2010a). This percent is lower than reported for each of the counties within the 5-county area (ranging from a low of 90.6 percent in Barton County to a high of 96 percent in Pratt County). Relative to the other counties in the 5-county area, Barton County had the largest percentage of the population who identified as Hispanic or Latino (13.3 percent) (U. S. Census Bureau 2012b) while Reno County had the highest percentage of the population who identified as African-American (4.1 percent) (U. S. Census Bureau 2012b).

Regional Economic Setting

Table 11 shows the median household income, poverty, and unemployment rates for the 5-county area, while table 12 lists the same for communities near the refuge. The five counties and nine communities have median household incomes below both State and national levels. Of the counties, Barton had the highest median household income at $43,763 per year, while Stafford had the lowest at $39,375. Of the communities, Great Bend had the highest median household income at $42,293 per year, while Stafford had the lowest at $33,182 (U. S. Census Bureau 2010a).

In 2010, 12.4 percent of the Kansas population was living below the poverty line, compared to 13.8 percent nationally. Poverty rates within the 5-county area are similar to State and national averages, with Pratt having the lowest rate (10 percent) and Stafford having the highest (14 percent). The communities near the refuge show substantial variability, from 6.7 percent in Larned to nearly 20 percent in St. John (U. S. Census Bureau 2010a).

Table 13 shows the percent employment by sector within the 5-county area. The combined 5-county area had a total employment of more than 73,000 individuals in 2011 (Bureau of Economic Analysis 2012). Farm employment accounted for nearly 6 percent of the workforce. The highest percentage of total

Table 11. State income, unemployment, and poverty statistics and county statistics in the area around Quivira National Wildlife Refuge, Kansas.

	Median household income (2010)	*Percentage of individuals below poverty (2010)*	*Percentage unemployed (2010)*	*Change in percent unemployed (2000–2010)*
Kansas	$49,424	12.4	4.1	1.3
Barton	$43,763	12.2	3.6	0.1
Pratt	$43,583	10.0	2.2	–0.8
Reno	$41,431	13.1	3.0	0.1
Rice	$43,164	13.7	4.2	0.6
Stafford	$39,375	14.0	2.7	0.6

Source: U. S. Census Bureau 2010a.

Table 12. Community income, unemployment and poverty statistics in the area around Quivira National Wildlife Refuge, Kansas.

	Median household income (2010)	*Percentage of individuals below poverty (2010)*	*Percentage unemployed (2010)*	*Change in percent unemployed (2000–2010)*
Ellinwood	$39,444	7.7	3.0	0.9
Great Bend	$42,293	13.7	3.9	1.3
Hutchinson	$38,880	15.7	3.2	–0.3
Larned	$37,235	6.7	2.8	0.8
Lyons	$41,552	15.7	3.7	1.5
Pratt	$39,142	11.1	2.0	0.1
Stafford	$33,182	15.2	2.5	0.5
Sterling	$36,192	14.4	6.3	–2.1
St. John	$37,589	19.0	3.4	2.2

Source: U. S. Census Bureau 2010a.

Table 13. Employment by sector in the area around Quivira National Wildlife Refuge, Kansas.

Industry	*2011*	*Percent of total*
Total employment	73,106	100
Wage and salary employment	54,353	74.3
Proprietors employment	18,753	25.7
Farm proprietors employment	3,365	4.6
Nonfarm proprietors employment	15,388	21.0
Farm employment	4,330	5.9
Private (nonfarm) employment	57,278	78.3
Forestry, fishing, and related activities	637	0.9
Mining	5,907	8.1
Utilities	124	0.2
Construction	3,362	4.6
Manufacturing	4,934	6.7
Wholesale trade	2,300	3.1
Retail trade	7,351	10.1
Transportation and warehousing	561	0.8
Information	828	1.1
Finance and insurance	3,354	4.6
Real estate and rental and leasing	1,628	2.2
Professional, scientific, and technical services	2,146	2.9
Management of companies and enterprises	671	0.9
Administrative and waste management services	2,731	3.7
Educational services	412	0.6
Health care and social assistance	8,406	11.5
Arts, entertainment, and recreation	867	1.2
Accommodation and food services	4,317	5.9
Other services, except public administration	3,483	4.8
Government and government enterprises	11,498	15.7
Federal, civilian	397	0.5
Military	502	0.7
State and local	10,599	14.5

Source: Bureau of Economic Analysis 2012.

employment was found in the government and government enterprise sector (15.7 percent of nonfarm employment). This sector includes both local and nonlocal government agencies. The second and third highest percentages of total employment were in health care and social assistance (11.5 percent) and retail trade (10.1 percent). Forestry, fishing, and related activities accounted for less than 1 percent of the total employment by sector.

Agricultural Sector

Kansas is a highly productive region in the United States for both crops and livestock. In 2011, Kansas had an agricultural output of more than $17 billion, with crop output contributing more than $6 billion, animal output contributing nearly $9 billion, and services and forestry contributing more than $2 billion. The top five commodities produced in the State were cattle and calves, corn, wheat, soybeans, and sorghum grain (Economic Research Service 2012).

As of the 2007 Census of Agriculture, the 5-county area was home to more than 4,000 farms, with more than 2.7 million acres in agricultural production. This accounted for more than 6.26 percent of the total land in production in the State (U. S. Department of Agriculture 2007). In 2007 within the 5-county area, Reno had the greatest number of farms and acreage in production (1,749 farms, and 780,893 acres). Pratt had the fewest number of farms (538) and Rice had the smallest acreage in production (428,422) (U.S. Department of Agriculture 2007).

Recreation and Tourism

Angling, hunting, and wildlife viewing are popular recreational activities across Kansas and within the five-county area. According to the recent 2011 National Survey of Fishing, Hunting and Wildlife-Associated Recreation, approximately 1.2 million residents and nonresidents took part in wildlife-associated activities in Kansas (FWS 2012a). Of all participants, 46 percent identified as sportsmen and women, engaging in either hunting or fishing, and 69 percent reported engaging in wildlife-watching activities. For the purpose of the National Survey, wildlife watching is broken down into away-from-home activities taking place at least 1 mile from home and around-the-home activities taking place within 1 mile from home. All visitors to the refuge that engage in wildlife watching are considered away-from-home participants. The number of hunting days by both residents and nonresidents totaled 5.2 million, with Kansas residents accounting for 78 percent of hunting days. The number of fishing days by residents and nonresidents totaled 4.1 million, with Kansas residents accounting for 98 percent of fishing days. In 2011, residents and nonresidents spent a

total of 1 million days watching wildlife away from home, with residents accounting for 77 percent of wildlife watching days. The in-state spending associated with these activities totaled $820 thousand in 2011, with $293 thousand spent on trip-related expenditures, $197 thousand spent on equipment, and $330 thousand spent for other items (FWS 2012a).

The Wetlands & Wildlife National Scenic Byway connects Cheyenne Bottoms Wildlife Area in Barton County to Quivira Refuge. Along this 77-mile stretch of road, visitors have the opportunity to view more than 300 bird species and visit the remains of the Santa Fe Trail, historic sites, museums, and natural sites. The byway also connects several cities. Claflin, Ellinwood, Great Bend, Hoisington, Hudson, St. John, and Stafford are all considered Byway Communities (Kansas Scenic Byways Program).

From 2009–2010, a visitor survey was conducted by Fort Hays State University's Kansas Wetlands Education Center. The survey found that day trips were the most popular trip length for visitors to the Wetlands & Wildlife National Scenic Byway, with trips 1–3 days in length being the second most popular. In general, day visitors spent under $100 within the local area, while visitors staying 1–3 days generally spent $100–$200. Most visitors to the area were Kansas residents. According to Barton County Counselor and Administrator, Richard Boeckman (personal interview, date unknown), several byway communities are collaborating to improve marketing and increase tourism in the area. He says the byway, refuge, and Cheyenne Bottoms are all considered important assets to the local economy.

Public Use of the Refuge

The USGS headed a National Wildlife Refuge Visitor Survey (USGS 2012a) at Quivira Refuge and several other refuges to tell us more about visitor use. Data in this report, outlined in the following sections, came from survey forms completed by visitors to Quivira Refuge during the selected sampling periods of fall 2010 and spring 2011.

According to the USGS (2012a), about half of visitors, or 47 percent, had only been to Quivira Refuge once in the 12-month survey period, while the other half, or 53 percent, had been there multiple times. These repeat visitors went to the refuge an average of 7 times during the 12-month period. Fifty nine percent of visitors used the refuge during only one season, 28 percent used it during multiple seasons, and 13 percent used it year round.

Most visitors, 64 percent, first learned about the refuge from friends or relatives, 21 percent from printed information, and 18 percent from highway signs. Key information sources used by visitors to find their way to the refuge included highway signs, by 54 percent; earlier knowledge, by 46 percent; and a road atlas or highway map, by 44 percent.

Twenty-five percent of visitors live in the local area, which is within 50 miles of the refuge, whereas 75 percent are nonlocal visitors (USGS 2012a). For 79 percent of local visitors and for 59 percent of nonlocal visitors, Quivira Refuge was the primary purpose, or sole destination, of their trip. Local visitors reported that they traveled an average of 32 miles to get to the refuge, while nonlocal visitors traveled an average of 319 miles. About 60 percent of visitors travelling to Quivira Refuge were from Kansas.

Nearly all, or 99 percent of, visitors to Quivira Refuge said that they were citizens or permanent residents of the United States (USGS 2012a). Visitors were 62 percent male, with an average age of 57 years, and 38 percent female, with an average age of 59 years. On average, visitors reported they had 16 years of formal education, college or technical school. The median level of income was $50,000–$74,999.

Visitors reported that they spent an average of 5 hours at Quivira Refuge during 1 day there (USGS 2012a). However, the most frequently reported length of visit during 1 day was 8 hours, as reported by 31 percent of respondents. The key modes of transportation used by visitors to travel around the refuge were private vehicle, by 93 percent of respondents, and walking or hiking, by 11 percent. More than half of visitors, or 69 percent, said that they were part of a group on their visit to the refuge, often travelling with family and friends.

According to the USGS, visitors took part in a variety of refuge activities during the survey period (USGS 2012a). The top activities reported were birdwatching, by 77 percent of respondents; wildlife observation, by 70 percent; auto tour route or driving, by 53 percent; and photography, by 51 percent. The primary reasons mentioned for their most recent visit included birdwatching, by 52 percent of respondents; hunting, by 18 percent; photography, by 10 percent; and wildlife observation, by 9 percent. The visitor center was used by 70 percent of visitors, mostly to ask information of staff or volunteers, by 91 percent of this group; or to view the exhibits, by 82 percent; or to use the facilities, by 75 percent.

Visitor Levels

Of those who visited Quivira Refuge and took part in the USGS's National Wildlife Refuge Visitor Survey, overall satisfaction with the services, facilities, and recreational opportunities we provided were rated as follows (Sexton et al. 2012):

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Painted turtles are easily viewed at Quivira Refuge.

- Ninety-two percent were satisfied with the recreational activities and opportunities.
- Ninety-one percent were satisfied with the information and education provided about the refuge and its resources.
- Ninety-three percent were satisfied with the services provided by employees or volunteers.
- Ninety-three percent were satisfied with the refuge's job of conserving fish, wildlife and their habitats.

Satisfaction levels were divided into quadrants. All Quivira Refuge services and facilities fell into the Keep Up the Good Work quadrant (Sexton et al. 2012). Refuge recreational opportunities fell into Keep Up the Good Work except for volunteer, kayak and canoe, bicycling, fishing, and hunting, which fell into the Look Closer quadrant. The average importance of fishing, hunting, bicycling, and volunteer opportunities in Look Closer may be higher among visitors who engaged in these activities during the past 12 months. However, there were either not enough people in the sample to evaluate such responses or it is unknown how many in the sample took part in an activity. Boating is not allowed on the refuge, which may explain the low importance rating for kayaking and canoeing. All transportation-related features fell into Keep Up the Good Work.

Economic Contributions of the Refuge

Quivira Refuge affects the local economy through the visitor spending it generates and the employment it supports. Combining the effects of our employment and visitor spending, the total economic activity generated in the 5-county study area is approximately $1.015 million in added value.

U.S. Fish and Wildlife Service Employment

Refuge management activities directly related to refuge operations generate an estimated 20 jobs and $667,500 in labor income. It is estimated that salary spending by Quivira Refuge staff generates secondary effects of 5 jobs, $168,600 in labor income, and $301,700 in value added to the local economy.

Visitor Spending

A region, and its economy, is typically defined as all counties within 50 miles of a travel destination (Stynes 1998). Visitors that live within the local, 50-mile area of a refuge typically have different spending patterns than those who travel from longer distances. Approximately 25 percent of visitors to Quivira Refuge said that they live within the local area. Nonlocal visitors, or 75 percent, stayed in the local area, on average, for 2 days. Table 14 shows local and nonlocal visitor expenditures reported on a per-person-per-day basis. Nonlocal visitors spent an average of $55 per person per day, and local visitors spent an average of $45.

3.9 Operations

This section describes funding, staff and facilities at Quivira Refuge.

Table 14. Total visitor expenditures, expressed in dollars per person per day, for Quivira National Wildlife Refuge, Kansas.

Visitors	*Sample size*	*Median*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Nonlocal	100	$42	$55	$57	$0	$313
Local	30	$29	$45	$55	$0	$250

Funding and Staff

Refuge staff is comprised of 11 permanent full-time employees, 1 permanent part-time employee, 3 temporary employees, and 2 regional employees that are not paid through the refuge (table 15). The current staff level remains well below the minimum prescribed in the June 2008 Final Report—Staffing Model for Field Stations (FWS 2008b), which recommends that eight more staff, including three maintenance workers, one biologist, two biological technicians, one refuge law enforcement officer, and one GPNC visitor services specialist be added.

Table 15. Base staff budgeted in fiscal year 2012 and other staff stationed at Quivira National Wildlife Refuge, Kansas.

Staff group	*Position*
Current staff	
management	General Schedule–13 refuge manager General Schedule–12 deputy refuge manager and collateral duty law enforcement officer (vacant) General Schedule–9 wildlife refuge specialist and collateral duty law enforcement officer General Schedule–11 zone fire management officer General Schedule–7 supervisory range technician (vacant)
biology	General Schedule–11 wildlife biologist
public use	General Schedule–12 park ranger—visitor services manager at the GPNC General Schedule–9 park ranger for visitor services
administration	General Schedule–9 administrative officer General Schedule–5 office assistant, 0.5 full-time equivalent
maintenance	Two Wage Grade Schedule–8 maintenance workers
maintenance, temporary or term	Two Wage Grade Schedule–6 tractor operators, career seasonal, 6 months General Schedule–5 range technician for invasive species control, term position
Current staff stationed at, but not paid by, Quivira Refuge	
biology	Zone biologist Partners biologist

Facilities

Facilities are used to support habitat and wildlife management programs and wildlife-dependent public uses for 65,000 annual visitors. The refuge has two full-time maintenance workers and two part-time tractor operators to support buildings, water conveyance structures, fences, and roads.

Facilities have been regularly updated over the years. The refuge headquarters was built in 1964 and a visitor center with a conference room was added in 1992. In 2011, these facilities were remodeled, and space was developed for seven more offices. The shop was built in 1979 and has been kept in good condition. Two residences were built in 1964 to provide housing for refuge employees at the headquarters and shop area and have been kept in good condition.

Half of the original block building office built in 1958 houses an environmental education classroom. The other half of the building is a bunkhouse that can house six seasonal employees or volunteers. The building is in poor condition and would be difficult to remodel or improve because of its construction.

We received a three-bedroom trailer as unused excess from the Federal Emergency Management Agency in 2009 and placed it at the environmental education classroom site. It is in good condition. There are two cold storage buildings, one eight-bay building was built in 1991 and a four-bay equipment storage building was built in 2005. Two full-hookup trailer pads are also available at the environmental education classroom site for use by volunteers. A new, concrete, accessible, aboveground tornado shelter was placed there in 2010.

We own 7 acres of land at the GPNC and a 23,000-square foot visitor center and office building that was built in 1995 and is in good condition. We will also own a garage and storage building on the site pending official transfer. Remaining land there is owned by the city of Wichita, including parking lots, Chisholm Creek Park, and associated trails.

Quivira Refuge's public use facilities are shown in figure 11. More than 45 miles of public roads exist either within, or next to, the refuge's boundaries. Of these, 16.8 miles are refuge owned. The refuge maintains 55 public parking lots, ranging from being graveled to grass surfaced.

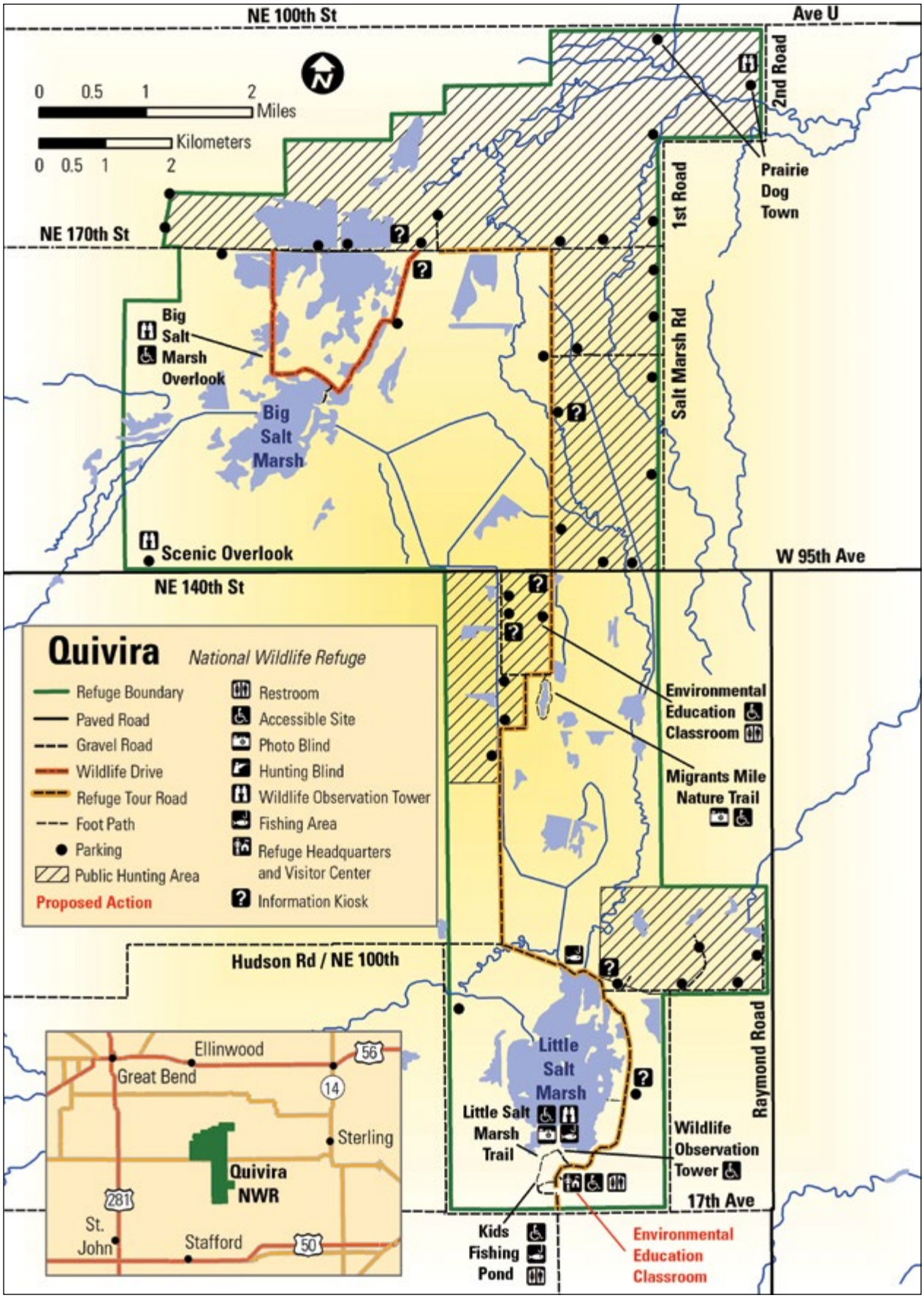


Figure 11. Public use facilities at Quivira National Wildlife Refuge, Kansas.

Refuge facilities include:

- headquarters office and visitor center building, 6,720 square feet
- maintenance shop, fire cache, and vehicle storage building, 9,200 square feet
- two 176-square foot grain bins
- eight-bay cold storage building, 6,750 square feet
- four-bay equipment storage building, 3,600 square feet
- environmental education classroom and bunkhouse, 1,900 square feet
- two 2002-square foot, three-bedroom houses for staff, with one stall, attached garage and one 400-square foot stall, detached garage for each
- oil storage building with 3 associated 1000-gallon, aboveground fuel tanks, 180 square feet
- pesticide storage building, 140 square feet
- fencing storage shed, 576 square feet
- two metal, 192-square foot pump houses for the domestic water supply
- pole shed building, 2,160 square feet
- storage building, 192 square feet
- asphalt hiking trail, 0.65 mile; earthen hiking trail, 0.57 mile; and photo blind at Migrants Mile
- earthen hiking trail at the LSM, 0.63 mile
- accessible wooden observation tower on the LSM, 6,536 square feet
- BSM overlook
- two vault toilet restrooms
- one photo blind at the LSM
- one accessible hunting blind
- nine information kiosks
- self-guided gravel auto tour route, 14 miles
- eight wayside interpretive exhibits
- two fishing piers
- fifty-five parking lots
- refuge roads, 16.8 miles
- canals, 25 miles
- one hundred and three water control structures
- nine entrance signs

FWS

The Kid's Fishing Pond has one of two fishing piers on the refuge.

Chapter 4—Management Direction

© Bob Gress

Wilson's Phalaropes

This chapter describes how we intend to carry out the proposed action through the formulation of objectives and strategies that are designed to help us achieve our goals for Quivira Refuge.

4.1 Management Focus

As stated in the Improvement Act, the primary mission of our Refuge System is wildlife conservation. Multiple policies and guidance documents have been developed to accomplish this mission, including the policy on Biological Integrity, Diversity, and Environmental Health and the 2011 Conserving the Future document developed in collaboration with our stakeholders and the public. The Biological Integrity, Diversity, and Environmental Health policy provides directives for supporting and restoring the biological integrity, diversity and health of the Refuge System, whereas Conserving the Future articulates the desired roles for refuges and provides recommendations for the next decade and beyond (FWS 2011) and states, "At the root of these challenges [that the Refuge System must address] is the increasing consumption of natural resources, which has caused loss, degradation and fragmentation of habitat around the world. Habitat loss is largely responsible for the current extinction event, in which the Earth may lose half of its species in the next 100 years."

Our focus and planning approach for Quivira Refuge is consistent with the visions and principles promoted in the Improvement Act; the policy on Biological Integrity, Diversity, and Environmental Health; and the Conserving the Future document, including conserving native communities and species of concern and developing "quantifiable conservation

objectives" that "integrate the conservation needs of the larger landscape (including the communities they support)."

4.2 Overview of Goals and Objectives

The vision, proposed alternative, and goals for Quivira Refuge collectively focus objectives and associated management strategies on achieving sustainable, diverse, native communities that will conserve native species of concern at landscape and local scales. Achieving this vision represents the greatest contribution we at the refuge can make in addressing current and future threats to natural resources in the central Great Plains. Threats include increasing habitat fragmentation and decreasing landscape connectivity, adverse effects on water quantity and quality, and cumulative risks associated with changing climate and energy production. To alleviate these and to meet the purposes of the refuge requires us to consider multiple perspectives, including Refuge System policies and guidance, the current understanding of native community ecology, increasing human demands on natural resources, continued landscape change, and our need to collaborate with the public and our partners, on projects that span beyond refuge boundaries.

4.3 Landscape Conservation Goal

Actively protect, preserve, manage, and restore the functionality of the diverse ecosystems of the Rattlesnake Creek watershed.

Quivira Refuge's contribution toward conserving natural resources in the central Great Plains must be considered within the context of the greater, surrounding landscape. Substantial loss and degradation of native environments have occurred there, which limits the amount, distribution, and quality of habitat available for native wildlife. Identifying primary needs of wildlife that are of conservation concern is essential for making decisions about the desired future condition of refuge lands, because we may have the potential to fulfill those needs. In addition, incorporating information on ecosystem function at the watershed scale is necessary because past and ongoing modifications near the refuge significantly affect our current, and future, capability to sustain the functions required to provide quality wildlife habitat. The watershed is the most appropriate scale at which to consider these factors because all flow of energy and materials in its environment are contained within its boundaries. This means that land use practices, such as conservation actions, at one site within a watershed can influence other sites within that same watershed.

In the case of Quivira Refuge, the Rattlesnake Creek watershed (subbasin) forms our most appropriate scale at which to consider landscape conservation planning. Refuge lands are at the lowest elevation of the subbasin, and the end of its primary surface water source, Rattlesnake Creek, is northeast of the BSM where it joins with Salt Creek on the refuge (figure 12). The subbasin mostly overlies the Great Bend Prairie Aquifer, which is a subregion of the High Plains Aquifer (Basin Management Team 2011). Although the area of the subbasin is 1,232 square miles, the area that actually contributes runoff to the refuge is only about 519 square miles and contributes drainage for USGS Zenith gaging station #07142575, which is located within a few miles of the creek's entrance into the refuge (USGS 2012d). The long-term average annual precipitation since 1948 is 24.33 inches, but it varies from about 15 to more than 27 inches. The average annual free-surface evaporation is about 64 inches (Sophocleous et al. 1997), with rates being highest during the summer months (Latta, 1950).

The dominant land use in this watershed is agriculture, and crop irrigation occurs largely by pumping ground water from the aquifer, which can affect ground water levels on, and near, the refuge. In addition, there is a direct connection between ground water levels and Rattlesnake Creek flows. The quantity of ground water pumped is inversely related to the amount and timing of precipitation, but most pumping occurs from May through October when surface water from Rattlesnake Creek is needed for managing refuge habitats to support annual wildlife needs.

Water rights in Groundwater Management District Number 5, which encompasses the subbasin, are overappropriated, with 1,377 water rights authorizing the use of 266,726 AFY. Ground water use often exceeds recharge (Basin Management Team 2011). The 10-year rolling average of ground water use for the stream–corridor part of the subbasin has been around 30,000 AFY for the years 2009–2011, and basin-wide estimates that include the refuge and the larger mineral intrusion area exceeded 55,000 AFY (Basin Management Team 2012). Since 1974, streamflow at USGS Zenith gaging station #07142575 has averaged 44.36 cfs, and average streamflow for the

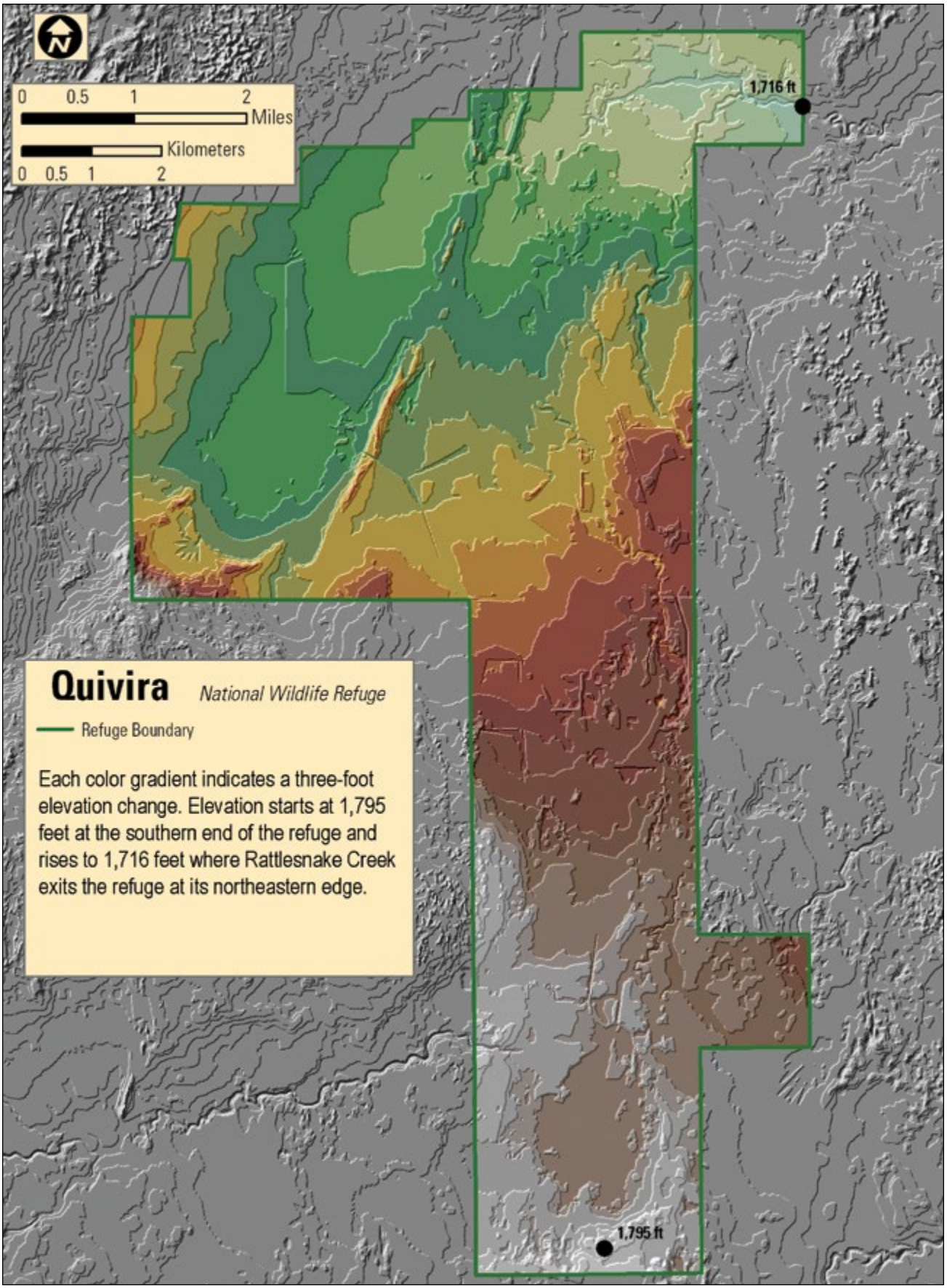


Figure 12. Elevation at Quivira National Wildlife Refuge, Kansas.

years 2000–2009 was 37.36 cfs (Basin Management Team 2011). These flows are below historical reports. A streamflow of 100 cfs was estimated in the area of the refuge at the time of establishment in the 1950s, and that was during a dry period (Heitmeyer et al. 2012). Declines in the ground water table lead to reduced streamflows that are often insufficient to meet surface water demands. Water levels have continued to decline throughout most of the subbasin between 2001 and 2012 (Basin Management Team 2012). Total water use for the subbasin reported for years 1989 through 2009 averaged 175,656 AFY, ranging from 119,204 AFY in 1997 to 216,347 AFY in 2002 (Basin Management Team 2011).

The refuge has a senior water right [Permit # 7571] allowing use of Rattlesnake Creek water quantities of 14,632 AFY and flows of 300 cfs. Since 1984, the minimum desirable streamflow criteria for USGS Zenith gaging station #07142575 have been: 15 cfs for the months of December through June, 5 cfs in July, 3 cfs from August through October, and 10 cfs in November. There are periods of record where the minimum desirable streamflow was not met, but water use was not administered because it was difficult to figure out individual diversion effects on streamflow (Basin Management Team 2012).

Information on current environmental conditions at the subbasin scale was evaluated to identify factors that could limit the value of the refuge and adjacent lands for wildlife. In addition, land use practices occurring in the watershed were considered that have altered, or could alter, important processes, like hydrology, and that constrain our, and the public's, ability to provide quality habitat in the entire subbasin. We used this evaluation to develop landscape objectives that address priority needs in the subbasin and to make decisions on which habitat types to provide on refuge lands. Relative to the rest of the subbasin, land use activities closer to the refuge have created an area that has more grassland and wetland habitat (figure 13). This offers potential benefits to native communities and species of concern.

Landscape Conservation Objective 1: Land Ownership and Collaboration

Throughout the life of the plan, collaborate with other programs and with natural resource agencies to promote land protection, restoration, and management in the Rattlesnake Creek watershed, emphasizing lands within 10 miles of the refuge boundary.

Strategies

- Continue to include Partners staff in our regular refuge staff meetings.
- Collaborate with Partners, NRCS, KDWPT, and other agencies to develop private lands programs that promote the sustainability of water resources, the control of invasive species, and the restoration of native plant communities in the Rattlesnake Creek watershed.
- Collaborate with educational institutions, as well as with other agencies and organizations, to craft pertinent research and monitoring programs to identify best management practices that can be incorporated into private lands programs.
- Collaborate with agencies responsible for regulating water use in the Rattlesnake Creek watershed to help identify and improve water use efficiencies.

Rationale

We considered expanding the refuge boundary and acquiring more fee-title lands to enhance landscape conservation. However, it would be difficult for us to obtain large tracts of land adjoining the refuge in fee title, and any acquired lands would require extensive restoration and maintenance. Agriculture and energy developments within the watershed have significantly altered surface and ground water dynamics, which has not only resulted in the loss and fragmentation of wetland and grassland habitats near the refuge, but has altered hydrologic functions that influence refuge wetlands and grasslands (Heitmeyer et al. 2012). Therefore, we decided that it would be better to collaborate with our partners to develop and conduct programs that address natural resource issues on private lands near the refuge.

Many agencies and organizations have programs that are available to landowners in the subbasin, including Partners, KDWPT, PLJV, NRCS, and the Rattlesnake Creek Partnership, among others. Such programs may provide better conservation in the Rattlesnake Creek watershed because current, and emerging, environmental threats, such as water deficiencies and invasive species, are pervasive and difficult, if not impossible, to address by only acquiring and restoring small tracts of land. Furthermore, new techniques, such as decision support systems and models, are being developed by several entities, like the landscape conservation cooperative, the Western

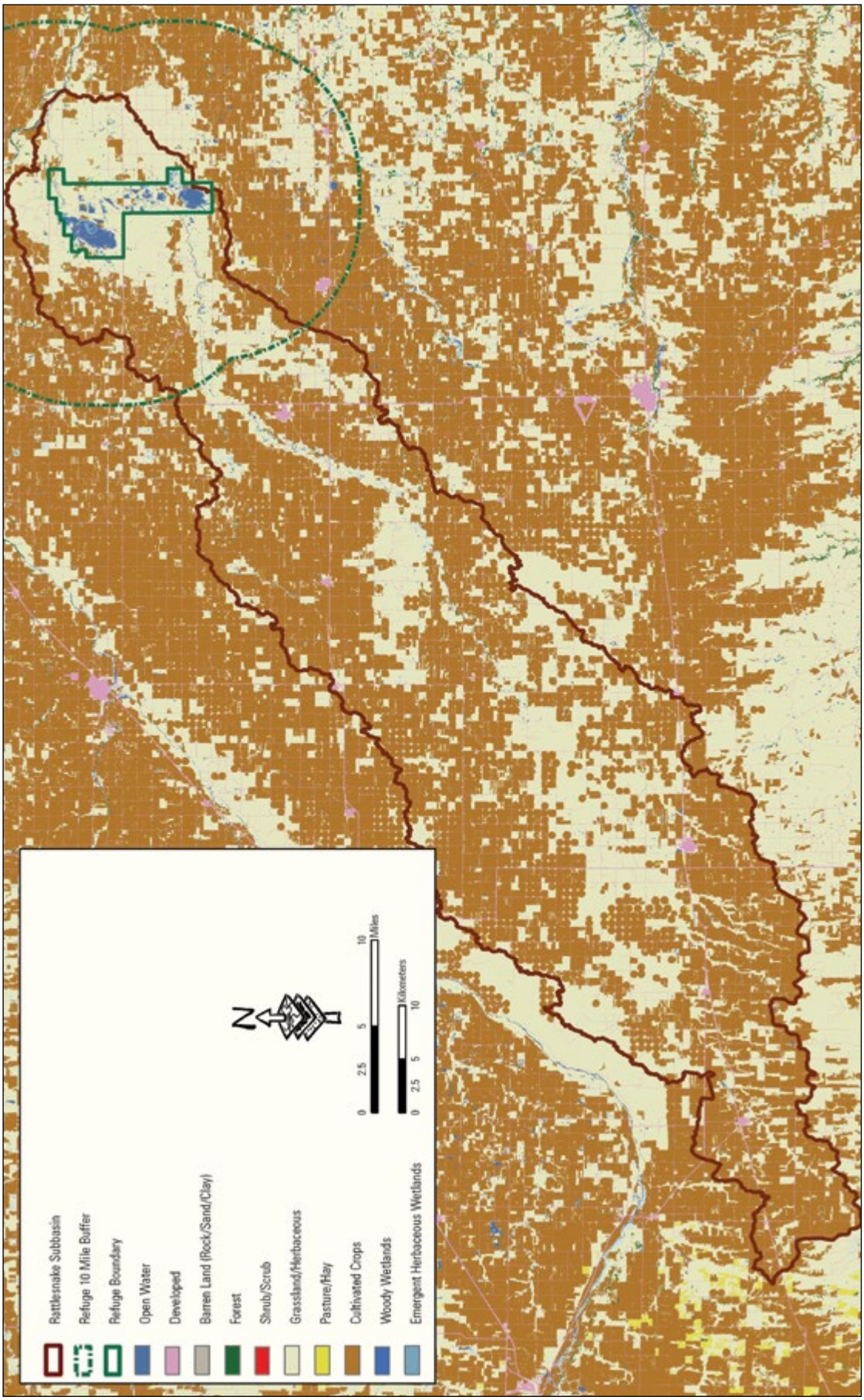


Figure 13. Land use and habitat outside the boundaries of Quivira National Wildlife Refuge, Kansas.

Governors Association, and KDWPT, which help target lands where implementation of program practices would generate the greatest benefits. Private lands programs are also cost effective because they are flexible and can be strategically deployed to address specific issues. They not only improve habitat for wildlife on lands around the refuge, but they help us to reduce the sources of invasive species, to protect senior water rights, and to do more on refuge lands.

This objective should complement, rather than override, the objectives of the Rattlesnake Creek Subbasin management plan, which identifies multiple, ranked areas for water conservation throughout the watershed. Many activities that occur more than 10 miles from the refuge influence our water resources. We support water conservation-related activities throughout the subbasin that contribute to the improvement and sustainability of water resources.

Landscape Conservation Objective 2: Habitat Fragmentation

- Reduce fragmentation of refuge grassland habitats within the next 15 years by strategically removing, at most, 850 acres of trees or tall shrubs, as shown in appendix H, to benefit grassland-dependent wildlife, particularly species that exhibit area sensitivity during essential life cycle events.

- Initiate the restoration of about 866 acres of remaining refuge agricultural lands (figure 6) during the next 15 years to suitable, native plant communities, based on ecological site descriptions, to help native grassland species, including those that are area sensitive during certain life cycle events.

Strategies

- Remove specific tree species as follows (other strategies may be used if they are likely to increase success in achieving objectives):

  - Eastern red cedar—cut, pile, and burn; prescribed fire to prevent invasion; mowing.

  - Black locust, honey locust, elm, Russian olive, cottonwood, or trees that resprout—cut and spray herbicides, or spray herbicides and cut, particularly black locust.

  - Cottonwood and eastern red cedar—cut and pile cedar under cottonwood, follow with burning.

  - Saltcedar—burn and apply herbicide to regrowth because cutting is difficult.

  - Plum and sumac—conduct a combination of three treatments within two growing seasons to include burning or mowing as low as possible.

  - Large cottonwood—chainsaw and follow up with herbicide.

- Restore agricultural lands, including areas that are removed from production but not seeded to natives, and treed areas.

  - Prepare a largely weed-free, smooth seedbed. Options include using herbicides or planting Glyphosate-ready crops or other agricultural crops, with the last year being a grain crop. As stated earlier, policy allows for the use of genetically modified crops, and that remains an option. However, the refuge has never permitted this use to date and does not plan to do so in the near future. It is a more commonly used strategy in the northern plains largely because of differences in agricultural trends.

  - Use high-diversity seeding, at least 15–20 species of forbs and grasses, that is suitable for the soil type and for other environmental conditions.

  - Collect seed from the refuge or buy local ecotypes.

  - Seed during normal-to-wet periods and avoid seeding during drought periods.

  - Broadcast seed over snow, if possible.

  - Buy a native grass harvester, such as a stripper, and harvest local seed.

Rationale

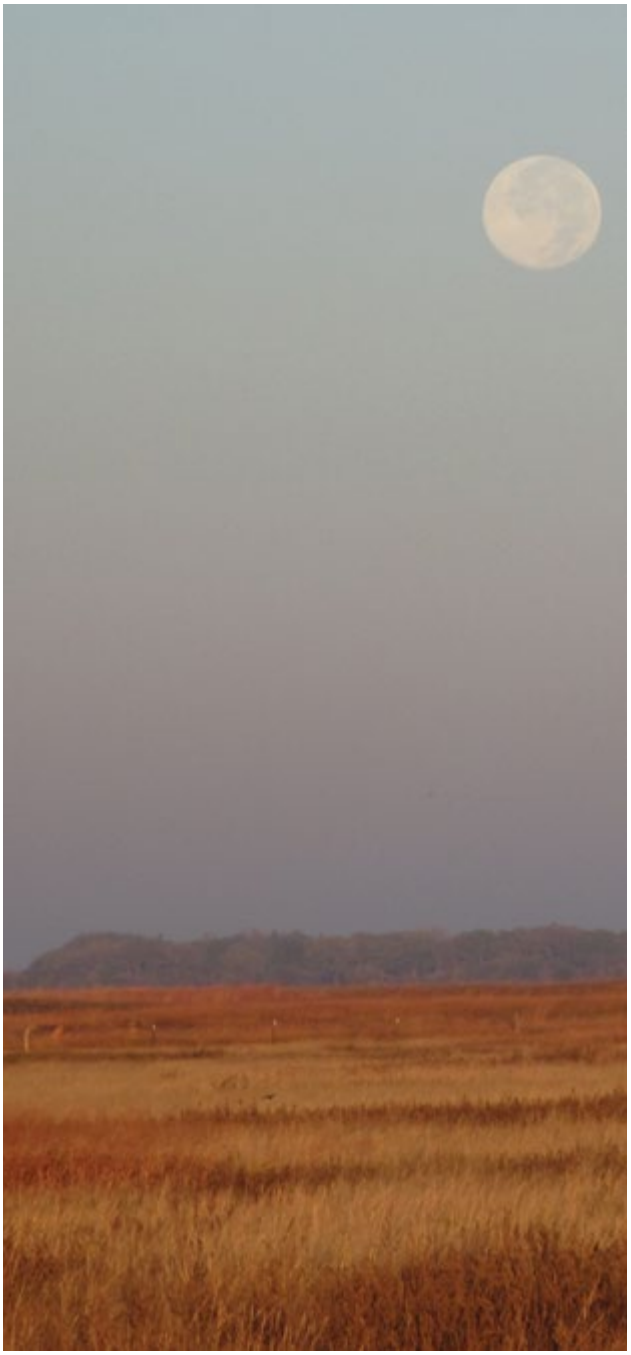
We studied refuge lands and the current surrounding landscape to identify the desired future vegetation types needed to sustain native habitats

and associated focal species. A review of existing spatial data showed that land use beyond the refuge boundary is dominated by crop and livestock production. Our planning team found that the remaining grassland tracts near the refuge are often isolated from each other and surrounded by croplands and by woody vegetation in areas that are not conducive to farming, like sandhills, and in shelterbelts that are used between fields and in areas that are managed for game, especially white-tailed deer. In addition, managing for livestock often creates areas with short-stature grasses and few forbs that do not provide adequate structure for native wildlife at certain times during the year. For example, fields of hay and other crops may be used by species for breeding or other activities early in the growing season, but harvesting, or plowing between plantings, often occurs before primary nesting activities are complete. Given these considerations, our planning team found that native prairie habitats were underrepresented in the landscape surrounding the refuge to sustain habitat for wildlife on the refuge.

Woody encroachment into habitat that was open before, resulting in the eventual replacement of grassland, has been reported as one of the greatest threats to this ecosystem (Knapp et al. 2008). Woody encroachment into grasslands around the world not only threatens ecosystem integrity but, more specifically, threatens the presence, abundance, nesting success, and local composition of grassland-obligate birds (Bakker 2003, Chapman et al. 2004). Based on our observation, this trend appears to hold true for the remaining tracts of sand prairie in, at least, the northern section of the Rattlesnake Creek watershed and on lands surrounding the refuge. Therefore, reducing woody vegetation would help refuge lands to provide unique and essential grassland habitat conditions.

Landscape Conservation Objective 3: Environmental Health and Climate Change

- Promote ecological resilience by restoring and maintaining native communities based on the following principles:
  - Continue to collect climate information and to conduct baseline inventories of refuge water use and wetland water chemistry during the next 15 years to document changes in abiotic factors to assess changes in environmental conditions that will help us develop our approach.
  - Conduct inventories of refuge habitats, including composition and structure of vegetation, at periodic intervals not to exceed 5 years, to document vegetation conditions that can be used to assess changes because of our actions and because of natural variation.



Barry Jones/FWS

A twilight view from Old Township Road on Quivira Refuge.

- Conduct informal surveillance of select wildlife species, such as waterfowl, shorebirds, and deer, during the next 15 years to detect disease outbreaks and monitor wildlife health.

Strategies

- Continue collecting climate information from established weather stations on refuge lands.
- Collaborate with our Region 6 Water Resources Division staff and with our partners to design and carry out:
  - monitoring programs on Rattlesnake Creek flow parameters at designated points of diversion on the refuge;
  - inventories of water chemistry on refuge lands.
- Develop educational programs to help the public understand the threat of environmental contaminants.
- Collaborate with our partners to collect relevant abiotic data and to periodically assess changes in environmental conditions that will help us adjust our activities.
- Reclaim mineral rights on refuge lands, as legally allowed, when existing oil wells are not used or abandoned.
- Continue to collaborate with our partners like KDWPT and academic organizations to conduct surveillance that increases the detection, prevention, and knowledge of disease outbreaks, including avian influenza and chronic wasting disease, and adjust refuge hunting programs if necessary.

Rationale

Land use practices in the Rattlesnake Creek watershed have not only resulted in the loss and fragmentation of native habitats, but they have also modified how remaining native habitats function. Agricultural and energy practices, as well as our past refuge management activities, have resulted in the introduction of nonnative plants and animals; an increased presence of chemicals, like fertilizers and pesticides; and altered disturbance regimes, such as the frequency, timing, and magnitude of fire, herbivory, and hydrology, that influence processes like nutrient cycling and sedimentation. The effects of these would likely be exacerbated by climate change, which is predicted to include higher temperatures and less frequent, but more intense, precipitation events at the refuge. Collectively, these factors can have significant effects on our ability to restore and support native plant communities and associated wildlife species.

Addressing these challenges will require us to develop flexible strategies that promote native species diversity, which has been reported to increase the resiliency of systems to climate change (Peterson et al. 1998). To accomplish this objective, we must use information about the current status of key abiotic factors that influence plant community composition and, ultimately, wildlife community composition in our management plans. We chose climate, water quality, and water quantity measures as primary abiotic factors to monitor because they influence the vegetation composition and structure of refuge habitats and are among the first to change in response to altered environmental conditions, regardless of what caused the change. For example, refuge lands are located at the lowest elevation in this agriculture-dominated watershed, thus, the amount, timing, and quality of water entering the refuge is not only influenced by climate patterns but also by agricultural practices, like irrigation and pesticide use, and by energy practices, like drilling and the storing of resources onsite.

4.4 Native Ecological Community Conservation Goal

Actively conserve and, as appropriate, improve environmental conditions within refuge boundaries to promote sustainable native ecological communities and support species of concern associated with this region of the Great Plains.

We are required to provide the plant communities necessary for wildlife to complete their annual life cycle needs, like breeding and migration. Thus, we chose habitat-based objectives that provide the resources necessary to support a native wildlife community over objectives based on individual wildlife species because (1) the long-term, sustainable productivity of habitats is essential for wildlife regardless of the landscape scale we consider; (2) most of the management activities conducted by our refuge staff indirectly influences wildlife composition and popula-

tion by altering vegetation composition and structure; (3) decisions about our management activities must be made within the context of current habitat conditions relative to the life requisites of multiple species; and (4) assessing habitat composition and structure to gauge our progress in achieving the vision and goals of Quivira Refuge is more reliable and informative than assessing wildlife populations because their migrations can include great fluctuations in things like turnover rates and lengths of stay that would affect our study of them.

We need to integrate multiple factors, including landscape form and function, regional and local environmental stressors, and the public's various perspectives, to make decisions about habitat types and management strategies. We used information from peer-reviewed outlets and refuge reports as the foundation on which to develop objectives that are supported by the best available science, that contain sufficient specificity to guide future management, and that could be studied to assess our progress and help us make decisions using an adaptive management framework (Adamcik et al. 2004). Before we held planning meetings, our refuge staff compiled and synthesized pertinent data—with the relevant literature referenced and cited throughout this document—to help guide our discussions and to make sure that our decisions were consistent with the facts. We also developed charts and tables to help us interpret data, and many of these are in this CCP.

Sometimes objectives can be misinterpreted when taken out of context. For example, seeing habitat-based objectives as static targets to achieve annually on the same tract of land is inconsistent with the more flexible reality of plant community ecology, and attempts to manage for static targets tend to alter important processes, like hydrology, that eventually lead to lower productivity. To resolve this potential problem, our refuge staff will apply the following to the set of biological objectives created to support this goal:

- We will consider these objectives collectively as representing a continuum of spatial and structural conditions that are characteristic of that habitat type in the central Great Plains.

- We will use these objectives as a reference to provide the full range of conditions necessary to support the wildlife community that is native to the refuge and the surrounding area.

- We will optimize the area and distribution (structure) of various habitat conditions characterized by the objectives to help focal species within the constraints imposed by using management that ensures sustained productivity (processes, function) of the habitat.

The following describes the initial steps we took to collect and organize information in a manner that would be useful for developing habitat-based objectives, including assumptions and rationales used to make decisions during our planning meetings.

Delineation of Current Habitat Types

Our staff at Quivira Refuge completed a spatially explicit plant community inventory in 2011. Based on 2008 aerial photography, communities were mapped to the alliance, or dominants, and finer associations, or subdominants, as defined by the NVCS using e-cognition software. The minimum mapping unit was 0.5 acre, but was adjusted to 0.2 acre during ground truthing of woody vegetation. More than 95 percent of the e-cognition polygons were ground truthed for accuracy and modified if necessary (figure 10 and table 7). A total of 43 associations, ranging in area from 0.3 to 4,926 acres, were mapped.

In addition, Quivira Refuge took part in a pilot project to map invasive species during 2011 (Edvarchuk and Ransom 2012). Approximately 10,160 acres, or 46 percent, of refuge lands were inventoried for 17 priority invasive species using standardized protocols that provided 90 percent confidence in detecting infestations greater than 100 square feet. A total of 3,573 individual infestations totaling 133 acres were mapped. These detailed maps were used to produce more map products using a GIS, as needed, to inform our planning activities. For example, plant associations provide valuable information for developing our strategies for specific areas, whereas broader community categories are more suitable when evaluating area needs of grassland-nesting birds.

Defining a Focal Wildlife Community

The refuge staff, with input from the core planning team, developed a list of focal species that we will use to help guide our development of habitat-based objectives. By providing the habitat types and conditions necessary to support focal species, we will also provide life requisites for other species and plants on the refuge and surrounding landscape. The concept of using select wildlife species to subdivide community resources along a continuum has been used to guide planning and management of both wetlands (Short 1989) and grasslands (VerCauteren and Gillihan 2004), as well as to describe habitat use patterns (Skinner 1975).

We chose migratory birds and threatened and endangered species known to use the refuge to serve as a starting point for developing the larger focal wildlife community because these species are a primary responsibility of the Refuge System and are central to the purpose of Quivira Refuge. The current refuge bird list contains more than 340 species and represents sightings recorded since refuge establishment. The list not only has native or endemic species characteristic of the region, but also species whose occurrences are considered rare or accidental and those that were introduced to the area following substantial habitat changes (Johnsgard 1978). The current list of threatened and endangered bird species known to occur on the refuge has species that are listed by both Federal and State governments. While refuge bird lists are not based on standardized surveys, this list is the best available information we have for some species occurrences on the refuge.

We further refined the refuge bird list to create a suite of focal species to help us quantify the range of structural and successional habitat conditions that we will need to provide for them. This approach helps us to prevent underestimating the wildlife values of the site, and it has been advocated by others. For example, breeding bird species documented in the Great Plains is approximately 320 (Johnsgard 2009), but developing suitable grassland restoration objectives for a local area may focus on as few as 32 bird species (Samson and Knopf 1994).

The following criteria were used to identify the focal community:

- Include species that conform to the purpose of the refuge, including those listed as endangered, threatened, or of concern by various laws or conservation plans. We consulted various plans, including our species of conservation and management concern for the Mountain–Prairie Region, the U.S. Shorebird Conservation Plan, the North American Waterfowl Management Plan, and the Central Mixed-grass Prairie Bird Conservation Region, which is part of the North American Bird Conservation Initiative.

- Include species that rely on unique or important refuge wetland habitats. Habitat uniqueness and importance on the refuge has been noted through its designation as a wetland of international importance by the Ramsar Convention and as a site of regional importance for shorebirds by the Western Hemisphere Shorebird Reserve Network.

- Include species that have comparatively greater dependence on, or association with, unique characteristics of refuge habitats, such as native sand prairie. The incorporation of species that use these habitats provides a more representative description of native upland communities and promotes diversity at spatial scales beyond refuge boundaries.

- Include species with core distributions that include refuge lands and have habitat needs that are not typically provided for on private lands in the vicinity. For example, species that require larger blocks of key habitat were given priority consideration relative to species that are considered habitat generalists or that have adapted to human modifications like urban encroachment and agriculture.

- Include species that are indicators of ecosystem health, such as having an abundance of prey species, or changing salinity conditions.

We identified 127 focal bird species that have recently occurred on the refuge and are representative of native habitat types and species of concern (table 16). We chose many focal species, in part, because of the importance of refuge habitats to a diversity of wetland-dependent species during migration. We do not expect to benefit all focal species every year because many factors outside the boundaries and control of the refuge influence species occurrences and densities. For example, climate conditions are a primary driver of waterfowl, shorebird, and whooping crane migration chronology and residence times. Furthermore, we will not be able to conduct monitoring programs for all focal species. Instead, life cycle needs of these species will be used to guide our development of habitat-based objectives, which subsequently will be used to develop annual management planning and implementation activities and monitoring programs.

Species other than birds, such as the Arkansas darter and regal fritillary, are important parts of native communities, and they may be added to the focal species list in the future because resources and landscape conditions will continue to change and more information of species–habitat relationships will become available.

Life Requisites of Focal Species

For each focal species, the life cycle events occurring on Quivira Refuge, such as breeding or migration, were noted and a literature search was conducted to locate quantitative information that

Table 16. Focal species by life event and habitat at Quivira National Wildlife Refuge, Kansas.

	Species common name	*Recent seasonal abundance*[1]				*Management priority by habitat association and life event*[2]		
		March to May	June to August	September to November	December to February	Migration	Breeding	Wintering
	Ducks, geese, and swans							
1	Greater white-fronted goose	c	r	c	c	WWW		WWW
2	Snow goose	c	r	c	c	WWW		WWW
3	Ross's goose	u		u	u	WW		WW
4	Cackling goose	c	r	c	c	WWW		WWW
5	Canada goose*	c	c	c	c	WWW	WWW GGG	WWW
6	Trumpeter swan	o		o	o	W		W
7	Tundra swan	o		o	o	W		W
8	Wood duck*	c	c	c	o	WWW		
9	Gadwall*	c	u	c	o	WWW	WW GG	
10	American wigeon*	c	u	c	o	WWW		
11	Mallard*	c	c	c	c	WWW	WWW GGG	WWW
12	Blue-winged teal*	c	c	c		WWW	WWW GGG	
13	Cinnamon teal	u	r	o	r	W		
14	Northern shoveler*	c	u	c	u	WWW	WW GG	WW
15	Northern pintail*	c	u	c	c	WWW	WW GG	WWW
16	Green-winged teal*	c	o	c	u	WWW		
17	Canvasback*	c	o	c	u	WWW		WW
18	Redhead*	c	o	c	u	WWW		WW
19	Ring-necked duck	c	o	c	u	WWW		WW
20	Greater scaup	o		o	o	W		W
21	Lesser scaup*	c	o	c	u	WWW		WW
22	Bufflehead	u		c	c	WWW		WWW
23	Common goldeneye	c		c	c	WWW		WWW
24	Hooded merganser*	u	r	u	u	WW		WW
25	Common merganser	u		r	c	WW		WWW
26	Red-breasted merganser	r		o	r	W		W
27	Ruddy duck*	c	u	c	u	WWW		WW
	Grouse and quail							
28	Greater prairie-chicken*	r	r	r	r		G	
29	Lesser prairie-chicken	Refuge was part of historical range, but is not now. May use in future, especially considering climate change adaptation.						
30	Northern bobwhite*	u	u	u	u		GG SS	
	Loons and grebes							
31	Pied-billed grebe*	c	c	c	o	WWW	WWW	
32	Horned grebe	u		u	o	WW		
33	Eared grebe*	c	o	c	r	WWW		
	Pelicans and miscellaneous							
34	American white pelican	c	c	c	o	WWW		

Table 16. Focal species by life event and habitat at Quivira National Wildlife Refuge, Kansas.

	Species common name	*Recent seasonal abundance*[1]				*Management priority by habitat association and life event*[2]		
		March to May	June to August	September to November	December to February	Migration	Breeding	Wintering
	Herons, egrets, and ibis							
35	American bittern*	u	u	u	o	WW	WW	
36	Least bittern*	o	u	o		W	WW	
37	Great blue heron*	c	c	c	u	WWW		
38	Great egret*	c	c	c		WWW	WWW (foraging)	
39	Snowy egret*	c	c	c		WWW	WWW (foraging)	
40	Little blue heron*	u	u	o		WW		
41	Green heron*	u	u	o		WW		
42	Black-crowned night-heron*	c	c	c	r	WWW	WWW	
43	Yellow-crowned night-heron*	u	u	o		W		
44	White-faced ibis*	c	c	c	r	WWW	WWW (foraging)	
	Birds of prey							
45	Mississippi kite*	u	u	o		TT	TT	
46	Bald eagle*	u	u	u	c	WW TT	TT	WWW TTT
47	Northern harrier*	c	o	c	c	WWW GGG	W G	WWW GGG
48	Swainson's hawk*	c	c	o		GGG TTT	SSS TTT	
49	Ferruginous hawk	o		r	o	G		G
50	Rough-legged hawk	u		r	u	WW GG		WW GGG
51	Prairie falcon	r	r	o	o			W
	Rails and cranes							
52	Black rail*	u	u	r		WW	WW	
53	King rail*	u	u	r	r	WW	WW	
54	Virginia rail*	c	c	u	o	WWW	WWW	
55	Sora*	c	u	c		WWW	WW	
56	Sandhill crane	c		c	o	WWW		W
57	Whooping crane	o		o	r	W		
	Shorebirds							
58	Black-bellied plover	u	u	u	r	WW		
59	American golden-plover	u	o	u		WW		
60	Western snowy plover*	c	c	c		WWW	WWW	
61	Semipalmated plover	c	u	c		WWW		
62	Piping plover	u	o	o		W		
63	Killdeer*	c	c	c	o	WWW	WWW	
64	Black-necked stilt*	c	c	u		WWW	WWW	
65	American avocet*	c	c	c		WWW	WWW	
66	Spotted sandpiper*	c	u	c		WWW		

Table 16. Focal species by life event and habitat at Quivira National Wildlife Refuge, Kansas.

	Species common name	*Recent seasonal abundance*[1]				*Management priority by habitat association and life event*[2]		
		March to May	June to August	September to November	December to February	Migration	Breeding	Wintering
67	Solitary sandpiper	u	u	o		WW		
68	Greater yellowlegs	c	c	c	o	WWW		
69	Willet	u	u	u		WW		
70	Lesser yellowlegs	c	c	c	r	WWW		
71	Upland sandpiper*	c	o	o		WWW	WW GG	
72	Whimbrel	o	o	o		W		
73	Long-billed curlew	o	o	o		W		
74	Hudsonian godwit	u	r	u		WW		
75	Marbled godwit	u	u	u		WW		
76	Ruddy turnstone	o	o	o		W		
77	Sanderling	o	o	o		W		
78	Semipalmated sandpiper	c	c	c		WWW		
79	Western sandpiper	c	c	c		WWW		
80	Least sandpiper	c	c	c		WWW		
81	White-rumped sandpiper	c	c	u		WWW		
82	Baird's sandpiper	c	c	c		WWW		
83	Pectoral sandpiper	u	u	u		WW		
84	Dunlin	u	o	u	r	WW		
85	Stilt sandpiper	c	c	c		WWW		
86	Buff-breasted sandpiper	o	r	u		WW		
87	Short-billed dowitcher	u	u	o		WW		
88	Long-billed dowitcher	c	c	c		WWW		
89	Wilson's snipe	u	r	u	o	WW		
90	Wilson's phalarope*	c	c	c		WWW	WWW GGG	
91	Red-necked phalarope	o	r	o		W		
	Gulls and terns							
92	Franklin's gull	c	u	c	r	WWW		
93	Interior least tern*	u	u	o		WW		
94	Black tern*	c	c	u		WWW		
95	Forster's tern*	c	c	o		WWW		
	Pigeons and doves							
96	Yellow-billed cuckoo*	o	u	r		SS		
	Owls							
97	Short-eared owl*	r		r	o			G
	Woodpeckers							
98	Red-headed woodpecker*	c	c	c		TTT		
	Flycatchers							
99	Western kingbird*	c	c	u		SSS TTT		
100	Eastern kingbird*	c	c	u		TTT		
101	Scissor-tailed flycatcher*	o	o	o		S		

Table 16. Focal species by life event and habitat at Quivira National Wildlife Refuge, Kansas.

	Species common name	*Recent seasonal abundance*[1]				*Management priority by habitat association and life event*[2]		
		March to May	June to August	September to November	December to February	Migration	Breeding	Wintering
	Shrikes and vireos							
102	Loggerhead shrike*	u	u	u	u		SS TT	
103	Bell's vireo*	u	u	o			SS	
	Larks							
104	Horned lark*	o	o	o	o	G	G	
	Thrushes, pipits, waxwings, and miscellaneous							
105	Sprague's pipit	r		r		G		
	Longspurs							
106	Lapland longspur	r		o	u			GG
107	Chestnut-collared longspur	r			r	G		
	Wood warblers							
108	Yellow warbler*	u	u	o		SS (riparian area)	SS TT	
109	Common yellowthroat*	c	c	u	o	GGG	WWW GGG	
	Sparrows and towhees							
110	Cassin's sparrow	r					G S	
111	Field sparrow*	c	u	c	u	GGG	GG	GG
112	Vesper sparrow	c	r	c		GGG		
113	Lark sparrow*	c	u	o		GGG	GG	
114	Savannah sparrow	c		c	o	GGG		
115	Grasshopper sparrow*	u	u	u		GG	GG	
116	Le Conte's sparrow	o		o	r	W G		
117	Harris's sparrow	c	r	c	c	GGG		SSS
	Grosbeaks and buntings							
118	Blue grosbeak*	u	u	r			SS	
119	Dickcissel*	c	c	r			GGG	
	Blackbirds and allies							
120	Bobolink*	u	u				GG	
121	Red-winged blackbird*	c	c	c	c	WWW	WWW	
122	Eastern meadowlark*	c	c	c	c		GGG	GGG
123	Western meadowlark*	u	o	u	c		G	GGG
124	Yellow-headed blackbird*	c	c	u	r	WWW	WWW	
125	Orchard oriole*	c	c	o			TTT	
126	Baltimore oriole*	c	c	o			TTT	
	Finches							
127	American goldfinch*	c	c	c	c	GGG	GGG	GGG

* Reported nesting on the refuge.

[1] Abundance is indicated as follows: c = common (certain to be seen in suitable habitat), u = uncommon (present, but not certain to be seen), o = occasional (seen a few times during season), r = rare (seen every 2–5 years).

[2] Habitat association is indicated as follows: G= grass or meadow, W= wetland–riparian area–flooded, S= shrubs, T= isolated trees–small groves. Within a cell, the number of times a letter is repeated is proportional to abundance. For example, WWW= common and W= occasional or rare in wetland habitat during the indicated life event.

characterized suitable habitat conditions for as many focal species as possible. Sources of information largely included dissertations, scientific periodicals, published books and refuge files held onsite. The specific information we sought included:

- chronology of use, including dates of spring migration, breeding, fall migration, and wintering activities on the refuge
- spatial needs for breeding, including minimum area, perimeter-to-area ratios, area of 50-percent occupancy, and distance from other required, or hostile, habitat types or conditions, such as nesting within a minimum distance to water or from a woodland edge
- vegetation composition at breeding sites, including the percent of grass, forb, and shrub
- vegetation structure at nest sites of breeding species, including litter depth, visual obstruction, and plant height
- characteristics of waterbird foraging habitats, including preferred foraging depths, diet, and vegetation cover

Information on each of these factors was not available for all species. This is not a problem, however, because information on individual species was grouped into functional guilds, such as species that forage in water less than 2 inches, to identify important parameters that influence habitat suitability. We further organized this information into categories that were based on our capability. For example, foraging depths of waterbirds were grouped in minimal increments of greater or equal to 2 inches because our staff experience suggests that the existing water infrastructure, such as structure type and canals, would facilitate management at this level of specificity. We do not denote distinct community types for individual species, but we provide a broader perspective of multiple species benefits provided by a habitat type in different successional conditions (figure 14).

While our approach maximizes the use of existing information, there are limitations. First, most quantitative information on the habitat needs of many species is based on certain points during the breeding season and reflects conditions near nest sites or breeding territories during the growing season. By comparison, there is relatively little quantitative information on the habitat needs during the nonbreeding period, except for dietary information and waterbird foraging depths. Therefore, the quantitative information compiled to develop objectives is limited because, as focal species table 16 shows, Quivira Refuge is an important migration stopover for wetland-dependent migratory birds, and it also provides some wintering habitat. In cases where we lacked detailed information, our planning team used less common descriptive measures and anecdotal information provided by experts to categorize the habitat needs of some focal species.

Second, most information on habitat needs of species was obtained from research not conducted on the refuge. As such, the results of this research may not apply directly to the refuge because of differences in landscape context, like the land use practices surrounding the refuge; abiotic qualities, like soils and climate; and other factors. Our planning team reduced this concern by considering only information from sand prairie or sandhill ecosystems. However, information on many species were still absent, thus, information from other ecotypes was also included. In these cases, the habitat measures, like visual obstruction and plant height, were included only if they could be met in refuge habitats. We made this determination by comparing the metrics reported in the literature to the ecological site potential of the appropriate habitat on the refuge.

Given these limitations, we decided that using habitat-based objectives for a given native plant community to represent a continuum of conditions along a successional gradient for long-term sustainability is an appropriate interpretation of the data. From our perspective, this more aptly represents the dynamic nature of systems and ends any attempt to maintain static habitat conditions within, and among, years or to manage exclusively for a few, select species or species groups. At the same time, it provides sufficient guidance to make sure that different seral stages required by wildlife are provided on refuge lands, with the understanding that refuge-specific information is limited and that the applicability of data collected on other sites may not apply directly to the refuge. It also embraces the value of using quantitative information, which:

- decreases the confusion associated with qualitative terms such as “tall” and “dense” and provides a unifying perspective of what management is attempting to achieve;
- enables our staff to establish thresholds that clarify when a decision must be made about treatment and the type of treatment to apply;
- provides a baseline on which to develop a monitoring plan that will provide refuge-

SYMBOL	OBJECTIVE(S)	EXAMPLES OF USE BY SPECIES
a.	Grassland b3	breeding grasshopper sparrow and western meadowlark
b.	Grassland b4	breeding dickcissel, blue-winged teal, eastern meadowlark
c.	Wetland a2, c2	foraging waterfowl and marsh birds
d.	Wetland b2	breeding and foraging bitterns and rails
e.	Grassland b1	nesting American avocet, least tern, and snowy plover
f.	Wetland a1, b1, c1	foraging shorebirds and roosting cranes
g.	Wetland a3, c3, d1	wintering waterfowl and foraging eagles
h.	Wetland b2	breeding and foraging bitterns and rails
i.	Grassland b2	breeding lark and field sparrow, and upland sandpiper
j.	Grassland a1, b5, b6, c1	breeding Bell's vireo, wintering Harris's sparrow (in shrub)
k.	Woodland	Baltimore oriole, bald eagle, and yellow warblers
l.	Grassland a1, b5, b6, c1	migrating vesper and field sparrows, breeding blue grosbeak
m.	Wetland e (springs)	Arkansas darters and source of *fresh* water for various wildlife

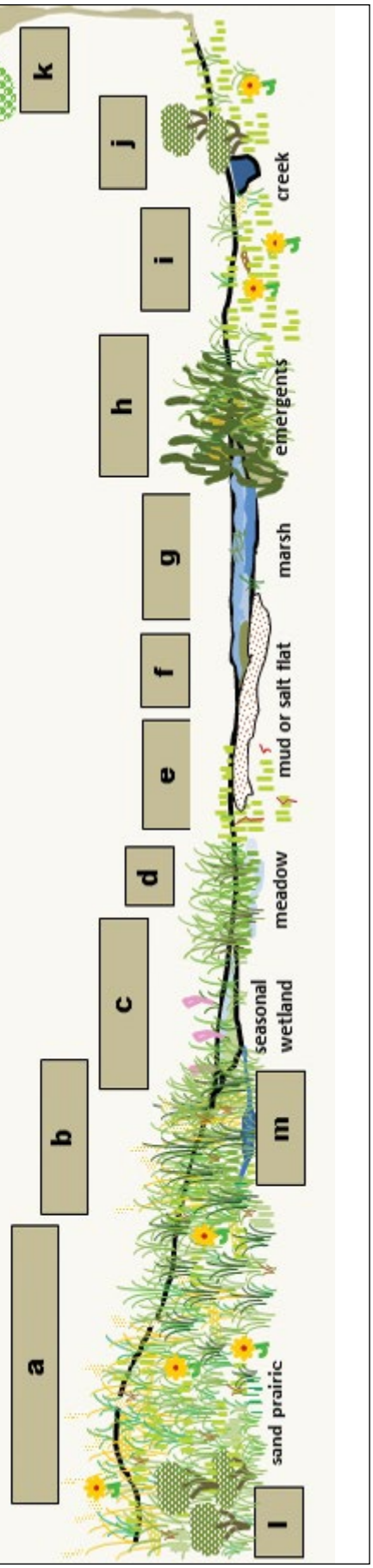


Figure 14. Native ecological community conservation objectives for Quivira National Wildlife Refuge, Kansas, illustrated in a community profile schematic.

specific information useful for understanding treatment effects and species–habitat relationships, which ultimately can be used to refine management treatments.

Native Ecological Community Conservation Objective 1: Wetlands

Maintaining the integrity and persistence of all wetland types is important. Of principal importance is restoring and maintaining the suitable hydrological cycles characteristic of each wetland type to the extent possible, as described in the objective below, because hydrology is the single greatest driver of wetland functions, including nutrient cycling and sediment dynamics, as well as plant community dynamics (Mitsch and Gosselink 2003, Euliss et al. 2004, Laubhan et al. 2012).

Criteria

A. Apply from mid-February through May—spring migration:

1. Reliably provide at least 70 percent of the 2,931 estimated potential acres of early successional habitat—defined as bare mudflat or salt flat with less than 25 percent cover vegetation—flooded to depths less than 6 inches to provide foraging habitat for shorebirds and waterfowl, as well as roosting habitat for cranes (table 17); tolerate 5 percent or less in exotic or invasive plant species.

2. Reliably provide at least 70 percent of the 1,581 estimated potential acres of early mid-successional habitat—defined as greater than 75 percent cover of annuals—moist soil—or wet meadow—sedges and rushes—flooded to depths less than 15 inches for foraging waterfowl (table 17); tolerate 1 percent or less in exotic or invasive plant species and 25 percent or less in perennial robust emergent vegetation, such as cattail.

3. Reliably provide at least 70 percent of the 2,160 estimated potential acres of mid- to late-successional habitat, defined as less than 25 percent cover of emergent vegetation and greater than 20 percent aquatic vegetation, flooded to depths of 6–30 inches to provide foraging and roosting habitat for American white pelican and waterfowl (table 17); tolerate 5 percent or less in exotic or invasive plant species.

B. Apply from May through July—breeding season:

1. Reliably provide at least 70 percent of the 1,740 estimated potential acres of early successional habitat, defined as bare mudflat and salt flats with less than 25 percent cover of all vegetation, next to moist or shallowly— equal to, or less than, 1 inch—flooded areas to provide breeding habitat for western snowy plovers, interior least

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An example of a wetland with interspersed tall, dense cover on Quivira Refuge.

terns, and resident focal species (table 17); tolerate 5 percent or less in exotic or invasive plant species.

2. about 400–500 acres, with a minimum block size of 50 acres, of mid- to late-successional habitat, defined as 30–60 percent interspersed, flooded emergent cover with a visual obstruction of 4–20 inches and a height greater than 20 inches to provide breeding and foraging habitat for pied-billed grebe, sora, Wilson's phalarope, black-crowned night-heron, and American bittern in most years (table 17); tolerate 5 percent or less in exotic or invasive species.

C. Apply from late July to November—fall migration:

1. Reliably provide at least 70 percent of the 576 estimated potential acres of early successional habitat, defined as bare mudflat or salt flat with less than 25 percent cover vegetation, flooded to depths less than 6 inches to provide foraging habitat for shorebirds and waterfowl, as well as roosting habitat for cranes (table 17); tolerate 1 percent or less in exotic or invasive species.

2. Reliably provide at least 70 percent of the 1,073 estimated potential acres of early mid-successional habitat, defined as greater than 75 percent cover of annuals—moist soil—or wet meadow—sedges or rushes—flooded to depths less than 15 inches for foraging waterfowl (table 17); tolerate 1 percent or less in exotic or invasive plant species and 25 percent or less in perennial robust emergent vegetation, such as cattail.

3. Reliably provide at least 70 percent of the 903 estimated potential acres of mid- to late-successional habitat, defined as less than 25 percent cover of emergent vegetation and greater than 20 percent aquatic vegetation, flooded to depths of 6–30 inches to provide foraging and roosting habitat for American white pelican and waterfowl (table 17); tolerate 5 percent or less in exotic or invasive plant species.

D. From November through February—winter—reliably provide at least 70 percent of the 5,086 estimated potential acres, with a minimum block size of 50 acres, of mid- to late-successional habitat, defined as less than 25 percent vegetation cover and greater than 20 percent aquatic vegetation, flooded to depths of 6–30 inches to provide foraging and roosting habitat for geese, diving ducks, swans, American white pelican, whooping and sandhill cranes, and bald eagles—foraging only (table 17); tolerate 5 percent or less in exotic or invasive plant species.

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Damselflies on a wetland with submerged aquatic vegetation.

E. Support the current integrity of freshwater springs on the refuge, including quantity, as possible, and waterflow direction; native vegetation composition; and Arkansas darter protection.

For each part of this objective, the greatest potential area is based on current water control structure elevations; available information, like spatial analysis using a GIS, aerial imagery, light detection and ranging and vegetation data, and our staff experience and knowledge of management potential; and on management philosophy described herein. Even if environmental and management conditions are ideal, the greatest potential is not intended to be met in any given year because of the need to vary prescriptions to mimic natural wetland processes to sustain long-term wetland structure and function. This means that, for a given created wetland, we will not maintain static hydroperiods within, and among, years.

Wetlands Strategies

- Store Rattlesnake Creek water in the LSM, in accordance with existing water rights, to:
  - provide a source of water that can be used to manage vegetation and to provide flooded habitat in created wetlands;
  - inundate mudflats and annual vegetation that will provide foraging habitat for waterbirds.

Table 17. Estimated greatest potential distribution of wetland habitat conditions (acres by unit and objective) for the proposed alternative for Quivira National Wildlife Refuge, Kansas.

		Mid-February through May spring migration			*May through July summer breeding*		*August–November fall migration*			*November–February winter*
		A1	A2	A3	B1	B2	C1	C2	C3	D
Wetland	*Acres*	Acres bare flats <25% vegetation, flood <6 inches	Acres >75% annual or meadow, flood <15 inches	Acres <25% emerging >20% submerged aquatic vegetation, flood 6–30 inches	Acres of bare flats <25% cover	Acres of 30–60% tall emerging, flood <10 inches	Acres of bare flats <25% vegetation, flood <6 inches,	Acres >75% annual or meadow, flood <15 inches	Acres <25% emerging >20% submerged aquatic vegetation, flood 6–30 inches,	Acres <25% emerging, flood 6–30 inches
Little Salt Marsh	931	181.2	0	662.9	3.8	87.3	181.1	0	662.9	931
Unit 7 (created)	62	15.8	40.5	5.6	15.8	0	15.8	40.5	5.6	62
Unit 10a (created)	19	12.9	12.9	6.3	0	6.3	0	12.9	0	19
Unit 10b (created)	14	0	0	10.3	0	0	3.9	0	10.3	14
Unit 10c (created)	7	6	6.1	0.8	6.1	0	0	6.1	0.8	7
Unit 11 (created)	30	11.9	12	16.3	0	0	0	12	6.3	30
Unit 12b (created)	12	8.8	8.8	2.9	0	11.5	0	8.8	2.9	12
Unit 14a (created)	100	15.5	73.9	0	27.3	0	15.6	73.9	0	100
Unit 14b (created)	45	43.1	43.1	1.7	0	1.7	0	43.1	1.7	45
Unit 16 (created)	14	0	5.8	8.5	0	14.2	0	5.8	8.5	14
Unit 20a (created)	69	60.3	60.4	8.5	0	8.5	0	60.4	8.5	69
Unit 20b (created)	66	0	62.2	3.7	0	3.7	0	62.2	3.7	0
Unit 21 (created)	11	3.9	0	5.9	3.8	1.5	3.8	0	5.9	11
Unit 22 (created)	12	0	0	12.1	0	12.1	0	0	12.1	12
Unit 23 (created)	14	0	0	14.1	0	14.1	0	0	14.1	14
Unit 24 (created)	54	0	0	54.1	0	54.1	0	0	54.1	54
Unit 25 (created)	54	0.6	53.4	0	0	0	0	53.4	0	54
Unit 26 (created)	69	69.1	69.1	0	0	0	0	69.1	0	69
Unit 28 (created)	61	60.8	60.9	0	0	0	0	60.9	0	61

Table 17. Estimated greatest potential distribution of wetland habitat conditions (acres by unit and objective) for the proposed alternative for Quivira National Wildlife Refuge, Kansas.

		Mid-February through May spring migration			*May through July summer breeding*		*August–November fall migration*			*November–February winter*
		A1	A2	A3	B1	B2	C1	C2	C3	D
Wetland	*Acres*	Acres bare flats <25% vegetation, flood <6 inches	Acres >75% annual or meadow, flood <15 inches	Acres <25% emerging >20% submerged aquatic vegetation, flood 6–30 inches	Acres of bare flats <25% cover	Acres of 30–60% tall emerging, flood <10 inches	Acres of bare flats <25% vegetation, flood <6 inches,	Acres >75% annual or meadow, flood <15 inches	Acres <25% emerging >20% submerged aquatic vegetation, flood 6–30 inches,	Acres <25% emerging, flood 6–30 inches
Unit 29 (created)	27	23.7	23.7	3.6	0	0	0	23.7	3.6	27
Unit 30 (created)	42	41.6	41.6	0	0	0	0	41.6	0	42
Unit 37 (created)	50	0	0	49.8	0	49.8	0	0	49.8	50
Unit 40 (created)	36	36.7	36.4	0	0	0	0	36.4	0	36
Unit 48 (created)	55	54.4	54.4	0.8	0	0	0	54.4	0.8	55
Unit 49 (created)	85	83.9	83.9	1.3	83.9	0	83.9	83.9	1.3	85
Unit 50 (created)	91	90.5	90.6	0	0	0	0	90.6	0	91
Unit 57 (created)	89	0	43.4	34.0	11.5	43.4	11.5	0	34	89
Unit 58 (created)	116	67.5	0	48.9	0	48.9	0	0	0	116
Unit 61 (created)	121	121.2	104.2	0	121.2	0	17.2	104.2	0	121
Unit 62 (created)	38	35.7	35.8	1.7	0	0	1.7	35.8	1.7	38
Unit 63 (created)	103	93	93	0	10	0	10.0	93	0	103
Unit 80 N. Lake	393	393.2	0	72.1	393.2	0	0	0	0	393
Marsh Road Meadow	494	267.6	226.2	226.2	267.6	0	0	0	0	0
Wildlife Drive (BSM)	801	723.2	0	107.3	697.1	0	25.1	0	0	801
Big Salt Marsh	1209	408.8	0	800.6	98.3	0	206.4	0	0	1209
Salt Springs	252	0	238.3	0	0	14.7	0	0	14.6	252
Total	5646	2930.9	1580.6	2160	1739.6	371.8	576	1072.7	903.2	5086

NOTE: Table does not include wetlands managed as part of the grassland habitat type.

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Northern shoveler in a wetland with midheight, sparse vegetation.

- Transport water from the LSM to:
  - create mudflats and shallow water habitats, <16 inches, for foraging and roosting waterbirds;
  - expose bare mudflat and salt flat habitat for nesting shorebirds;
  - promote the germination and growth of vegetation in created wetlands.
- Support infrastructure and replace water control structures as necessary. Develop structures for A2 and A3.
- Use a combination of treatments, such as prescribed fire, chemical, grazing, and mechanical, to reduce and control invasive species and hazardous fuel.
- Refine the measures used in objectives as new information becomes available, such as through monitoring programs or research.
- When appropriate, use wildfires to help achieve land and resource management objectives.
- Refine strategies as new or better information become available to improve success in accomplishing objectives.
- Disk wetland soil surface when necessary and appropriate to benefit or encourage germination and growth of desirable vegetation.

Wetlands Rationale

Located within the migration corridor of the central flyway, Quivira Refuge is an important stopover for a diversity of waterbirds. Thus, we consider providing migratory habitat to be most important; and a primary role of refuge wetlands is to provide plant foods rich in carbohydrates, like seeds, tubers, and browse, and animal foods high in protein, like invertebrates. During spring, these foods provide the energy necessary for birds to reach their breeding grounds and, for some species, accumulate reserves necessary for egg production. In the fall, these foods provide energy for birds traveling to wintering grounds and protein for feather molt. Diets vary among species, with shorebirds consuming predominantly invertebrates, waterfowl consuming a combination of plant foods and invertebrates, cranes consuming predominantly plant foods, and American white pelican consuming fish.

While providing migration habitat is our primary concern, refuge wetlands also support limited breeding habitat for several bird species and, in some years, provide early winter habitat, primarily for large-bodied waterbirds that forage in wetlands. Therefore, we want to provide suitable habitat for completing these life cycle events even though the area of habitat needed is much less than for migration habitat. Primary nesting species include the federally listed interior least tern, the State-threatened western snowy plover, pied-billed grebe, sora, Wilson's phalarope, American bittern, and black-crowned night-heron.

Early winter habitat offers abundant, energy-rich foods and, for some waterfowl species, thermal cover in stands of tall emergent vegetation such as cattail and bulrush. As with the breeding season, the foods and cover required by these species are typically produced when we manage refuge wetlands for migration habitat. Therefore, the primary consideration for winter habitat is to make suitable sites available by flooding at suitable times and depths. In addition, wildlife values of a given wetland change within, and among, years, and attempts to manage for static conditions often leads to lower primary productivity that reduces wildlife benefits. Given these considerations, objectives were developed by considering refuge wetlands collectively rather than by developing objectives for each wetland unit.

The refuge also has a unique habitat in the freshwater springs, which supports a population of the State-threatened Arkansas darter. We want to maintain the integrity of these springs for them. Because little is known of the historical condition of this area, necessitating further study, the life history needs of the Arkansas darter will be used to guide our management efforts while we conduct more research.

Little Salt Marsh

Historically, hydrology of the marsh was determined by a combination of ground water levels and overbank flooding of Rattlesnake Creek. Water levels in the marsh fluctuated greatly and in some years no surface water was present. Similarly, water chemistry ranged from brackish to fresh depending on the amount of surface water inputs. However, before refuge establishment, Rattlesnake Creek was diverted directly into the marsh. Consequently, complete drying of marsh substrates is rare as some water enters the marsh annually and water chemistry likely has changed.

The ability to restore the hydrology of the LSM and reactivate the historic Rattlesnake Creek channel is not considered feasible because refuge water rights may be forfeited. In addition, extensive ground water depletion in the watershed, coupled with reduced flows in Rattlesnake Creek, has severely reduced the quantity and timing of water reaching the refuge that affects management capability. For example, in years of below average precipitation and extensive agricultural demands, insufficient water quantities are delivered to the refuge to exercise all habitat management options (Heitmeyer et al. 2012). Consequently, continuing to use the LSM as a storage reservoir is the best way for providing quality wildlife habitat on the refuge.

Although the hydrology of the LSM has been altered, management can still manipulate water levels within the marsh to promote important processes (for example, nutrient cycling) and simultaneously optimize habitat for a diversity of waterbirds. Partial drawdowns can be conducted to oxidize soils and facilitate plant decomposition on the marsh perimeter, which provide nutrients for invertebrates and create suitable conditions for plant germination and growth on islands and along the marsh perimeter (Fredrickson and Taylor 1982, Laubhan et al. 2012). In addition, partial drawdowns also create bare flats suitable for nesting shorebirds and concentrate prey for shorebirds (invertebrates), as well as bald eagles and American white pelicans (fish). Conversely, addition of water during storage phases of the cycle results in flooding of newly established vegetation and creates a range of water depths suitable for roosting and foraging by many waterbirds throughout the year, including shorebirds and cranes.

Big Salt Marsh

The historical hydrology of the BSM has been altered by activities both on, and off, the refuge. Development of the water transport infrastructure on the refuge has included canals that facilitate the movement of water from Rattlesnake Creek to the BSM, whereas ground water depletion in the watershed has likely reduced the quantity and timing of ground water discharge to the BSM. In combination, we presume that increased use of Rattlesnake Creek water and smaller amounts of ground water dis-

Rachel Laubhan/FWS

Big Salt Marsh

charge has resulted in lower salinities, which is supported by the increased occurrence of cattail and other species that germinate under low saline conditions. In addition, the increased input of Rattlesnake Creek water has altered the timing of flooding and reduced the frequency and extent of drying. Collectively, these changes have stimulated a change in vegetation community composition, including an increase in cattail and an accompanying decline in salt-tolerant emergent species such as alkali bulrush and alkali sacaton. We also presume that these changes have altered the composition of the invertebrate community.

Although vegetation communities with different salinity tolerances provide food and cover to focal wildlife species, emergent vegetation better adapted to less saline conditions can be managed in other areas of the refuge to provide food resources and robust structural cover, as in created wetlands and wet meadows. By contrast, the ability to provide an interspersion of barren salt flats with large expanses of saltgrass and scattered areas of salt-tolerant emergent plant species is unique to the BSM area because saline conditions limit the amount of vegetation cover on mud and alkali flats, which provides open areas near water that are suitable for nesting interior least terns and snowy plover, foraging and roosting habitat for cranes, and foraging habitat for migratory shorebirds. In addition, the deeper parts of the marsh provide flooded open water that provides foraging and roosting habitat for American white pelicans and diving ducks throughout the year.

Given these considerations, mimicking historical conditions to the extent possible and relying on ground water discharge as the primary hydrologic input represents our best way for managing the BSM. Dynamic fluctuations in water quantity and quality will occur within, and among, years. In most years, surface water will be allowed to evaporate in late summer and ground water discharge will slowly begin to provide surface water in late October, with the marsh becoming full by January. Areas that are typically shallow when the marsh is fully flooded will have water during the spring, and then slowly begin drying in late spring through the summer. Use of Rattlesnake Creek water will be diverted to keep water chemistry, as in salinity, within the range of conditions necessary to sustain native plant communities or to avoid infrastructure damage during substantial flooding events.

Big Salt Marsh Strategies

- Support or improve appropriate salinity gradients through water management, including limiting relatively fresher water from Rattlesnake Creek.
- Support or improve water control structures and associated infrastructure.
- Use a combination of treatments, such as prescribed fire, chemical, grazing, and mechanical, to promote native plant communities and reduce invasive species and hazardous fuel.
- Evaluate, then change or install water control structures to improve surface waterflows.
- Evaluate, then change or remove roads, such as ditches and roads on the west side, Y road, Road to Mandalay, and Tern Pad Road, that significantly alter surface waterflows.
- Evaluate the south end and, when oil wells become inactive, remove oil well roads and restore those areas.
- Replace the Unit 80 structure with a larger structure to better export water from the BSM to Salt Creek and to improve water management capability to better prevent flooding of least tern and snowy plover nests.
- When appropriate, use wildfires to help achieve land and resource management objectives.

Created Wetlands

The primary purpose of managing created wetland units is to produce plant and animal foods for migratory birds during spring and fall migration that supplement foods provided in other wetland types, see objectives A2 and C2 above. Plant food production in these units usually exceeds the production in other wetland types on the refuge because the time and rate of drawdowns can be manipulated to stimulate the germination and growth of desirable annual vegetation, like barnyard grass and sprangletop, that produces abundant seed and structure for invertebrate production after reflooding in the fall and winter. Similarly, making these foods available to a greater diversity of birds is possible because we can control the time and depth of flooding (Fredrickson and Taylor 1982, Laubhan and Fredrickson 1997, Laubhan et al. 2012, Laubhan and Roelle 2001). Created wetland units that we manage to mimic seasonally flooded wetlands to produce foods also provide

many other benefits. For example, drawdowns to stimulate plant germination often can be timed to create mudflats, oxidize soils, and increase invertebrate availability during spring shorebird and crane migration. Following plant germination, units can be shallowly flooded to improve plant growth and seed production, and provide summer foraging habitat for breeding species.

Some created wetlands on Quivira Refuge can also be managed as temporary or semipermanent wetlands to supplement migration or breeding habitat and thermal cover for certain species.

Created Wetlands Strategies

- Manage hydroperiods for desired conditions. Gather and apply information on the germination and growth needs of plants and on the utilization criteria, such as chronology, foraging depths, and nesting needs, of the species that use these wetlands.
- Keep water transfer infrastructure and associated water control structures 95-percent free of emergent vegetation.
- Evaluate water control structure conditions and replace or change them as necessary. One such structure is on Dead Horse Slough.
- Use a combination of treatments, such as prescribed fire, chemical, grazing, and mechanical, to reduce and control invasive species and hazardous fuel.
- Inventory these units to refine the measures used in objectives. Correlate water level gauge readings with unit elevation gradients to help predict habitat potentials.
- When appropriate, use wildfires to help achieve land and resource management objectives.

Freshwater Springs

The freshwater springs are a source of permanent water that is unique to the refuge. The site has been modified by the installation of a pipe and the creation of more small pools to trap spring flows and by the installation of a pipe that created an artesian well. These pools support aquatic vegetation, and surrounding lands support a mixture of native and nonnative vegetation and scattered trees. Monitoring programs of wildlife use here have not been conducted, but the value of this habitat for waterbirds is likely limited because of the small size and depth of these pools and the presence of trees. However, the area does support an isolated population of Arkansas darter.

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Created Wetland

Freshwater Springs Strategies

- Within 5 years, begin collaboration with experts and review current information to evaluate potential habitat improvements that support Arkansas darters, including the possible removal of existing infrastructure north of the springs.
- Within the life of the CCP, develop a more detailed management plan specific to the freshwater springs area that incorporates the current knowledge of experts and current information.

Temporary and Seasonal Prairie Wetlands

There are many temporary and seasonal wetland basins interspersed throughout the upland community on the refuge. The exact locations of all basins are not known, but most are less than 0.5 acre. Local precipitation and ground water fluctuations determine their hydrology, and no water management capabilities exist for them. Consequently, plant communities there are dynamic and range from perennial sedges and rushes and annual emergent vegetation to obligate upland species. When flooded, we presume that these basins provide temporary foraging habitat for waterbirds, like waterfowl and ibis, and supplement foods in other wetland types. Other uses for these wetlands may also occur.

We manage these basins as part of their surrounding upland communities and typically use prescribed fire and grazing to alter vegetation

Rachel Laubhan/FWS

Seasonal Prairie Wetland

community composition and structure. However, we will not intentionally drain or ditch these wetlands, and we will control their nonnative vegetation.

Temporary and Seasonal Prairie Wetlands Strategies

- Determine and map the location of these basins.
- Protect the integrity of basin morphology, such as their shape, structure and pattern.
- Avoid mechanical disturbances that will drain these basins.
- Time prescribed fires and grazing to avoid their peak periods of use by wildlife.
- Control nonnative vegetation and hazardous fuel.
- When appropriate, use wildfires to help achieve land and resource management objectives.

Native Ecological Community Conservation Objective 2: Grasslands

The grasslands objective was written based on the considerations of different species–habitat relationships of focal species, known characteristics of the soil–plant associations on the refuge, the need for periodic management treatments, and limitations of management. Individually, objectives capture perceived differences in bird habitat types within the grassland community that also seem realistic for management implementation. It represents the potential range of natural environmental conditions of the grassland community needed to promote the long-term sustainability of the system. Quantifiable measures of vegetation composition, height, density, litter depth, and other factors are commonly reported attributes of breeding grassland bird habitat descriptions and were used to develop the objective (appendix H).

Available quantitative information of grassland bird cover and structural needs during the nonbreeding season is comparably less than that during breeding. Knowledge of birds outside of the breeding

season traditionally relates to diet, energetics, foraging behavior, and, more recently, large-scale movements between breeding and wintering grounds. Descriptions that quantify structure and composition of habitat preferred by nonbreeding grassland passerines are lacking. Yet, management of grassland determines the extent, distribution, and within stand attributes of different habitat conditions within the community. Limited information of nonbreeding bird habitat was used to determine shrub attributes in grassland and is discussed in more detail below. Otherwise, until more information becomes available, management presumes that accomplishment of the grasslands objective relevant to the breeding season will concurrently satisfy habitat needs during the nonbreeding season. For example, by managing for a range of successional stages during the breeding and growing season as defined in the objective below, then a similar range of conditions will be provided during the nonbreeding season. As well, the distribution of the different successional stages would be expected to shift, dependent on methods of dispersal and growth in relation to current plant composition (Ratajczak et al. 2011), the ecological site potential, environmental conditions under relatively wet and dry conditions, and disturbance history.

Some woody vegetation is acceptable within native grasslands, thus the planning team had to evaluate relevant available information to identify optimal habitat conditions and suitable management actions such as mowing or burning. Again, species–habitat relationship information, such as percent shrub cover and proximity to other habitat types, facilitated this process.

Criteria

A. From January through March—nonbreeding—provide a range from 5–30 percent of tall, about 3–10 feet, native shrub interspersed within larger grassland blocks to support both focal grassland and shrub–grassland specialists.

B. Apply from April through August—breeding:

1. Provide at least 500 acres of estimated habitat that is predominantly native—short, bare to sparse—to help associated focal species, such as breeding killdeer, American avocet, interior least tern, western snowy plover, upland sandpiper, and ground-foraging passerines; composition less than 5 percent grass or fine-stemmed emergent, less than 5 percent forb, and no shrub; mean greatest height less than 6 inches; visual obstruction, or height density, less than 4 inches; no litter depth; no overlap with similar habitat made available under wetland objective B1 above.

2. Provide at least 70 percent of the estimated 4,163 acres of predominantly native—short–mid, sparse–medium—grassland habitat, including at least 1 area on, or near, a prairie dog town on, or next to, refuge lands to support associated focal species, such as breeding burrowing owl, field sparrow, lark sparrow, grasshopper sparrow, upland sandpiper, and western meadowlark; composition 40–50 percent grass or fine-stemmed emergent, 10–20 percent forb, and 10–20 percent shrub; mean greatest height of 6–20 inches; visual obstruction, or height density, less than 4 inches; litter depth of 0.2–1.2 inches.

3. Provide at least 70 percent of the estimated 2,053 acres of predominantly native—mid–tall, medium—grassland habitat to support associated focal species, such as breeding western meadowlark, grasshopper sparrow, bobolink, dickcissel, northern harrier, and blue-winged teal; composition 40–50 percent grass or fine-stemmed emergent, 10–20 percent forb, and less than 15 percent shrub; mean greatest height greater than 6 inches; visual obstruction, or height density, of 4–12 inches; litter depth greater than 0.8 inch.

4. Provide at least 70 percent of the estimated 2,756 acres of predominantly native—tall, medium-dense—grassland habitat to support associated focal species, such as breeding western meadowlark, grasshopper sparrow, bobolink, dickcissel, northern harrier, and blue-winged teal; composition 40–50 percent grass or fine-stemmed emergent, 10–20 percent forb, and less than 15 percent shrub; mean greatest height greater than 20 inches; visual obstruction, or height density, of 4–12 inches and greater than 12 inches; litter depth greater than 0.2 inch; acres outside of those with at least 50 percent plum or shrub coverage—1,278.58 acres—which mostly occur in subirrigated soil types where tallgrasses characteristically dominate.

5. Provide more than 10 sparse stands of shrub—mostly plum—interspersed within larger grassland blocks and riparian corridors to support associated focal species, such as lark and field sparrows; shrub height about 3–10 feet; stand size about

0.40–0.90 acre each; and within-stand shrub coverage of 7–11 percent.

6. Provide more than 10 dense stands of shrub—mostly plum—habitat interspersed within larger grassland blocks and riparian corridors to support shrub-dependent focal species, such as Bell's vireo; shrub height about 3–10 feet; stand size about 0.75–1.5 acre each; and within-stand shrub coverage of 25–35 percent.

C. From September through December—nonbreeding—provide the same as criterion A.

There are about 9,512 acres of native, grass-dominated vegetation associations outside of what is defined as wetland, based on GIS calculations of recent coverage (table 18). The acreage estimates used in the grassland criteria B.1–4 do not include other association types in the larger grassland landscape: about 82 acres of nonnative, invasive cheatgrass; 1,279 acres of plum or shrub-dominated (equal to, or greater than, 50 percent) habitat; about 870 acres of recently or currently farmed lands; 1,008 acres of trees; and 3,483 acres of herbaceous or emergent wetland association types, such as prairie cordgrass–three square (2,054), cattail–rush (1,096), water (176), spikerush (135), and Phragmites (23). Still, these other association types interspersed throughout the larger grassland blocks are managed as part of grassland.

While the restoration of farmed lands, nonnative habitats, and many woody-dominated habitats to native grassland association types will be started over the next 15 years, the duration of this restoration phase is unknown and may take many years, depending on various factors such as climate. Because of this uncertainty, these other association types are not included in the acreages used in the grassland criteria B.1–4.

Strategies

- Use a wide range of disturbance types, levels, and frequencies to support or improve habitat, including prescribed grazing or fire, flooding and drying, and chemical and mechanical methods.

- Use a combination of treatments such as prescribed fire, chemicals, grazing, and mechanical methods to reduce and control invasive species and hazardous fuel.

FWS

Killdeer in short, sparse upland habitat.

FWS

Little bluestem in intermediate grassland.

FWS

Switchgrass in tall, dense grassland.

- Promote the restoration and conservation of native understories and the reduction or elimination of cheatgrass-dominated understories when applying treatments for shrub-related objectives.

Table 18. Dominant nonwetland habitat types at Quivira National Wildlife Refuge, Kansas.

Habitat type	*Dominant vegetation*	*Estimated acres*
Native tallgrass	Switchgrass	1,720
	Big bluestem	974
	Sand bluestem	62
	Total	2,756
Native midgrass	Little bluestem	2,053
Native shortgrass	Saltgrass	4,362
	Prairie dog town	19
	Buffalograss	1
	Total:	4,381
Natural bare–sparse	Sand flats	322
Shrub	Plum, sumac, dogwood	1,279
Nonnative upland grass	Cheatgrass	82
Agricultural (farmed)	Agricultural (farmed)	885
Trees	Cottonwood	355
	Locust	253
	Saltcedar	125
	Other	105
	Red cedar	85
	Willow	57
	Russian olive	28
	Total:	1,008
Wetland	Prairie cordgrass–three square	2,054
	Cattail–rush	1,096
	Water	176
	Spikerush	135
	Phragmites	23
	Total:	3,483
Other	Roads	316
	Bare ground (like oil pads)	12
	Buildings, structures	6
	Total:	327
Grand total outside wetland		16,581

- Evaluate the feasibility of managing sites when planning annual prescriptions. For example, some semipermanent shrub sites have long-term coverage of some shrub habitat where management can be difficult to impossible and other sites occur between drainages that can impede equipment access.

- Conduct a monitoring program early on to meet our objectives for shrubs because we have limited knowledge and information on plum habitat.

- When appropriate, use wildfires to help achieve land and resource management objectives.

Rationale

Quivira Refuge is recognized for wetland and waterbird resources, but the refuge is also comprised of thousands of acres of upland, native sand prairie habitat that commonly support grassland obligates and species of concern, such as grasshopper sparrow and dickcissel. The decline of grassland bird populations are of serious conservation concern (Sauer et al. 2008). In general, these declines are attributed to habitat loss and degradation caused by many factors, including land use changes, the spread of invasive species, habitat fragmentation, urbanization, and the management of water quantity and quality. The relative importance of each of these factors depends on the resources and scales considered. Quivira Refuge lands have the potential to contribute to grassland bird conservation, especially when considering that public lands compose less than 3 percent of Kansas and Quivira Refuge comprises a smaller percentage of those lands that are specifically managed for natural resource conservation.

Some woody vegetation is acceptable within native grasslands. Nonbreeding (fall, winter, spring) specialists of grassland and shrub–grassland in Texas, many of which also occur on Quivira Refuge, had their highest combined densities reported in shrub–grassland habitat with less than 30 percent interspersed woody vegetation generally less than 3.28 yards tall by 24.71 acres (3 meters tall by 10 hectares) compared to habitat with less than 10 percent woody interspersion or less than 50 percent woody interspersion (Igl and Ballard 1999). When evaluated separately, grassland specialists had their highest densities in the same habitat as when combined, but shrub–grassland specialists had their highest densities in woodland dominated by trees more than 3.28 yards tall and secondarily in brushland dominated by woody plants less than 3.28 yards tall and comprising more than 30 percent woody canopy coverage. If Quivira trends are similar to what was reported, then management will be supporting less optimal habitat for grassland–shrub

Barry Jones/FWS

View from sandhills.

specialists to support both grassland and shrub–grassland specialists during the nonbreeding season. The same intent influenced the decision to provide at least 10 dense and sparse stands each—or between 5–30 percent interspersed total shrub coverage—during the breeding season. Also considered was the knowledge that much additional shrub coverage occurs in the landscape that is not defined as shrub habitat for refuge mapping and planning purposes because stands are less than 0.2 acre in size or have more than 50 percent shrub coverage (not a dominant plant type within stand).

There are about 9,512 acres of native grass-dominated vegetation associations outside of what is defined as "wetland" based on GIS calculations of recent coverage. Grassland communities are dynamic and cannot be held in static conditions, as illustrated in State transition diagrams of soil–vegetation associations and ecological site descriptions (Natural Resource Conservation Service 2010). For example, factors contributing to grassland dynamics include variation in climate effects, such as from changes in precipitation, temperature, and wind; landscape features, such as differences in soil, aspect, and slope position; plant–wildlife interactions, such as plant adaptations to herbivory and soil disturbance; and the timing of environmental changes or disturbances in relation to plant and wildlife life stages (Anderson 2006, Helzer 2010). Thus, it is unrealistic to set an objective that attempts to maintain static conditions over time. Development of this objective considered these factors, the recent spatial location of various vegetation associations, and the understanding that areas of the refuge will be "rested" (no planned burning or grazing) each year. This explains the desirability to attain a minimum of 70 percent of the estimated potential acres of the associated grassland conditions described in the grassland criteria B. 1–4. While this proportion is somewhat arbitrary, it promotes the sustainability of ecosystem processes and the need for periodic disturbance as well as management's ability to mimic natural stressors, such as when using fire and herbivory.

Native Ecological Community Conservation Objective 3: Woodlands

At least 125 acres of woodlands largely located on the refuge perimeter and within 55 yards of the refuge's main roads will remain (figure 15) during the next 15 years, see appendix H.

Strategies

- Based on current conditions, maintain woodlands in areas identified in appendix H.
- Keep select trees or small groves that are located in areas along roads or next to other nondesirable habitat on and off the refuge where removal would not provide substantial benefits to native wildlife, such as obligate grassland birds, and where their presence may benefit species of concern, such as Loggerhead shrike or bald eagle. Ultimately, this will be the refuge manager's decision based on available information.
- Conduct no substantial active management, such as regular stand thinning and fire suppression in most cases, specifically to benefit

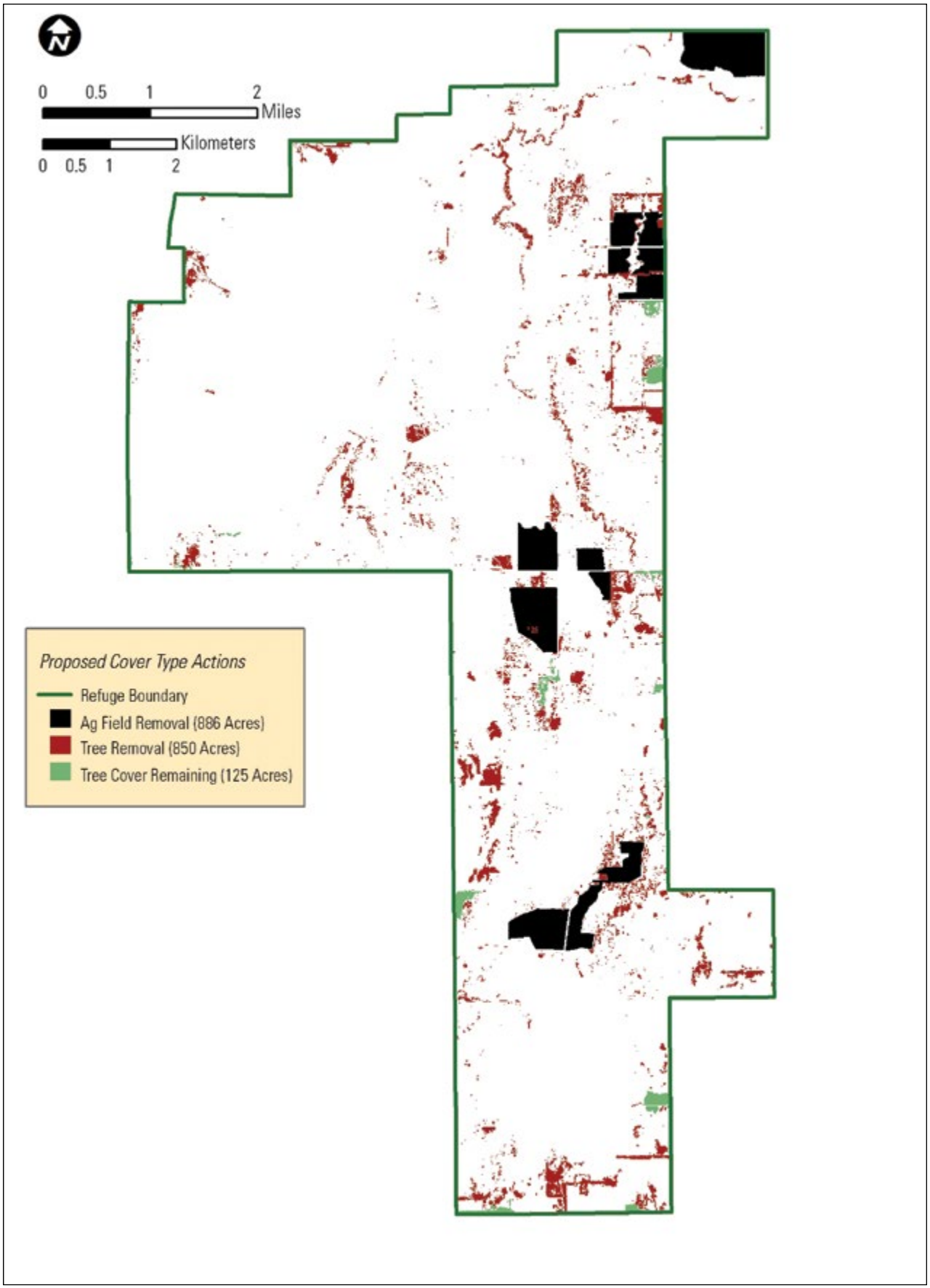

Figure 15. Cropland and tree coverage planning at Quivira National Wildlife Refuge, Kansas.

species largely associated with nonnative woodlands. Prioritize time and money resources for other species–habitat communities over woodland, especially shelterbelts and nonnative types.

- Manage woodlands to reduce seed or propagation sources or to maintain fence lines and other infrastructure, such as removing red cedar growth under canopy trees or Russian olive in the Artesian Grove.

- Do not allow encroachment of woodland into surrounding habitat.

- Allow limited native trees to remain onsite where they might have occurred naturally, such as up to a few willow or cottonwood trees near a spring.

Rationale

Historically, nonwetland habitats comprising the refuge were dominated by native prairie interspersed with inclusions of shrubs (Heitmeyer et al. 2012). However, changes in land use practices in the watershed, coupled with our past management direction, led to the encroachment of shrubs and native and nonnative trees. By 2008, thousands of acres of woody vegetation existed on refuge lands (figure 16). Years ago, our refuge staff decided that restoring native prairie communities represented the best use of refuge lands, given the extensive loss and fragmentation of this habitat in the watershed and the accompanying population declines of some species, particularly of grassland obligates that rely on it.

However, removing all trees during the next 15 years may not be warranted given the location of woodlands surrounding the refuge and other hostile habitat on and off refuge lands. And it may not be feasible given our limited staff and budgets.

Migratory birds that require woodlands to complete essential life history events, like nesting, historically were not common on the refuge. Thus, they generally were not selected as focal species during the planning process. However, isolated trees and small groves would benefit focal species, such as loggerhead shrike and Swainson's hawk. Because woodland areas are attractive to wildlife enthusiasts, primarily bird watchers and photographers, a list of birds recorded using the woodlands not now planned for removal in the next 15 years was compiled from refuge files and recent observations to assess potential loss in birdwatching opportunities on the refuge (table 11). This list—which is presumed to be incomplete given that formal surveys have not been conducted—includes 49 species, indicating that birdwatchers will still have opportunities to view woodland-associated birds on refuge lands in easily accessible areas. It seems that bird species richness will be maintained.

4.5 Visitor Services Goal

Visitors enjoy quality wildlife-dependent recreation opportunities.

As part of the Service's guiding principles, legitimate and appropriate wildlife-dependent uses of refuges include compatible activities involving hunting, fishing, wildlife observation, photography, interpretation and education.

FWS

Shrubland

FWS

Woodland

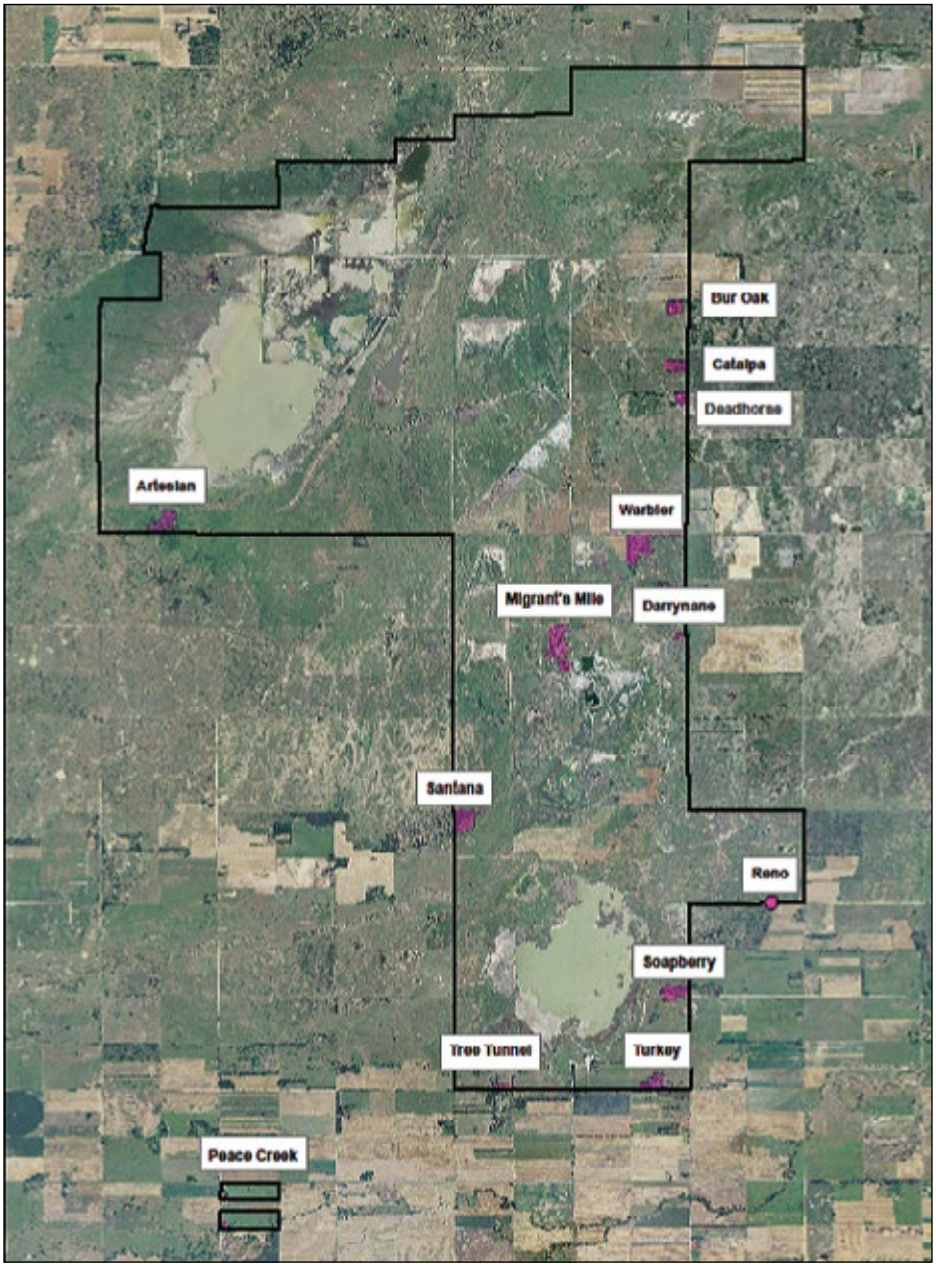

Figure 16. Location of woodland groves at Quivira National Wildlife Refuge, Kansas, in 2012.

Hunting Objective 1

Throughout the life of the plan, continue to allow compatible waterfowl, upland bird, and small game hunting opportunities within traditional boundaries (figures 11) that adequately protect whooping cranes and promote employee and public safety.

Strategies

- Write a detailed hunt plan during the life of the CCP. Refuge-specific regulations may apply to any hunt program on the refuge.
  - Consider an extended light goose season during the spring conservation order.
  - Update the CFR to be consistent with the approved hunt plan.
- Close the refuge to waterfowl and upland bird hunting as necessary to protect whooping cranes. The refuge manager has the authority to decide when to open and close the refuge to hunting.
- Continue to provide and improve access to hunting information through kiosks, signs, interpretive displays, handout literature, and by other means, such as through social media and the refuge's Web site.
- Do not allow the hunting of certain species that are not common or are closely associated with potential impacts to species of concern, such as rail, woodcock, snipe, sandhill crane, and prairie-chicken. Because the occurrence of many of these species is limited, hunting opportunities will not be significantly reduced and educational opportunities related to the conservation of these species and associated communities could be promoted.
- Continue to allow hunting of Northern bobwhite, pheasant, and dove within traditional hunt boundaries (on less than 40 percent of the refuge). Of note, bobwhite occurrence on the refuge regularly includes areas both inside and outside of hunt boundaries. Allow the hunting of small game according to refuge-specific regulations.
- Close the refuge to the public between dusk and dawn, except for special events or activities that require a refuge permit or for unique circumstances permitted by the refuge manager.
- Allow only nontoxic shot on the refuge.
- Provide adequate law enforcement that supports staff and public safety and the protection of natural resources.

Rationale

The perspectives and opinions on public use-related issues vary widely. Therefore, an objective approach was applied to discuss and evaluate public-use activities within the context of Service laws, policies, and guidance. Many of the concerns related to hunting activities involved decisions beyond the scope of this CCP. Therefore, a more detailed stepdown management plan is needed that considers: (1) reducing risks to threatened, endangered and protected species; (2) the safety of refuge staff and the public; (3) the logistics or the ability to implement actions that ensure compliance with laws and regulations; (4) potential conflicts among use activities; and (5) the requirement of refuge-specific regulations and permits, such as limits to hunting intensity, season, method, and area within approved boundaries and opportunities for youth or the military.

Among the major factors that are considered in decisionmaking, besides the balancing of multiple use activities and compatibility with wildlife, are observations of whooping crane behavior and habitat use that is unique or specific to the area of the refuge. Both consumptive and nonconsumptive users share concern for the protection of whooping cranes. Also, many hunters indicated a preference for the opportunity to hunt the North Lake area for a limited number of days, which is often due to refuge closures because whooping cranes are present, over hunting in alternative areas over more hunt days when there has traditionally been no to little observed use of the refuge by whooping cranes. As part of planning, we will continue to consider tradeoffs like these and other management decisions.

Hunting Objective 2

Throughout the life of the plan, broaden and increase safe and compatible hunting opportunities on the refuge, such as for deer, turkey, and furbearers, that will require refuge-specific permits (figure 17).

Strategies

- Use refuge-specific regulations to restrict aspects of trapping activities, such as the number, location, and types of traps used, and require the approval of a special use permit by the refuge manager.
- Consult with the State of Kansas and experts, when writing a more-detailed hunt plan, on factors important in decisionmaking, such as limits based on deer health and population targets or thresholds.
- Understand that the hunting of deer, turkey, and furbearers will not necessarily need to occur throughout the entire approved area, nor during every season or year.

Rationale

Before and during the planning of this CCP, the public requested consideration of opportunities for deer and turkey hunting. Deer population trends have increased substantially since refuge establishment, from less than 20 in the entire local population to a density of 41 individual deer per 0.39 square mile (1 square kilometer) based on recent distance sampling reported by Blecha et al. (2011). There are concerns about the combination of high-density populations and the rate of spread of Chronic Wasting Disease, which was reported in Stafford County in 2013.

Some think hunting could help address deer-related issues, while others feel that deer hunting would negatively impact deer viewing opportunities. While opinions on deer hunting on the refuge vary, there seems to be general agreement that unique hunt opportunities, such as for youth, are acceptable. All hunting possibilities—including exceptions to hunting closures when whooping cranes are present such as for the limited use of archery in hunting deer—will be explored in the development of a more-detailed hunt plan. Safety, compatibility with wildlife, logistics, and the potential tradeoffs of multiple use activities will be considered in the development of policy and guidance.

The wild turkey population varies annually on the refuge, but has generally increased since the establishment of the refuge. While turkey hunting will be allowed, refuge-specific regulations will limit opportunities. Compatibility with wildlife and potential conflicts with nonconsumptive uses, especially in the spring, will be considered.

Furbearer hunting will require refuge-specific regulations. Approval of a special use permit will be required to control aspects of hunting or trapping, and the desired reduction of furbearer impacts to refuge infrastructure and management implementation will be considered.

Fishing Objective 1

Throughout the life of the plan, allow fishing in refuge waters with minimal disturbance to other wildlife and the natural aquatic ecosystem.

Strategies

- Allow fishing, in accordance with State and Federal regulations, year round on all waters on the refuge.
- Provide and maintain accessible fishing docks for visitors with disabilities.
- Do not allow boats on any waters.
- Do not stock Refuge waters (except Kids' Fishing Pond, see objective 2), but instead manage wetlands and lakes for migratory birds, allow these to fluctuate through natural hydrologic cycles.
- Do not allow bait collecting and live fish bait, except night crawlers, on any waters.
- Provide educational materials and interpretive exhibits about native fish, the threat of introducing or spreading nonnative plants or wildlife and other things that could hurt the environment, like diseases harmful to humans or wildlife populations.
- Plan and conduct unique fishing events for kids to encourage and support a new generation of anglers.
- Do not allow frogging.

Rationale

Fishing is a tool to help the public connect with nature and to promote existing and future programs. Fishing and its promotion provides a type of compatible public use that is encouraged by initiatives such as the Department of the Interior's "Youth and the Great Outdoors" and the U.S. Fish and Wildlife Service's "Let's Go Outside." Boats and bait collecting

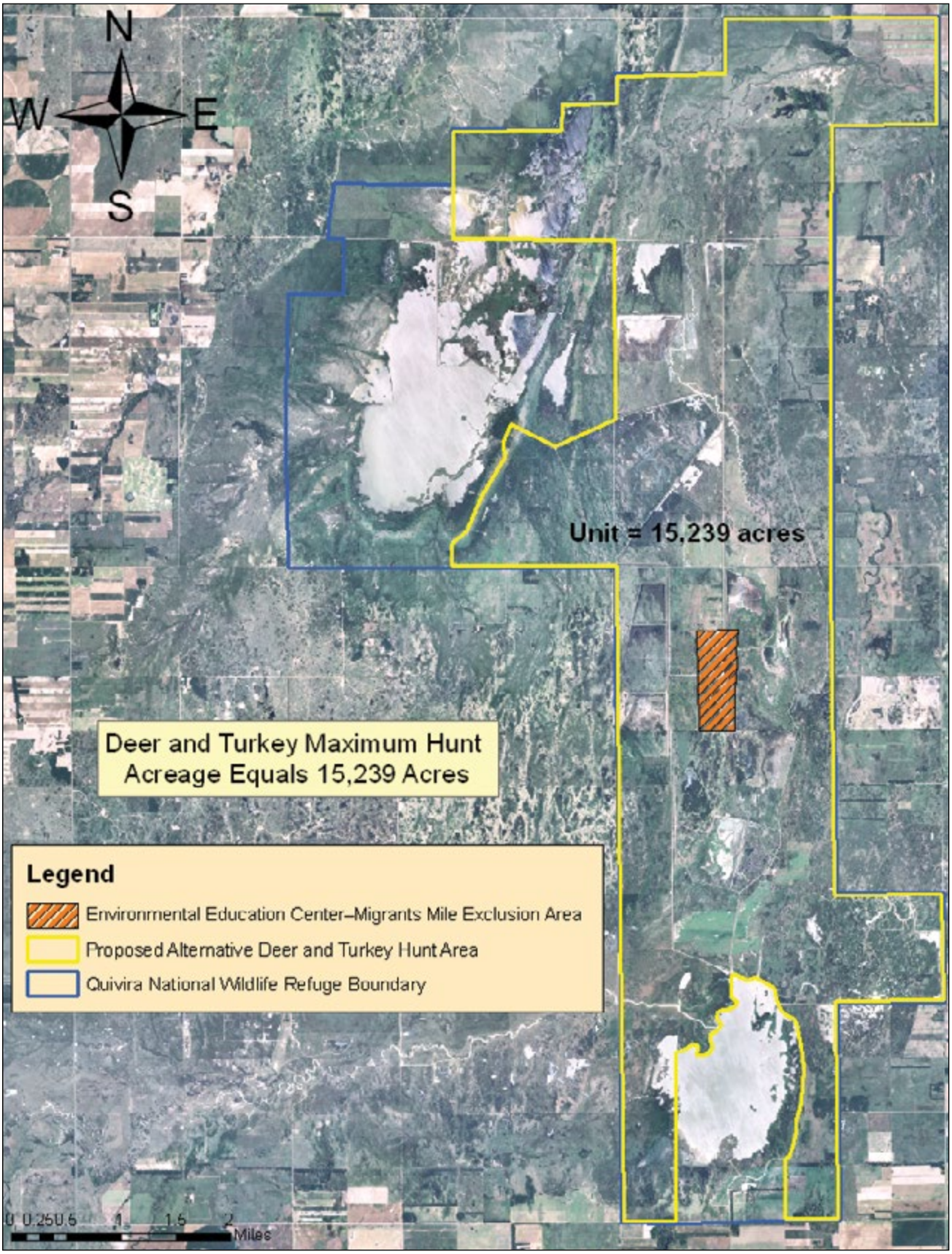

Figure 17. Proposed deer and turkey hunt area, Quivira National Wildlife Refuge, Kansas.

are not allowed because they increase the risk of exotic and invasive species introduction and spread.

Frogging will be prohibited on the refuge because, at various life phases (eggs, tadpoles, adult), frogs are an important diet item for many wildlife species. Also, frogging commonly occurs at night when the refuge is closed to the public. Therefore, frogging opportunities would be very limited. Because bait collecting is not allowed on the refuge, we would need regulations to control the frog species and sizes collected, among other considerations, and these would be difficult to enforce, especially when law enforcement on the refuge is limited.

Fishing Objective 2

Enhance fishing and fishing education opportunities for youth by maintaining the Kids' Fishing Pond and annually stocking it with sport fish species.

Strategies

- Allow fishing, in accordance with State and Federal regulations, for kids 14 and under (and adults accompanying such children). Adults will not be permitted to fish without children.
- Maintain the existing accessible fishing dock.
- Produce and install an interpretive panel about aquatic ecology with children-supplied artwork and text.
- Produce and support an interpretive media that is coproduced, written, and continually revised by, and for, children to enhance their knowledge of fishing and fish resources.

Rationale

Similar to Objective 1, but in addition, maintaining a population of sport fish at the Kids' Fishing Pond by stocking provides a location where fish populations are continually stable. It also provides a type of compatible public use that follows initiatives described in objective 1.

Wildlife Observation and Photography Objective 1

Throughout the life of the plan, increase awareness and access to wildlife observation and photography opportunities on the refuge and the Great Plains Nature Center.

Strategies

- Maintain and improve the 14-mile wildlife auto tour route, trails, other public roads, observation towers, spotting scopes, and photography blinds.
- Keep and improve diverse and dynamic interpretive displays, social media, and handout literature that continually enhance and increase visitors' awareness of and interest in exploring the refuge.
- Loan equipment, like binoculars, scopes, and backpacks, through the Birding Initiative and through Connecting People With Nature.
- Continue to provide opportunities at the GPNC for wildlife observation and photography during operating hours and from sunrise to sunset every day via City of Wichita Chisholm Creek Park.
- Keep refuge open daily during daylight hours.
- Allow and encourage use throughout the entire refuge except in seasonally closed areas.
- Promote awareness of opportunities through the Wetlands and Wildlife National Scenic Byway.
- Collaborate with Friends groups and others to install a tower camera at the bald eagle and BSM areas to provide more observation opportunities of remote wildlife.
- Allow horseback riding and bicycling on established roads, not on hiking trails.
- Allow the walking of pets according to refuge regulations. Pets must be leashed and under their owners' control at all times,

unless for purposes approved by the refuge manager.

Wildlife Observation and Photography Objective 2

Over the next 10 years, promote and expand public use of woodland groves by birdwatchers, and photographers.

Strategies

- Develop information in brochures, panels and social media that promote wildlife observation and photography in designated woodland areas around the refuge.
- Enhance access to at least some woodland groves while considering management constraints and other priorities.
- Promote awareness of opportunity through the Wetlands and Wildlife National Scenic Byway.
- Encourage minimal use of the Artesian Grove through interpretive panels explaining the special nature of the site.
- See that activities comply with refuge regulations and Service policy.

Rationale for Wildlife Observation and Photography Objectives 1 and 2

Use information provided to promote connections that nurture the appreciation and stewardship of natural resources. Promoting conservation partnerships with support groups (such as Friends groups and scenic byway) would increase awareness of observation and photography opportunities, and general respect for wildlife resources. Better access to refuge areas would make it easier for people to observe and photograph wildlife.

Environmental Education and Interpretation Objective 1

Within 10 years, refuge staff will design and conduct 5–10 programs to enhance the advocacy and improve awareness of our mission and management; fish and wildlife resources; our refuge management activities; and the refuge's natural, cultural, and historic resources.

Strategies

- Develop an environmental education and interpretation plan.
- Refuge staff will continue to coordinate with Friends of Quivira to create special events and educational programs.
- Provide environmental education programs at the refuge that teach curriculum-based programs for all school grade levels to help meet State educational standards.
- Encourage the use of the refuge by educational organizations as an "outdoor classroom."
- Continue to promote national initiatives, such as Connecting People with Nature, America's Great Outdoors, and Let's Go Outside!
- Continue to engage visitors to the refuge through loan programs for binoculars and other educational products.
- Continue to provide interpretive programs at the refuge on a variety of refuge management and wildlife-oriented subjects, both by request and as scheduled activities, and increase programs as staff and time allow.
- Interpret the cultural history of the refuge area, including tribal uses and early settlement.
- Continue relevant and effective annual school events, such as those about the conservation of whooping cranes.
- Continue networking and communicating with area educators as to availability of environmental education programs and opportunities both on and off the refuge.
- Allow virtual geocaching.

FWS

Visitors participate in the Monarch Mania event held at Quivira Refuge.

Environmental Education and Interpretation Objective 2

Within 5 years, refuge staff will increase interpretive media by 25 percent, thus reaching more public both onsite and offsite.

Strategies

- Educate and inform individuals, schools, and other organizations through accessible programs, exhibits, signs, pamphlets, the Internet, and social media.
- Continually evaluate interpretive media like brochures, signs, and displays for relevancy, effectiveness, and timeliness.
- Use social media to increase contact and exposure to the refuge.

Environmental Education and Interpretation Objective 3

Interagency staff at the GPNC will conduct an average of 1,700 onsite and offsite programs every year focusing on "at risk" youth and other underserved audiences.

Strategies

- Evaluate needs and increase Service staff, as applicable, to support programming efforts.
- Increase communication and networking efforts with Unified School District 259 (Wichita) and area school administrators to advertise and market GPNC programs (such as school field trips and in-classroom presentations)
- Coordinate educational programs with area educators to make sure that State Core standards are being met through programming efforts.
- Increase the distribution of educational kits and discovery boxes to educators.
- Continue to promote national initiatives, such as Connecting People with Nature, America's Great Outdoors, and Let's Go Outside!
- Educate and inform individuals, schools, and other organizations through accessible programs, exhibits, signs, pamphlets, the Internet, and social media.
- Continue to support the GPNC through its partnership with the City of Wichita Department of Park and Recreation and the KDWPT.
- Use funding opportunities from the Urban Presence Initiative to support educational programming at the GPNC.

Environmental Education and Interpretation Objective 4

Within 5 years Refuge and GPNC staff will create a definition of environmental education and increase the level of professionalism of environmental education programs presented.

Strategies

Partner agency staff will attend capacity building training and environmental education workshops.

Environmental Education and Interpretation Objective 5

Increase outreach and marketing efforts to increase participation by teachers and students in the Junior Federal Duck Stamp program by 10 percent within 5 years.

Strategies:

- Hire a consultant to evaluate our program and suggest improvements to increase participation.
- Display artwork throughout the year at various locations, at least 10 venues per year, including the Kansas State Fair, to further promote interest in wildlife and art.
- Create educational and marketing products, such as calendars and guides, that will engage potential participants, including parents, teachers and students.
- Educate and inform individuals, schools, and other organizations through accessible programs, exhibits, signs, pamphlets, the Internet, and social media.

Environmental Education and Interpretation Objective 6

Throughout the life of the plan maintain 2 miles of foot trails and increase interpretative signs on trails by 50 percent within 10 years.

Strategies

- Evaluate Birdhouse Boulevard trail and interpretive components for potential improvements and updates.
- Evaluate the Headquarters and Little Salt Marsh trails for interpretive signage needs and install signage as outlined.
- Evaluate signage needs on the Migrants Mile Trail and replace and install as outlined.
- Evaluate trail surfaces, boardwalks, directional signs, and bridges and improve as needed.
- Develop and provide printed media such as trail maps and guides.
- Consider incorporating a fitness program on refuge and GPNC trails through HealthyKansas.org

Rationale for Environmental Education and Interpretation Objectives 1–6

It is important for all ages of the public to have an understanding of the refuge and GPNC missions, goals, and responsibilities. Both facilities are in the "backyard" of several local communities, providing a sense of pride can be nurtured and perpetuated by increased understanding through education and interpretation. In addition, all the local communities benefit economically from their proximity to the facilities and their popularity as destinations. As community members come to know more about the refuge and the GPNC, they will be better able to educate both other residents and visitors.

Other Uses Objective

Throughout the life of the plan, provide appropriate and compatible opportunities for wildlife-dependent and non–wildlife-dependent recreation that support the six priority public uses or contribute to the appreciation of the refuge. These opportunities will not be allowed to disturb wildlife and will not be allowed when areas are closed for safety reasons.

Strategies

- Allow dog training by individuals, not commercial vendors, as described in appendix B.
- Allow commercial photography with a special use permit.
- Allow commercial tours for birding only with a special use permit.
- Allow firewood cutting in limited designated areas with a special use permit.

- Do not allow the collection of berries, fruit, roots, and mushrooms.
- Do not allow the collection of shed antlers and wildflowers.
- Do not allow commercial guiding for hunting.
- Do not allow boating or camping.
- Do not allow unauthorized vehicle use on roads and trails.
- Do not allow off-road vehicle use.
- Do not allow the collection of reptiles and amphibians or crayfish.
- Review requests for other non–wildlife-dependent for compatibility and appropriateness on a case-by-case basis.

Rationale

The Improvement Act states that other uses can occur within the Refuge System, but they must support, or not conflict with, a priority public use. Furthermore, a use may not keep a national wildlife refuge from accomplishing its purposes or the mission of the Refuge System.

The refuge supports various forms of nature-based outdoor recreation that, while not strictly wildlife dependent, may support or facilitate wildlife-dependent recreation. These include activities such as equestrian use, bicycling, or hiking, which are compatible with the purposes of the refuge and contribute to the appreciation and enjoyment of it. These opportunities have been found to be appropriate at certain times of the year, and compatible with the goals and objectives set by the refuge. The opportunities will not be allowed to disturb wildlife during certain times of the year, and will not be allowed when areas are closed for safety reasons.

4.6 Public Outreach Goal

Visitors of all abilities understand, appreciate, and support the Service mission, as well as the refuge's unique habitats and importance to migratory birds and other wildlife and plant species.

Following are objectives for a variety of public outreach activities.

Public Outreach Objective 1

Within 5 years, refuge and GPNC staff will design and conduct outreach programs to present to 10–20 civic and environmental organizations annually in local communities within a 50-mile radius of each respective site.

Strategies

- Develop speaker-led multimedia programs that emphasize refuge or GPNC features, facilities, management goals, and natural, cultural, and historic resources. Actively seek new civic organizations, clubs, educational groups, and other entities to which we can present programs.
- Work with Friends of Quivira and Friends of the Great Plains Nature Center to promote public awareness of the refuge and its mission and provide opportunities for the public to learn more about the resources of the Great Plains.
- Emphasize the importance of Quivira and the GPNC to area communities because of the strong draw the sites have to visitors from outside the area. Present information about what makes each site special, such as unique features to the sites, great bird-watching opportunities, and rare species occurrences.
- Work with the Friends of the Great Plains Nature Center to develop information about how Quivira Refuge and the GPNC function as "green" operations in the environment. Provide educational material about geothermal, solar, and other features at these sites through media such as displays, literature, and the Web.
- Install a tower camera at the bald eagle and BSM areas to provide more observation opportunities of remote wildlife to heighten understanding and awareness of refuge resources, encourage refuge visitation, and increase positive personal experiences with natural resources.

FWS

The blue goose, representing the Refuge System, rides in the Octoberfest Parade held in Stafford, Kansas.

Public Outreach Objective 2

By working in partnership with respective Friends groups, foster appreciation and increase knowledge of the refuge and GPNC by holding at least 10 special events annually and through the Friends' newsletters and Web sites.

- Present theme-oriented special events throughout the year that emphasize either subjects, such as butterflies or birds, or activities, such as fishing.
- Make sure that all special events are used to emphasize the purpose, mission, and wildlife of the refuge and the GPNC.
- Contribute regular articles to Friends newsletters and Web sites about refuge and GPNC news, management actions, and other pertinent subjects.
- Recruit, train, and use volunteers from local communities to help us meet our management and public use goals at Quivira Refuge and the GPNC. Strive to help GPNC volunteers contribute at least 2,800 hours of service to the nature center. The Friends of the GPNC volunteer coordinator will work to increase and enhance the GPNC volunteer corps.

Public Outreach Objective 3

Within 5 years, contribute to knowledge and appreciation of the refuge, GPNC, and the Service through a minimum of 65,000 public visits to the respective sites; 8,000 visits to offsite stations such as the Kansas State Fair, and 40,000 visits to online media.

- Increase and continually freshen Quivira Refuge Web content by offering fresh, informative, and pertinent content about refuge operations, bird and wildlife sightings, hunting, events, and more. The GPNC staff and webmaster continue to update existing pages and add more pages as needed for new events, projects, and programs.
- Oversee the development, maintenance, and staff of our information booth at the annual Kansas State Fair for both Quivira Refuge and the GPNC and continue to update and change its theme. Make sure that information about our various operations, missions, and activities is regularly available, but also offer fun and educational, hands-on exhibits for the entire family.
- Develop static, portable displays about refuge and GPNC wildlife, facilities, and management that can be used at fairs, conventions, and other events that last a day or more.
- Install traffic counters at strategic locations to count visitor use.
- Work with partners to survey visitor use.

Rationale for Public Outreach Objectives 1–3

Following the 2011 "Conserving the Future" visioning workshop, implementation teams were cre-

ated to address a variety of issues, such as urban wildlife refuges, community partnerships, communication, interpretive and environmental education, volunteers, hunting, fishing, and outdoor recreation. These implementation teams were tasked with developing plans that outline goals, objectives, and strategies to meet issues identified at the visioning workshop. Once these plans are complete, Quivira Refuge staff will review and incorporate their recommendations to enhance public outreach as they apply to refuge and GPNC operations and visitor services opportunities. The plans will also form the basis for various stepdown plans, such as for Visitor Services, that will be created following the completion of this document.

Public outreach furthers the mission of the refuge and the Refuge System for the protection of public trust resources by garnering support for wildlife and their wild places. Using the principle that appreciation begins and is nurtured through understanding, outreach builds and enhances a sense of stewardship in the public, which in turn allows the public to feel better connected to the natural world through the refuge and the GPNC.

4.7 Cultural Resources Goal

The cultural resources and cultural history of the refuge are identified, valued, and preserved and connect staff, visitors, and the community to the area's past.

Following is the objective for cultural resources on Quivira Refuge.

Cultural Resources Objective

Protect and preserve cultural resources on the refuge through coordination with the Region 6 cultural resources branch, which helps our refuge staff in meeting the requirements of Section 106 of the National Historic Preservation Act and other cultural resources-related legislation.

Strategies

- Inform the Region 6 cultural resources staff of refuge projects early in project planning by using the Cultural Resources Review Form.
- Develop exhibits and signs to enhance educational opportunities.
- Encourage collaboration with interested tribes in developing relevant materials and correct interpretation.

Rationale

The refuge was once an important Native American gathering site for hunting and salt gathering. Different cultural values are acknowledged, respected, and celebrated by the Refuge System (FWS 2011). Cultural services are one of many ecosystem services, or benefits, that one can get from nature (FWS 2011).

4.8 Visitor and Employee Safety and Resource Protection Goal

Provide for the safety, security and protection of visitors, employees, natural and cultural resources and facilities of the refuge and Great Plains Nature Center.

Following are objectives for a variety of visitor and employee safety and resource protection activities.

Visitor and Employee Safety Objective

Ensure visitor safety and the safety of our employees at Quivira Refuge and the GPNC. Strive to keep the refuge 100-percent visitor accident free and keep employee accidents and injuries, as reportable to the Office of Workers Compensation Program, below the regional average of 6.2 hours of lost time a year over the life of the plan.

Strategies

- Educate and inform visitors of their responsibilities when visiting national wildlife refuges and the ways they might mitigate potential dangers and hazards.

- Use directional and informative signs, visitor information kiosks, updated Web pages, and posted warnings to help reduce preventable accidents and mishaps.

- Close roads deemed unsafe for travel because of weather conditions or poor visibility, and post closings on our Web page promptly to alert visitors about our conditions before travelling, if possible.

- Maintain up-to-date station safety plans that provide emergency contacts, procedures, and training for all employees.

- Conduct an annual safety inspection of all facilities.

- Provide emergency shelters, accessible facilities, and suitable trails and roads.

- Review and follow infectious disease plans and policies and update as necessary every year.

- Law enforcement officers help with protecting visitors and report serious incidents to the proper authorities, per our guidance found in regulation 054 FW 1.

- Keep a collateral duty safety officer at Quivira Refuge.

- Provide employees with suitable personal protective equipment.

- Make sure that all required safety and operator training is completed before engaging in risky tasks or work situations. Make sure that other training, such as cardiopulmonary resuscitation, or CPR, and first aid, is available to employees as needed or requested.

- Make sure that employees review job hazard analyses before engaging in at-risk tasks.

- Practice sound risk management, "the state in which risks are acceptable."

Rationale

Visiting a national wildlife refuge can be inherently dangerous. Snake bites, stinging and biting insects and their associated diseases, extreme hot and cold temperatures, wind, lightning, tornados, standing or turbulent water, uneven terrain, and steep edges can potentially turn a pleasant day out into a life-altering experience. Our role is to help identify these dangers, inform about them, and mitigate these dangers to the greatest extent possible.

Reducing the potential for accidents and injuries is cost efficient, provides better job satisfaction for employees, and is the right way to conduct business. We require written job hazard analyses before undertaking all at-risk tasks, such as operating an all-terrain vehicle or pounding fence posts. A library of job hazard analyses is available on the Region 6 safety office Web site and at refuge headquarters.

Resource Protection Objective

Protect wildlife and other natural and cultural resources from damage, theft, or illegal taking to preserve resources for visitors to the refuge and to prevent their unnatural decline.

Strategies

- Enforce hunting, fishing, and all other regulations in accordance with the CFR, State laws, and refuge regulations to protect designated critical habitat and wildlife.

- Close areas to protect wildlife from human disturbance when necessary.

- Enforce regulations and apply refuge closure strategies, as determined by the refuge manager, to protect whooping cranes and other resources of concern.

- Use law enforcement and education to protect cultural resources in accordance with Federal, State, and tribal laws, policies and guidelines.

- Keep at least two dual-function law enforcement officers or one dual-function and one full-time permanent law enforcement officer.

- Provide ample and easy access to refuge regulations through various media such as printed leaflets, Web site and social media, and six information kiosks located throughout the refuge.

Rationale

To adequately staff refuges with sufficient officers to protect wildlife and habitat and to make refuges safe places for staff and visitors is a top priority for the Refuge System. Conserving the Future (FWS 2011), Recommendation 16, charges us to: Conduct a new, independent analysis of refuge law enforcement to measure progress and to identify needed improvements.

4.9 Administration Goal

Provide and support facilities, strategically acquire and allocate staff, increase volunteer opportunities and partnerships, and effectively develop and use money to support the long-term integrity of infrastructure, habitats, and wildlife resources at the refuge and the Great Plains Nature Center.

Following are objectives for a variety of administration activities.

Strategies

- Continue to correctly document budget and staff needs through memos and reports.
- Continue to hire one to five seasonal biological aids and technicians and continue to hire range technicians, as money allows, each year.
- Provide office space at Quivira Refuge for a regional refuge zone biologist, a Partners private lands biologist, and for other program staff as needed.
- Use the Youth Conservation Corps program to help accomplish refuge goals and objectives.
- Raise money through grants and initiatives, such as AmeriCorps and Youth in the Great Outdoors, to supplement our staff and projects.
- Keep permanent fire staff to include a fire management office, and refill a supervisory range technician.

Funding and Staff Objective 1

Strive to keep funding level for 11 permanent full-time and 1 permanent part-time staff positions; provide regional or zone office space as needed; and continue to seek money for vacant, seasonal, temporary, and youth positions.

Funding and Staff Objective 2

Plan to recruit and fill new positions that are identified in this CCP as being needed for accomplishing the goals and objectives to protect habitat, infrastructure, and wildlife resources at Quivira Refuge and the GPNC throughout the life of the plan.

FWS

The Great Plains Nature Center

Strategies

- Identify needed positions and projects in the Refuge Operations Needs System database and update as requested. The top refuge priority identified in the database is one full-time maintenance worker.
- Coordinate with our regional law enforcement coordinator.
- Continue to correctly document budget and staff needs through memos and reports.
- Evaluate and add a new position at the GPNC to meet needs
- Refine and increase participation in our refuge volunteer program.

Rationale

Conserving the Future (FWS 2011) states, "We must engage and prepare a diverse group of qualified and enthusiastic professionals that want to make the Service and the Refuge System their life's work. We must be adaptive and flexible to recruit a workforce that reflects society…to ensure a workforce of the best and brightest minds…we must look for ways to transfer knowledge from senior staff. As part of this succession, we will value diversity of people and skills to create a culture of inclusivity."

Conserving the Future (FWS 2011), Recommendation 22, charges us to: within the next 10 years, make our workforce match the diversity in the civilian labor workforce and recruit and keep a workforce that reflects the ethnic, age, socioeconomic and cultural backgrounds, and language diversity of contemporary America.

Facilities Objective 1

Within 5 years at the refuge and GPNC, review and update our refuge deferred maintenance projects list and document deficiencies, and submit a ranked project list for potential money every year.

Strategies

- Support and enhance the water delivery infrastructure necessary to achieve our wetland goals and objectives for the refuge.
- Maintain the roads and parking lots required to support public use opportunities consistent with our goals and objectives.
- Maintain the fencing, wells, and other infrastructure necessary to operate a grazing program that helps us achieve our goals and objectives for the refuge.
- Maintain existing buildings, including an office, visitor center, maintenance shop, three storage buildings, one pole barn, two residences, and two comfort stations.
- Review displays, interactive, portable, and static, about area flora, fauna, ecology, and history at our visitor centers and update as resources allow.
- Maintain and enhance the existing 2 miles of trails and accompanying structures, like bridges, boardwalks, interpretive signs, and kiosks, to provide quality visitor use experiences.
- Explore creating more trails on the refuge to provide more opportunities for compatible wildlife-dependent recreation.
- Maintain infrastructure at the GPNC, including Koch Habitat Hall, Coleman Auditorium, offices, classrooms, and a storage garage, to support our multiagency partnership with the City of Wichita Park and Recreation Department and KDWPT.

Rationale

Visitor services infrastructure for both the refuge and GPNC need routine annual and long-term maintenance to keep them in good-to-excellent condition. Because of our salty environment at the refuge, our water control facilities and equipment deteriorate faster than those at refuges that protect freshwater marshes. Much of the refuge is also comprised of the sandy, Sand Prairie ecotype soils, which necessitates more constant maintenance to keep water control structures from washing out. Some old water control structures need to be replaced. Boundary fences and signs are in constant need of replacement because of severe weather events, environmental degradation and occasional vandalism.

The maintenance shop requires an addition and updating. The bunkhouse and environmental education classroom were created out of the old, original 1957 block office building, which was abandoned because of poor domestic water quality. So, there is a

need to again abandon this building and move operations to the current headquarters site to consolidate facilities and operations at one location with good quality water. An improved environmental education program could ensue near the headquarters with access to accessible trails, the observation tower, the visitor center, the Kid's Fishing Pond and to quality wetlands and grasslands for interpretation.

Energy conservation modifications have recently been made at several facilities, but more improvements are needed.

Facilities Objective 2

At the GPNC, within 5 years, identify changes and additions to the facility that will improve our cooperative partnership and agency's performances while enhancing the visitors' experience.

Strategies

- Work with partner staffs and develop a plan to expand the building, thus adding office space, classrooms, and a large public meeting space that has the possibility to accommodate traveling exhibits.
- Encourage Friends of the GPNC to investigate strategies to pay for building a new addition to the facility and for improved and enhanced programming efforts.
- Continue to work with corporate sponsors to provide up-to-date and state-of-the-art exhibits in the Koch Habitat Hall.

Rationale

Current exhibits are reaching the end of their expected lifespan and should be replaced and updated. The building will be insufficient for anticipated future needs.

Facilities Objective 3

Within 15 years, design and develop a new environmental education site near the headquarters area.

Strategies

- Include a capital improvement project in the Service asset and maintenance management system.
- Develop a conceptual site plan and engineering design.
- Demolish and rehabilitate old environmental education site.
- Construct new environmental education site.

Rationale

Same as objective 2 and rationale for environmental education and interpretation objective 1. Centralized buildings improve visitor service, reduce staff travel, and improve water quality.

Facilities Objective 4

Within 15 years design and construct another cold storage building and fire cache on the refuge.

Strategies

- Include a capital improvement project in the Service asset and maintenance management system.
- Develop a conceptual site plan and engineering design.
- Potentially demolish and rehabilitate old site.
- Construct new cold storage building and fire cache.

Rationale

Additional storage space is needed to better protect vehicles and to support other refuge objectives.

FWS

Migrants Mile Trail

4.10 Stepdown Management Plans

This CCP is a broad umbrella plan that provides general concepts and specific wildlife, habitat, visitor services, and partnership objectives over the next 15 years. The purpose of stepdown management plans is to provide detail for our managers and employees so they may more effectively carry out the specific actions and strategies authorized by this CCP. Table 19 lists the stepdown plans needed, their status, and their next revision dates.

4.11 Monitoring and Evaluation

We believe that the uncertainty surrounding habitat management can be dealt with most efficiently within the paradigm of adaptive resource manage-

Table 19. Stepdown management plans for Quivira National Wildlife Refuge, Kansas.

Plan	*Completed plan, year approved*	*New or revised plan, completion year*
Habitat management plan (annual)	2012	2013 revise annually
Habitat management plan	—	2017
Inventory and monitoring plan	—	2014
Integrated pest management plan	2012	2017
Fire management plan	2009	2014 validate annually
Visitor services plan	1986	2017
Law enforcement plan	2012	2017
Station safety plan	2012	2017
Water management plan (annual)	2012	2013 revise annually
Hunting plan	—	2016
Trapping plan	—	2016
GPNC operations plan	2012	2013 revise annually
Santana Research Natural Area plan	1984	revise as appropriate

ment (see figure 18) (Holling 1978, Kendall 2001, Lancia et al. 1996, Walters and Holling 1990). This approach provides a framework within which we can make objective decisions and reduce the uncertainty surrounding those decisions. The key components of an adaptive resource management plan follow:

- clearly defined management goals and objectives
- a set of management actions with associated uncertainty as to their outcome
- predictions of various alternative responses to management strategies
- monitoring or assessing select natural resource conditions of interest, largely directed by objectives
- communicating and using new information to direct future decisionmaking

The adaptive management framework facilitates an iterative process, whereby our understanding of the effectiveness of strategies and the response and conditions of natural resources on the refuge is improved over time. Reducing the uncertainty of habitat management via adaptive resource management helps in the continual development of long-term habitat management plans.

4.12 Plan Amendment and Revision

This CCP will be reviewed annually to decide if it needs revision. A revision will occur when significant information becomes available, such as a change in ecological conditions. The final CCP will be augmented by detailed stepdown management plans to address the completion of specific strategies in support of the CCP goals and objectives. Revisions to the CCP and the stepdown management plans will be subject to public review and NEPA compliance. At a minimum, this plan will be evaluated every 5 years and revised after 15 years.

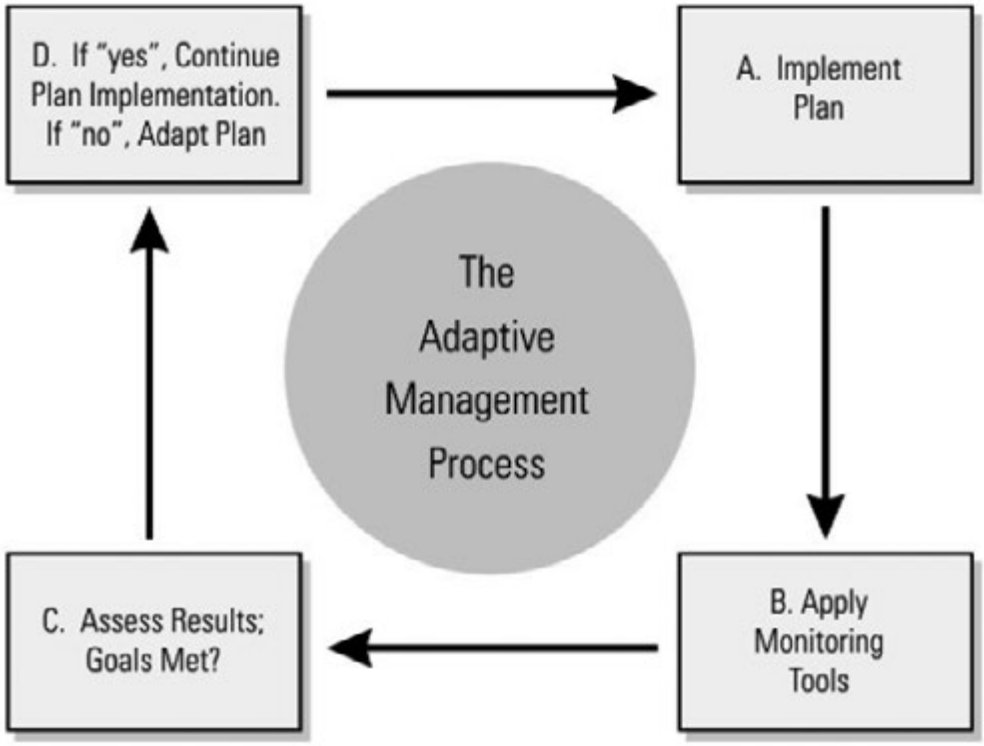

Figure 18. The adaptive resource management process.

Glossary

abiotic—Pertaining to nonliving things.

accessible—Pertaining to physical access to areas and activities for people of different abilities, especially those with physical impairments.

adaptive resource management—The rigorous application of management, research, and monitoring programs to gain information and experience necessary to assess and change management activities; a process that uses feedback from research, monitoring programs, and evaluation of management actions to support or change objectives and strategies at all planning levels; a process in which policy decisions are carried out within a framework of scientifically driven experiments to test predictions and assumptions inherent in management plan. Analysis of results helps managers decide whether current management should continue as is or whether it should be modified to achieve desired conditions.

Administration Act—National Wildlife Refuge System Administration Act of 1966.

alternative—A reasonable way to solve an identified problem or satisfy the stated need (40 CFR 1500.2); one of several different means of accomplishing refuge purposes and goals and contributing to the Refuge System mission (Draft Service Manual 602 FW 1.5).

amphibian—A class of cold-blooded vertebrates including frogs, toads or salamanders.

annual—A plant that flowers and dies within 1 year of germination.

baseline—A set of essential observations, data, or information used for comparison or a control.

biological control—The use of organisms or viruses to control invasive plants or other pests.

biological diversity, also biodiversity—The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur (Service Manual 052 FW 1.12B). The National Wildlife Refuge System's focus is on indigenous species, biotic communities, and ecological processes.

biotic—Pertaining to life or living organisms; caused, produced by, or comprising living organisms.

canopy—A layer of foliage, generally the uppermost layer, in a vegetative stand; mid-level or understory vegetation in multilayered stands. Canopy closure (also canopy cover) is an estimate of the amount of overhead vegetative cover.

CCC—See Civilian Conservation Corps.

CCP—See comprehensive conservation plan.

CFR—See Code of Federal Regulations.

cfs—Cubic feet per second.

Civilian Conservation Corps (CCC)—Peacetime civilian "army" established by President Franklin D. Roosevelt to perform conservation activities from 1933–42. Activities included erosion control; firefighting; tree planting; habitat protection; stream improvement; and building of fire towers, roads, recreation facilities, and drainage systems.

Code of Federal Regulations (CFR)—The codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government. Each volume of the CFR is updated once each calendar year.

compatibility determination—See compatible use.

compatible use—A wildlife-dependent recreational use or any other use of a refuge that, in the sound professional judgment of the Director of the U.S. Fish and Wildlife Service, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge (Draft Service Manual 603 FW 3.6). A compatibility determination supports the choice of compatible uses and identified stipulations or limits necessary to make sure that there is compatibility.

comprehensive conservation plan (CCP)—A document that describes the desired future conditions of the refuge and provides long-range guidance and management direction for the refuge manager to accomplish the purposes of the refuge, contribute to the mission of the Refuge System, and to meet other relevant mandates (Draft Service Manual 602 FW 1.5).

concern—See issue.

conspecific—An individual belonging to the same species as another.

cool-season grasses—Grasses that begin growth earlier in the season and often become dormant in the summer. These grasses will germinate at lower temperatures. Examples of cool-season

grasses at the refuge are western wheatgrass, needle and thread, and green needlegrass.

coteau—A hilly upland including the divide between two valleys; a divide; the side of a valley.

cover, also cover type, canopy cover—Present vegetation of an area.

cultural resources—The remains of sites, structures, or objects used by people in the past.

depredation—Destruction or consumption of eggs, broods, or individual wildlife because of a predatory animal; damage inflicted on agricultural crops or ornamental plants by wildlife.

drawdown—The act of manipulating water levels in an impoundment to allow for the natural, cyclical drying out of a wetland.

EA—See environmental assessment.

ecosystem—A dynamic and interrelating complex of plant and animal communities and their associated nonliving environment; a biological community, with its environment, functioning as a unit. For administrative purposes, the Service has designated 53 ecosystems covering the United States and its possessions. These ecosystems generally correspond with watershed boundaries and their sizes and ecological complexity vary.

EIS—Environmental impact statement.

emergent—A plant rooted in shallow water and having most of the vegetative growth above water such as cattail and hardstem bulrush.

endangered species, Federal—A plant or animal species listed under the Endangered Species Act of 1973, as amended, that is in danger of extinction throughout all or a substantial part of its range.

endangered species, State—A plant or animal species in danger of becoming extinct or extirpated in a particular state within the near future if factors contributing to its decline continue. Populations of these species are at critically low levels or their habitats have been degraded or depleted to a substantial degree.

endemic species—Plants or animals that occur naturally in a certain region and whose distribution is relatively limited to a particular locality.

environmental assessment (EA)—A concise public document, prepared in compliance with the National Environmental Policy Act, that briefly discusses the purpose and need for an action and alternatives to such action, and provides sufficient evidence and analysis of effects to decide whether to prepare an environmental impact statement or finding of no significant impact (40 CFR 1508.9).

EPA—Environmental Protection Agency.

extinction—The complete disappearance of a species from the earth; no longer existing.

extirpation—The extinction of a population; complete eradication of a species within a specified area.

fauna—All the vertebrate and invertebrate animals of an area.

Federal trust resource—A trust is something managed by one entity for another who holds the ownership. The Service holds in trust many natural resources for the people of the United States of America as a result of Federal acts and treaties. Examples are species listed under the Endangered Species Act, migratory birds protected by international treaties, and native plant or wildlife species found on a national wildlife refuge.

Federal trust species—All species where the Federal Government has primary jurisdiction including federally endangered or threatened species, migratory birds, anadromous fish, and certain marine mammals.

flora—All the plant species of an area.

FMP—fire management plan.

forb—A broad-leaved, herbaceous plant; a seed-producing annual, biennial, or perennial plant that does not develop persistent woody tissue but dies down at the end of the growing season.

fragmentation—The alteration of a large block of habitat that creates isolated patches of the original habitat that are interspersed with a variety of other habitat types; the process of reducing the size and connectivity of habitat patches, making movement of individuals or genetic information between parcels difficult or impossible.

Friends group—Any formal organization whose mission is to support the goals and purposes of its associated refuge and the National Wildlife Refuge Association overall; Friends organizations and cooperative and interpretive associations.

General Schedule—Pay rate schedule for certain Federal positions. Sometimes "GS."

geographic information system (GIS)—A computer system capable of storing and manipulating spatial data; a set of computer hardware and software for analyzing and displaying spatially referenced features (such as points, lines and polygons) with nongeographic attributes such as species and age.

GIS—See geographic information system.

goal—Descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units (Draft Service Manual 620 FW 1.5).

grassland tract—A contiguous area of grassland without fragmentation.

habitat—Suite of existing environmental conditions required by an organism for survival and reproduction; the place where an organism typically lives and grows.

habitat disturbance—Substantial alteration of habitat structure or composition; may be natural (for

example, wildland fire) or human-caused events (for example, timber harvest and disking).

habitat type, also vegetation type, cover type—A land classification system based on the concept of distinct plant associations.

herbivory—The state or condition of feeding on plants or plant parts.

herptile—A reptile or an amphibian.

HMP—Habitat management plan.

HUA—Hydrologic unit area.

hydroperiod—The seasonal pattern of the water level of a wetland that is often used to characterize wetland types. Examples of seasonal patterns include flood frequency, duration, and depth.

impoundment—A body of water created by collection and confinement within a series of levees or dikes, creating separate management units although not always independent of one another.

Improvement Act—National Wildlife Refuge System Improvement Act of 1997.

indigenous—Originating or occurring naturally in a particular place.

integrated pest management (IPM)—Methods of managing undesirable species such as invasive plants; education, prevention, physical or mechanical methods of control, biological control, responsible chemical use, and cultural methods.

introduced species—A species present in an area because of intentional or unintentional escape, release, dissemination, or placement into an ecosystem as a result of human activity.

invasive plant, also noxious weed—A species that is nonnative to the ecosystem under consideration and whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health.

inviolate sanctuary—A place of refuge or protection where animals and birds may not be hunted.

IPM—See integrated pest management.

issue—Any unsettled matter that requires a management decision; for example, a Service initiative, opportunity, resource management problem, a threat to the resources of the unit, conflict in uses, public concern, or the presence of an undesirable resource condition (Draft Service Manual 602 FW 1.5).

Kansas Department of Wildlife, Parks and Tourism (KDWPT)—A State agency responsible for overseeing the conservation of game and nongame species in Kansas.

management alternative—See alternative.

migration—Regular extensive, seasonal movements of birds between their breeding regions and their wintering regions; to pass usually periodically from one region or climate to another for feeding or breeding.

migratory birds—Birds that follow a seasonal movement from their breeding grounds to their wintering grounds. Waterfowl, shorebirds, raptors, and songbirds are all migratory birds.

mission—Succinct statement of purpose or reason for being.

mitigation—Measure designed to counteract an environmental effect or to make an effect less severe.

mixed-grass prairie—A transition zone between the tallgrass prairie and the shortgrass prairie dominated by grasses of medium height that are approximately 2–4 feet tall. Soils are not as rich as the tallgrass prairie and moisture levels are less.

monitoring—The process of collecting information to track changes of selected parameters over time.

national wildlife refuge—A designated area of land, water, or an interest in land or water within the National Wildlife Refuge System, but does not include coordination areas; a complete listing of all units of the Refuge System is in the current "Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service."

National Wildlife Refuge System (Refuge System)—Various categories of areas administered by the Secretary of the Department of the Interior for the conservation of fish and wildlife including species threatened with extinction, all lands, waters, and interests therein administered by the Secretary as wildlife refuges, areas for the protection and conservation of fish and wildlife that are threatened with extinction, wildlife ranges, game ranges, wildlife management areas, and waterfowl production areas.

National Wildlife Refuge System Improvement Act of 1997 (Improvement Act)—Sets the mission and the administrative policy for all refuges in the National Wildlife Refuge System; defines a unifying mission for the Refuge System; establishes the legitimacy and appropriateness of the six priority public uses (hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation); establishes a formal process for determining appropriateness and compatibility; establish the responsibilities of the Secretary of the Department of the Interior for managing and protecting the Refuge System; requires a comprehensive conservation plan for each refuge by the year 2012. This Act amended parts of the Refuge Recreation Act and National Wildlife Refuge System Administration Act of 1966.

native species—A species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.

Neotropical migrant—A bird species that breeds north of the United States and Mexican border and winters primarily south of this border.

NEPA—National Environmental Policy Act of 1969.

nest success—The percentage of nests that successfully hatch one or more eggs of the total number of nests started in an area.

NOA—Notice of availability.

nongovernmental organization—Any group that is not comprised of Federal, State, tribal, county, city, town, local, or other governmental entities.

noxious weed, also invasive plant—Any living stage (including seeds and reproductive parts) of a parasitic or other plant of a kind that is of foreign origin (new to or not widely prevalent in the United States) and can directly or indirectly injure crops, other useful plants, livestock, poultry, other interests of agriculture, including irrigation, navigation, fish and wildlife resources, or public health. According to the Federal Noxious Weed Act (PL 93–639), a noxious weed (such as invasive plant) is one that causes disease or has adverse effects on humans or the human environment and, therefore, is detrimental to the agriculture and commerce of the United States and to public health.

NRCS—Natural Resources Conservation Service of the U.S. Department of Agriculture.

objective—An objective is a concise target statement of what will be achieved, how much will be achieved, when and where it will be achieved, and who is responsible for the work; derived from goals and provide the basis for determining management strategies. Objectives should be achievable and time specific and should be stated quantitatively to the extent possible. If objectives cannot be stated quantitatively, they may be stated qualitatively (Draft Service Manual 602 FW 1.5).

overwater species—Nesting species such as diving ducks and many colonial-nesting birds that build nests within dense stands of water-dependent plants, primarily cattail, or that build floating nests of vegetation that rest on the water.

OWLS—Outdoor wildlife learning site.

passerine—Pertaining to an order of birds, Passeriformes, that comprises more than half of all birds and that typically has feet adapted for perching.

patch—An area distinct from that around it; an area distinguished from its surroundings by environmental conditions.

perennial—Lasting or active through the year or through many years; a plant species that has a lifespan of more than 2 years.

plant community—An assemblage of plant species unique in its composition; occurs in particular locations under particular influences; a reflection or integration of the environmental influences on the site such as soil, temperature, elevation, solar radiation, slope, aspect, and rainfall; denotes a general kind of climax plant community, such as ponderosa pine or bunchgrass.

prescribed fire—The skillful application of fire to natural fuels under conditions such as weather, fuel moisture, and soil moisture that allow confinement of the fire to a predetermined area and produces the intensity of heat and rate of spread to accomplish planned benefits to one or more objectives of habitat management, wildlife management, or hazard reduction.

priority public use—One of six uses authorized by the National Wildlife Refuge System Improvement Act of 1997 to have priority if found to be compatible with a refuge's purposes. This includes hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation.

proposed action—The alternative proposed to best achieve the purpose, vision, and goals of a refuge (contributes to the Refuge System mission, addresses the significant issues, and is consistent with principles of sound fish and wildlife management).

public—Individuals, organizations, and groups; officials of Federal, State, and local government agencies; American Indian tribes; and foreign nations. It may include anyone outside the core planning team. It includes those who may or may not have shown an interest in Service issues and those who do or do not realize that Service decisions may affect them.

public involvement—A process that offers affected and interested individuals and organizations an opportunity to become informed about, and to express their opinions on, Service actions and policies. In the process, these views are studied thoroughly and thoughtful consideration of public views is given in shaping decisions for refuge management.

purpose of the refuge—The purpose of a refuge is specified in or derived from the law, proclamation, Executive order, agreement, public land order, donation document, or administrative memorandum establishing authorization or expanding a refuge, refuge unit, or refuge subunit (Draft Service Manual 602 FW 1.5).

raptor—A carnivorous bird such as a hawk, a falcon, or a vulture that feeds wholly or chiefly on meat taken by hunting or on carrion (dead carcasses).

Reclamation—Bureau of Reclamation of the U.S. Department of the Interior.

refuge operations needs system (RONS)—A national database that contains the operational needs of each refuge that need money. Projects included

are those required to carry out approved plans and meet goals, objectives, and legal mandates.

refuge purpose—See purpose of the refuge.

Refuge System—See National Wildlife Refuge System.

refuge use—Any activity on a refuge, except administrative or law enforcement activity, carried out by or under the direction of an authorized Service employee.

resident species—A species inhabiting a given locality throughout the year; nonmigratory species.

rest—Free from biological, mechanical, or chemical manipulation, in reference to refuge lands.

restoration—Management emphasis designed to move ecosystems to desired conditions and processes, such as healthy upland habitats and aquatic systems.

riparian area or riparian zone—An area or habitat that is transitional from terrestrial to aquatic ecosystems including streams, lakes, wet areas, and adjacent plant communities and their associated soils that have free water at or near the surface; an area whose parts are directly or indirectly attributed to the influence of water; of or relating to a river; specifically applied to ecology, "riparian" describes the land immediately adjoining and directly influenced by streams. For example, riparian vegetation includes all plant life growing on the land adjoining a stream and directly influenced by the stream.

RONS—See refuge operations needs system.

rough fish—A fish that is neither a sport fish nor an important food fish.

SAMMS—See Service Asset Maintenance Management System.

scoping—The process of obtaining information from the public for input into the planning process.

seasonally flooded—Surface water is present for extended periods in the growing season, but is absent by the end of the season in most years.

sediment—Material deposited by water, wind, and glaciers.

Service—See U.S. Fish and Wildlife Service.

Service Asset Maintenance Management System (SAMMS)—A national database that contains maintenance projects for each refuge that need money; projects include those required to keep existing equipment and buildings, correct safety deficiencies for the implementation of approved plans, and meet goals, objectives, and legal mandates.

sheet flow—The overland flow of water, typically from precipitation to lower elevation areas.

shelterbelt—Single to multiple rows of trees and shrubs planted around cropland or buildings to block or slow down the wind.

shorebird—Any of a suborder (Charadrii) of birds such as a plover or a snipe that frequent the seashore or mudflat areas.

spatial—Relating to, occupying, or having the character of space.

special status species—Plants or animals that have been identified through Federal law, State law, or agency policy as requiring special protection of monitoring programs. Examples include federally listed endangered, threatened, proposed, or candidate species; State-listed endangered, threatened, candidate, or monitor species; Service's species of management concern; species identified by the Partners in Flight program as being of extreme or moderately high conservation concern.

special use permit—A permit for special authorization from the refuge manager required for any refuge service, facility, privilege, or product of the soil provided at refuge expense and not usually available to the public through authorizations in Title 50 CFR or other public regulations (Refuge Manual 5 RM 17.6).

species of concern—Those plant and animal species, while not falling under the definition of special status species, that are of management interest by virtue of being Federal trust species such as migratory birds, important game species, or significant keystone species; species that have documented or apparent populations declines, small or restricted populations, or dependence on restricted or vulnerable habitats.

stepdown management plan—A plan that provides the details necessary to carry out management strategies identified in the comprehensive conservation plan (Draft Service Manual 602 FW 1.5).

strategy—A specific action, tool, or technique or combination of actions, tools, and techniques used to meet unit objectives (Draft Service Manual 602 FW 1.5).

submergent—A vascular or nonvascular hydrophyte, either rooted or nonrooted, that lies entirely beneath the water surface, except for flowering parts in some species.

surrogate species—A species used as an indicator of landscape habitat and system conditions. It represents multiple species and habitats within a defined landscape or geographic area.

threatened species, Federal—Species listed under the Endangered Species Act of 1973, as amended, that are likely to become endangered in the future throughout all, or a substantial part, of their range.

threatened species, State—A plant or animal species likely to become endangered in a particular state within the near future if factors contributing to

population decline or habitat degradation or loss continue.

travel corridor—A landscape feature that facilitates the biologically effective transport of animals between larger patches of habitat dedicated to conservation functions. Such corridors may facilitate several kinds of traffic including frequent foraging movement, seasonal migration, or the once in a lifetime dispersal of juvenile animals. These are transition habitats and need not contain all the habitat elements required for long-term survival or reproduction of its migrants.

trust resource—See Federal trust resource.

trust species—See Federal trust species.

USDA—U.S. Department of Agriculture.

U.S. Fish and Wildlife Service (Service, FWS)—The principal Federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. The Service manages the 93-million-acre National Wildlife Refuge System comprised of more than 530 national wildlife refuges and thousands of waterfowl production areas. It also operates 65 national fish hatcheries and 78 ecological service field stations, the agency enforces Federal wildlife laws, manages migratory bird populations, restores national significant fisheries, conserves and restores wildlife habitat such as wetlands, administers the Endangered Species Act, and helps foreign governments with their conservation efforts. It also oversees the Federal aid program that distributes millions of dollars in excise taxes on fishing and hunting equipment to State wildlife agencies.

FWS—See U.S. Fish and Wildlife Service.

U.S. Geological Survey (USGS)—A Federal agency whose mission is to provide reliable scientific information to describe and understand the earth; decrease loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

USGS—See U.S. Geological Survey.

vision statement—A concise statement of the desired future condition of the planning unit, based primarily on the Refuge System mission, specific refuge purposes, and other relevant mandates (Draft Service Manual 602 FW 1.5).

visual obstruction—Pertaining to the density of a plant community; the height of vegetation that blocks the view of predators and conspecifics to a nest.

visual obstruction reading (VOR)—A method of visually quantifying vegetative structure and composition.

VOR—See visual obstruction reading.

wading birds—Birds having long legs that enable them to wade in shallow water including egrets, great blue herons, black-crowned night-herons, and bitterns.

Wage Grade Schedule—Pay rate schedule for certain Federal positions. Sometimes "WG."

waterfowl—A category of birds that includes ducks, geese, and swans.

watershed—The region draining into a river, a river system, or a body of water.

wetland management district (WMD)—Land that the Refuge System acquires with Federal Duck Stamp money for restoration and management primarily as prairie wetland habitat critical to waterfowl and other wetland birds.

wildland fire—A free-burning fire requiring a suppression response; all fire other than prescribed fire that occurs on wildlands (Service Manual 621 FW 1.7).

wildlife-dependent recreational use—Use of a refuge involving hunting, fishing, wildlife observation, wildlife photography, environmental education, or interpretation. The National Wildlife Refuge System Improvement Act of 1997 specifies that these are the six priority public uses of the Refuge System.

woodland—Habitats dominated by trees.

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