

Draft Comprehensive Conservation Plan and Environmental Assessment

Quivira National Wildlife Refuge

Kansas

April 2013

Prepared by

Quivira National Wildlife Refuge
1434 NE. 80th Street
Stafford, Kansas 67578
620 / 486 2393

U.S. Fish and Wildlife Service
Region 6, Mountain–Prairie Region
Division of Refuge Planning
134 Union Boulevard, Suite 300
Lakewood, Colorado 80228
303 / 236 8145

CITATION

Fish and Wildlife Service. 2013. Draft comprehensive conservation plan and environmental assessment—Quivira National Wildlife Refuge, Kansas. Lakewood, CO: U.S. Department of the Interior, Fish and Wildlife Service. 264p.

Contents

<i>Summary</i>	XI
<i>Abbreviations</i>	XVII
CHAPTER 1—Introduction	1
1.1 Purpose and Need for the Plan	3
1.2 Early History of Conservation	3
1.3 The U.S. Fish and Wildlife Service and the National Wildlife Refuge System	4
<i>U.S. Fish and Wildlife Service</i>	4
<i>National Wildlife Refuge System</i>	4
<i>The Public and the Refuge System</i>	5
1.4 National and Regional Mandates	5
1.5 Contributions to Regional and National Plans	5
<i>Conserving the Future</i>	6
<i>Partners in Flight North American Landbird Conservation Plan</i>	6
<i>North American Waterbird Conservation Plan</i>	6
<i>North American Waterfowl Management Plan</i>	6
<i>United States Shorebird Conservation Plan</i>	6
<i>Endangered Species Recovery Plans</i>	7
<i>Kansas State Wildlife Action Plan</i>	7
<i>Climate Change</i>	7
1.6 Strategic Habitat Conservation	8
1.7 Landscape Conservation Cooperatives	8
1.8 The Planning Process	9
<i>Coordination with the Public</i>	11
<i>State Coordination</i>	12
<i>Tribal Coordination</i>	12
<i>Results of Scoping</i>	12
CHAPTER 2—The Refuge	13
2.1 Establishment, Acquisition, and Management History	13
<i>Water Management History</i>	14
2.2 Purpose	14
2.3 Special Values of the Refuge	14
<i>Rare, Diverse, and Quality Habitat</i>	16
<i>Wildlife Species</i>	16
<i>Species of Concern</i>	16
<i>Water Resources</i>	16
<i>Communities and People</i>	16
<i>Education and Visitor Services</i>	16
<i>Cultural Resources</i>	16
<i>Facilities and Infrastructure</i>	16
<i>Special Designations</i>	16
2.4 Vision	17

2.5 Goals	17
<i>Landscape Conservation Goal</i>	17
<i>Native Ecological Community Conservation Goal</i>	17
<i>Visitor Services Goal</i>	17
<i>Public Outreach Goal</i>	17
<i>Cultural Resources Goal</i>	18
<i>Visitor and Employee Safety and Resource Protection Goal</i>	18
<i>Administration Goal</i>	18
2.6 Planning Issues	18
<i>Water Quantity and Quality</i>	18
<i>Tree Management</i>	19
<i>Whooping Crane Closures</i>	19
<i>Prohibiting the Collection of Shed Antlers</i>	19
<i>Deer and Turkey Hunting</i>	19
<i>Increasing Public Use and Wildlife Compatibility</i>	19
CHAPTER 3—Alternatives	21
3.1 Development of Alternatives for the Refuge	21
3.2 Alternatives Considered but Dropped from Detailed Study	23
3.3 Elements Common to All Alternatives	23
3.4 Alternative A (Current Management—No Action)	24
<i>Landscape Conservation Actions</i>	24
<i>Native Ecological Community Conservation Actions</i>	25
<i>Visitor Services Actions</i>	29
<i>Public Outreach Actions</i>	30
<i>Cultural Resources Actions</i>	30
<i>Visitor and Employee Safety and Resource Protection Actions</i>	30
<i>Administration Actions</i>	31
3.5 Alternative B (Proposed Action)	32
<i>Focal Species or Resources Actions</i>	32
<i>Landscape Conservation Actions</i>	38
<i>Native Ecological Community Conservation Actions</i>	38
<i>Visitor Services Actions</i>	40
<i>Public Outreach Actions</i>	41
<i>Cultural Resources Actions</i>	41
<i>Visitor and Employee Safety and Resource Protection Actions</i>	41
<i>Administration Actions</i>	42
3.6 Alternative C	42
<i>Landscape Conservation Actions</i>	42
<i>Native Ecological Community Conservation Actions</i>	43
<i>Visitor Services Actions</i>	45
<i>Public Outreach Actions</i>	46
<i>Cultural Resources Actions</i>	46
<i>Visitor and Employee Safety and Resource Protection Actions</i>	46
<i>Administration Actions</i>	46
3.7 Summary of Alternatives and Consequences	46
CHAPTER 4—Affected Environment	69
4.1 Physical Environment	69
<i>Climate</i>	69
<i>Climate Change</i>	70
<i>Air Quality</i>	73
<i>Geology and Physiography</i>	73

<i>Water Resources</i>	75
<i>Soils</i>	76
4.2 Biological Resources	78
<i>Plant Communities</i>	79
<i>Wildlife Communities</i>	88
4.3 Cultural Resources	94
<i>Presettlement (European) History</i>	94
<i>Historical Euro-Americans and Exploration</i>	95
<i>Settlement and Early Land Use Changes</i>	95
4.4 Special Management Areas	97
4.5 Visitor Services	97
<i>Hunting</i>	97
<i>Fishing</i>	98
<i>Wildlife Observation and Photography</i>	98
<i>Environmental Education</i>	98
<i>Interpretation</i>	99
<i>Special Events</i>	99
<i>Other Uses</i>	100
<i>Public Outreach</i>	100
4.6 Partnerships	100
4.7 Management Uses	101
<i>Rest</i>	102
<i>Water Management</i>	102
<i>Prescribed Fire</i>	102
<i>Grazing</i>	103
<i>Mechanical Treatments</i>	103
<i>Chemical Treatments</i>	103
4.8 Socioeconomic Environment	104
<i>Population, Ethnicity, and Education</i>	104
<i>Regional Employment and Income</i>	105
<i>The Public's Use of the Refuge</i>	108
<i>Visitor Satisfaction Levels</i>	110
<i>Baseline Economic Activity</i>	109
<i>U.S. Fish and Wildlife Service Employment</i>	109
<i>Visitor Spending</i>	109
4.9 Administration	110
<i>Staff and Budget</i>	110
<i>Facilities and Infrastructure</i>	110
CHAPTER 5—Environmental Consequences	113
5.1 Analysis Methods	113
5.2 Effects Common to All Alternatives	114
<i>Regulatory Effects</i>	114
<i>Environmental Justice</i>	114
<i>Cultural Resources</i>	114
<i>Geology and Soils</i>	114
5.3 Land Conservation Effects	115
<i>Climate Change</i>	115
<i>Climate Change—Alternative A</i>	115
<i>Climate Change—Alternative B (Proposed Action)</i>	116
<i>Climate Change—Alternative C</i>	116
<i>Land Protection—Alternative A</i>	117

Land Protection—Alternative B (Proposed Action)	117
Land Protection—Alternative C	118
5.4 Native Ecological Community Conservation Effects	118
Big Salt Marsh—Alternative A	118
Big Salt Marsh—Alternative B (Proposed Action)	119
Big Salt Marsh—Alternative C	119
Little Salt Marsh—Alternative A	119
Little Salt Marsh—Alternative B (Proposed Action)	119
Little Salt Marsh—Alternative C	119
Riparian Corridor—Alternative A	120
Riparian Corridor—Alternative B (Proposed Action)	120
Riparian Corridor—Alternative C	120
Created Wetlands—Alternative A	120
Created Wetlands—Alternative B (Proposed Action)	121
Created Wetlands—Alternative C	122
Freshwater Springs—Alternative A	122
Freshwater Springs—Alternative B (Proposed Action)	123
Freshwater Springs—Alternative C	123
Meadow—Alternative A	123
Meadow—Alternative B (Proposed Action)	124
Meadow—Alternative C	124
Woodland—Alternative A	124
Woodland—Alternative B (Proposed Action)	125
Woodland—Alternative C	125
Sand Prairie Complex—Alternative A	125
Sand Prairie Complex—Alternative B (Proposed Action)	126
Sand Prairie Complex—Alternative C	127
Cropland—Alternative A	127
Cropland—Alternative B (Proposed Action)	128
Cropland—Alternative C	128
Migratory Birds—Alternative A	128
Migratory Birds—Alternative B (Proposed Action)	128
Migratory Birds—Alternative C	128
Fish—Alternative A	130
Fish—Alternative B (Proposed Action)	130
Fish—Alternative C	130
Threatened and Endangered Species and Species of Concern—Alternative A	131
Threatened and Endangered Species and Species of Concern—Alternative B (Proposed Action)	131
Threatened and Endangered Species and Species of Concern—Alternative C	131
Wildlife Native to the Region—Alternative A	132
Wildlife Native to the Region—Alternative B (Proposed Action)	132
Wildlife Native to the Region—Alternative C	132
Wildlife Health—Alternative A	132
Wildlife Health—Alternative B (Proposed Action)	132
Wildlife Health—Alternative C	133
Inventory, Monitoring, and Research—Alternative A	133
Inventory, Monitoring, and Research—Alternative B (Proposed Action)	133
Inventory, Monitoring, and Research—Alternative C	133
5.5 Visitor Services Effects	134
Hunting—Alternative A	134
Hunting—Alternative B (Proposed Action)	134
Hunting—Alternative C	135
Fishing—Alternative A	136
Fishing—Alternative B (Proposed Action)	136
Fishing—Alternative C	136
Wildlife Observation and Photography—Alternative A	137

Wildlife Observation and Photography—Alternative B (Proposed Action)	137
Wildlife Observation and Photography—Alternative C	137
Environmental Education and Interpretation—Alternative A	138
Environmental Education and Interpretation—Alternative B (Proposed Action)	138
Environmental Education and Interpretation—Alternative C	138
Other Uses—Alternative A	138
Other Uses—Alternative B (Proposed Action)	138
Other Uses—Alternative C	138
5.6 Public Outreach Effects	138
Alternative A	139
Alternative B (Proposed Action)	139
Alternative C	139
5.7 Cultural Resources Effects	139
Alternative A	139
Alternative B (Proposed Action)	139
Alternative C	139
5.8 Visitor and Employee Safety and Resource Protection Effects	139
Visitor and Employee Safety—Alternative A	139
Visitor and Employee Safety—Alternative B (Proposed Action)	140
Visitor and Employee Safety—Alternative C	140
Resource Protection—Alternative A	140
Resource Protection—Alternative B (Proposed Action)	140
Resource Protection—Alternative C	141
5.9 Administration Effects	141
Staff and Budget—Alternative A	141
Staff and Budget—Alternative B (Proposed Action)	141
Staff and Budget—Alternative C	141
Facilities and Infrastructure—Alternative A	141
Facilities and Infrastructure—Alternative B (Proposed Action)	142
Facilities and Infrastructure—Alternative C	142
5.10 Socioeconomic Effects	142
Effects from the Refuge Revenue Sharing Act	142
Effects of Refuge Staff Salary Spending within the Local Economy	143
Effects of Refuge Purchases of Goods and Services within the Local Economy	143
Effects of Visitor Expenditures	144
Summary of Economic Effects for Alternative A	147
Summary of Economic Effects for Alternative B	148
Summary of Economic Effects for Alternative C	149
5.11 Cumulative Impacts	150
CHAPTER 6—Implementation of the Proposed Action	151
6.1 Comprehensive Conservation Plan Focus	151
6.2 Landscape Conservation Goal	152
Landscape Conservation Objective 1: Land Ownership and Collaboration	154
Landscape Conservation Objective 2: Habitat Fragmentation	155
Landscape Conservation Objective 3: Environmental Health and Climate Change	156
6.3 Native Ecological Community Conservation Goal	157
Native Ecological Community Conservation Objective 1: Wetlands	162
Native Ecological Community Conservation Objective 2: Grasslands	170
Native Ecological Community Conservation Objective 3: Woodland	174
6.4 Visitor Services Goal	177
Hunting Objective 1	177

<i>Hunting Objective 2</i>	177
<i>Hunting Objective 3</i>	180
<i>Fishing Objective 1</i>	180
<i>Fishing Objective 2</i>	182
<i>Wildlife Observation and Photography Objective 1</i>	182
<i>Wildlife Observation and Photography Objective 2</i>	183
<i>Environmental Education and Interpretation Objective 1</i>	183
<i>Environmental Education and Interpretation Objective 2</i>	184
<i>Environmental Education and Interpretation Objective 3</i>	184
<i>Environmental Education and Interpretation Objective 4</i>	185
<i>Environmental Education and Interpretation Objective 5</i>	185
<i>Environmental Education and Interpretation Objective 6</i>	185
<i>Other Uses Objective</i>	185
6.5 Public Outreach Goal	186
<i>Public Outreach Objective 1</i>	186
<i>Public Outreach Objective 2</i>	187
<i>Public Outreach Objective 3</i>	187
6.6 Cultural Resources Goal	188
<i>Cultural Resources Objective</i>	188
6.7 Visitor and Employee Safety and Resource Protection Goal	188
<i>Visitor and Employee Safety Objective</i>	189
<i>Resource Protection Objective</i>	189
6.8 Administration Goal	190
<i>Staff and Budget Objective 1</i>	190
<i>Staff and Budget Objective 2</i>	191
<i>Facilities and Infrastructure Objective 1</i>	191
<i>Facilities and Infrastructure Objective 2</i>	192
<i>Facilities and Infrastructure Objective 3</i>	192
<i>Facilities and Infrastructure Objective 4</i>	192
6.9 Stepdown Management Plans	193
GLOSSARY	195
BIBLIOGRAPHY	255

APPENDIXES	
Appendix A	
<i>Key Legislation and Policy</i>	201
Appendix B	
<i>List of Preparers and Contributors</i>	205
Appendix C	
<i>Public Involvement</i>	207
Appendix D	
<i>Draft Compatibility Determinations</i>	209
Appendix E	
<i>Grassland Fragmentation Assessment</i>	225
Appendix F	
<i>Species Lists</i>	231

FIGURES

Figure 1. Quivira National Wildlife Refuge and Great Plains Nature Center, Kansas	2
Figure 2. Basic strategic habitat conservation process	8
Figure 3. Great Plains Landscape Conservation Cooperative with Quivira National Wildlife Refuge, Kansas	9
Figure 4. Process steps for comprehensive conservation planning and associated environmental analysis.	10
Figure 5. Water control structures, Quivira National Wildlife Refuge, Kansas.	15
Figure 6. Habitat types, Quivira National Wildlife Refuge, Kansas	22
Figure 7. Land use and habitat outside the boundaries of Quivira National Wildlife Refuge, Kansas	37
Figure 8. Playa Lakes Joint Venture region, Quivira National Wildlife Refuge, Kansas	71
Figure 9. Refuge soil map, Quivira National Wildlife Refuge, Kansas.	77
Figure 10. Potential presettlement conditions, Quivira National Wildlife Refuge, Kansas.	81
Figure 11. Vegetation cover types in 1954, Quivira National Wildlife Refuge, Kansas	84
Figure 12. Vegetation cover types in 2008 (NVCS), Quivira National Wildlife Refuge, Kansas	85
Figure 13. Public use facilities at Quivira National Wildlife Refuge, Kansas.	111
Figure 14. Cropland and tree coverage planning under alternative B (proposed action), Quivira National Wildlife Refuge, Kansas.	129
Figure 15. Elevation at Quivira National Wildlife Refuge, Kansas.	153
Figure 16. Native Ecological Community Conservation Objectives for Quivira National Wildlife Refuge, Kansas, Illustrated in a Community Profile Schematic.	161
Figure 17. Location of woodland groves at Quivira National Wildlife Refuge, Kansas, in 2012.	176
Figure 18. Proposed waterfowl hunt area, Quivira National Wildlife Refuge, Kansas	178
Figure 19. Proposed upland game hunt area, Quivira National Wildlife Refuge, Kansas	179
Figure 20. Proposed deer and turkey hunt area, Quivira National Wildlife Refuge, Kansas.	181
Figure 21. Current grassland conditions at Quivira National Wildlife Refuge, Kansas.	227
Figure 22. Future grassland conditions at Quivira National Wildlife Refuge, Kansas	228
Figure 23. Current nonhostile grassland conditions at Quivira National Wildlife Refuge, Kansas	229

TABLES

Table 1. Summary of the Comprehensive Conservation Plan process for Quivira National Wildlife Refuge, Kansas	11
Table 2. Land acquisition history of the Quivira National Wildlife Refuge, Kansas	14
Table 3. Focal species by life event and habitat at Quivira National Wildlife Refuge, Kansas.	33
Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.	47
Table 5. Vegetation descriptions for Quivira National Wildlife Refuge, Kansas	79
Table 6. 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.	80
Table 7. Comparison of vegetation cover types between 1954 and 2011 on Quivira National Wildlife Refuge, Kansas.	86
Table 8. National Vegetation Classification System (NVCS) associations, Quivira National Wildlife Refuge, Kansas	87
Table 9. Threatened and Endangered Species and Species of Concern, Quivira National Wildlife Refuge, Kansas	88
Table 10. Observed woodland bird use at Quivira National Wildlife Refuge, Kansas	91

Table 11. State and county population estimates in the area around Quivira National Wildlife Refuge, Kansas.105

Table 12. Community population estimates in the area around Quivira National Wildlife Refuge, Kansas.105

Table 13. State income, unemployment, and poverty statistics and county statistics in the area around Quivira National Wildlife Refuge, Kansas106

Table 14. Community income, unemployment and poverty statistics in the area around Quivira National Wildlife Refuge, Kansas.106

Table 15. Employment by sector in the area around Quivira National Wildlife Refuge, Kansas.106

Table 16. Total visitor expenditures, expressed in dollars per person per day, for Quivira National Wildlife Refuge, Kansas. .109

Table 17. Base staff budgeted in fiscal year 2012 and other staff stationed at Quivira National Wildlife Refuge, Kansas. . .110

Table 18. Annual effects of Refuge Revenue Sharing Act payments under alternatives A, B and C on the area around Quivira National Wildlife Refuge, Kansas143

Table 19. Annual effects of salary spending in the area around Quivira National Wildlife Refuge, Kansas.143

Table 20. Breakdown of current purchases of goods and services in the area around Quivira National Wildlife Refuge, Kansas.144

Table 21. Annual effects of purchases of goods and services in the area around Quivira National Wildlife Refuge, Kansas. .144

Table 22. Estimated annual visitation activity at Quivira National Wildlife Refuge, Kansas, by alternative.146

Table 23. Annual effects of nonlocal visitor spending by alternative in the area around Quivira National Wildlife Refuge, Kansas.147

Table 24. Economic effects of alternative A148

Table 25. Economic effects of alternative B148

Table 26. Change in economic effect from alternative A to alternative B149

Table 27. Economic effects of alternative C149

Table 28. Change in economic effect from alternative A to alternative C150

Table 29. Estimated greatest potential distribution of wetland habitat conditions (acres by unit and objective) for the proposed alternative for Quivira National Wildlife Refuge, Kansas164

Table 30. Dominant nonwetland habitat types at Quivira National Wildlife Refuge, Kansas.172

Table 31. Stepdown management plans for Quivira National Wildlife Refuge, Kansas.193

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 partnership with the Kansas Department of Wildlife, Parks and Tourism, and the City of Wichita Department of Park and Recreation.

This is a summary of the draft comprehensive conservation plan and environmental assessment that we have prepared for Quivira National Wildlife Refuge. The full document contains background information and our analyses for managing the refuge.

The Refuge

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.

The Planning Process

The National Wildlife Refuge System Improvement Act of 1997 requires us to develop a comprehensive conservation plan for each national wildlife refuge. The final plan for the Quivira National Wildlife Refuge is scheduled for completion in 2013 and will guide the management of the refuge for the next 15 years.

The planning process for a comprehensive conservation plan is a series of steps including environmental analysis. We encourage and value public involvement throughout the process. Our planning team compiled a list of issues to consider and analyzed management alternatives for the comprehensive conservation plan that would not only address these issues but also meet the purposes, vision, and goals of the refuge.

There are three alternatives analyzed within the draft comprehensive conservation plan and environmental assessment for the refuge that are summarized under the “Alternatives” section of this summary.

After the planning team prepares the final comprehensive conservation plan for publication, a notice of availability will be published in the Federal Register, and copies of the final comprehensive conservation plan or accompanying summary will be sent to those on our mailing list.

Issues

Based on an analysis of comments collected from the public and our staff and on a review of the needs of the National Wildlife Refuge System Improvement Act of 1997 and the National Environmental Policy Act of 1969, we identified several key issues for Quivira National Wildlife 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 water table would also likely affect grassland and meadow habitats.

Tree Management

There are differences of opinion about tree management on Quivira National Wildlife 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 National Wildlife Refuge closes to hunting to avoid disturbing them and to prevent accidental shooting. 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, Kansas Department of Wildlife, Parks and Tourism 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 National Wildlife 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 Code of Federal Regulations 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.

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.

The Future of 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.

Vision

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.



Barry Jones/USFWS

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

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

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 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 keep the long-term integrity of infrastructure, habitats, and wildlife resources at the refuge and at the Great Plains Nature Center.



White Pelicans

Rachel Laubham/USFWS

Alternatives

This section summarizes the three analyses within this draft comprehensive conservation plan and environmental assessment.

Alternative A (Current Management—No Action)

Alternative A is the no-action alternative, which represents the current management of Quivira National Wildlife Refuge. This alternative provides the baseline against which to compare the other alternatives. It also fulfills a need of the National Environmental Policy Act of 1969. Under alternative A, our management activity would continue unchanged. We would not develop any new management, restoration, or education programs at the refuge. Current habitat and wildlife practices benefiting migratory species and other wildlife would not be expanded or changed. Habitat management would remain focused primarily on benefiting migratory birds. Our staff would keep monitoring, inventory, and research activities at current levels. Budget and staff levels would remain the same with little change in overall trends. Programs would follow the same direction, emphasis, and intensity as they do now.

Alternative B (Proposed action)

We would 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 would increase our attention and understanding of the connectedness of habitats and the effectiveness of our management. To achieve this alternative, relatively minor changes in our operations; inventory, monitoring programs, and research; staff; and infrastructure would likely be required.

Alternative C

To the extent possible, we would promote self-sustaining natural processes with less regard to the

effects on focal species relative to alternative B, though we understand that complete ecological restoration is impossible. Our key values for restoring natural ecological processes include achieving the long-term sustainability of native communities and lowering maintenance costs. We find that it is widely accepted that native plant communities tend to be more resilient to climate change and other environmental stressors than nonnative and highly managed ecosystems. Native wildlife species, including our trust resources, are also able to adapt to such changes. Our efforts, such as prescribed fire, grazing, and invasive species control, would be focused on keeping native plant community composition and diversity, and we would presume that native wildlife would benefit from these activities. Relative to our other alternatives, habitat conditions would be allowed to fluctuate more with climatically driven wet and dry cycles, however, we would still need to mitigate the effects of past land uses on the refuge and in the watershed that have permanently altered some ecological processes.

Considerable time would be required up front for us to assess current ecological functions, find key elements that should be restored, and evaluate potential restoration options that could be conducted given biological, economic, social, political, and legal constraints.

Our ability to restore surface and subsurface hydrology is the one factor most likely to influence restoration potential. First, to keep water rights to conserve natural resources, we would need some water control structures to remain on Quivira National Wildlife Refuge to divert Rattlesnake Creek water. Second, we cannot alter, or fully mitigate for, some infrastructure and actions known to change hydrologic processes, such as county roads that bisect important flow paths on the refuge and water uses by others that deplete ground water in the watershed. While these are major constraints, opportunities would still exist to improve ecological functions. For example, we could alter water amounts and movements to mimic natural, seasonal patterns of flooding, and we could remove or change dikes and trails on the refuge to restore hydrologic connectivity and sheet flow in certain refuge areas.

We would carry out this alternative in stages over many years, and changes in our research and monitoring programs, staff, operations, and infrastructure on the refuge would be required. Our success would be greatly influenced by our ability to develop new and expanded partnerships with stakeholders in the Rattlesnake Creek watershed.

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
GIS	geographic information system
GPLCC	Great Plains Landscape Conservation Cooperative
GPNC	Great Plains Nature Center
HGM	hydrogeomorphic method
Improvement Act	National Wildlife Refuge System Improvement Act of 1997
IPM	integrated pest management
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
PIF	Partners in Flight
PLJV	Playa Lakes Joint Venture

Region 6	Region 6 of the U.S. Fish and Wildlife Service
the refuge	Quivira National Wildlife Refuge
Refuge System	National Wildlife Refuge System
RONs	Refuge Operations Needs System
RRS	Refuge Revenue Sharing Act
Service	U.S. Fish and Wildlife Service
T and E	threatened and endangered
U.S.	United States
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
YCC	Youth Conservation Corps

A glossary of these and other terms follows chapter 6.

Chapter 1—Introduction



© Bob Gress

Black-necked Stilt

We, the U.S. Fish and Wildlife Service (Service or USFWS) 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 draft comprehensive conservation plan (CCP) and environmental assessment (EA).

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. Chapter 1 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 draft plan:

- Chapter 2 describes the refuge and planning issues.
- Chapter 3 sets out the alternatives for management of the refuge.
- Chapter 4 describes the physical, biological, and social environment that the alternatives would affect.
- Chapter 5 explains the expected consequences of carrying out each alternative.
- Chapter 6 describes objectives and strategies for the proposed action, alternative B, which compose the draft CCP.

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 draft 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. When completed, the CCP will serve as a working guide for management programs and activities 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.

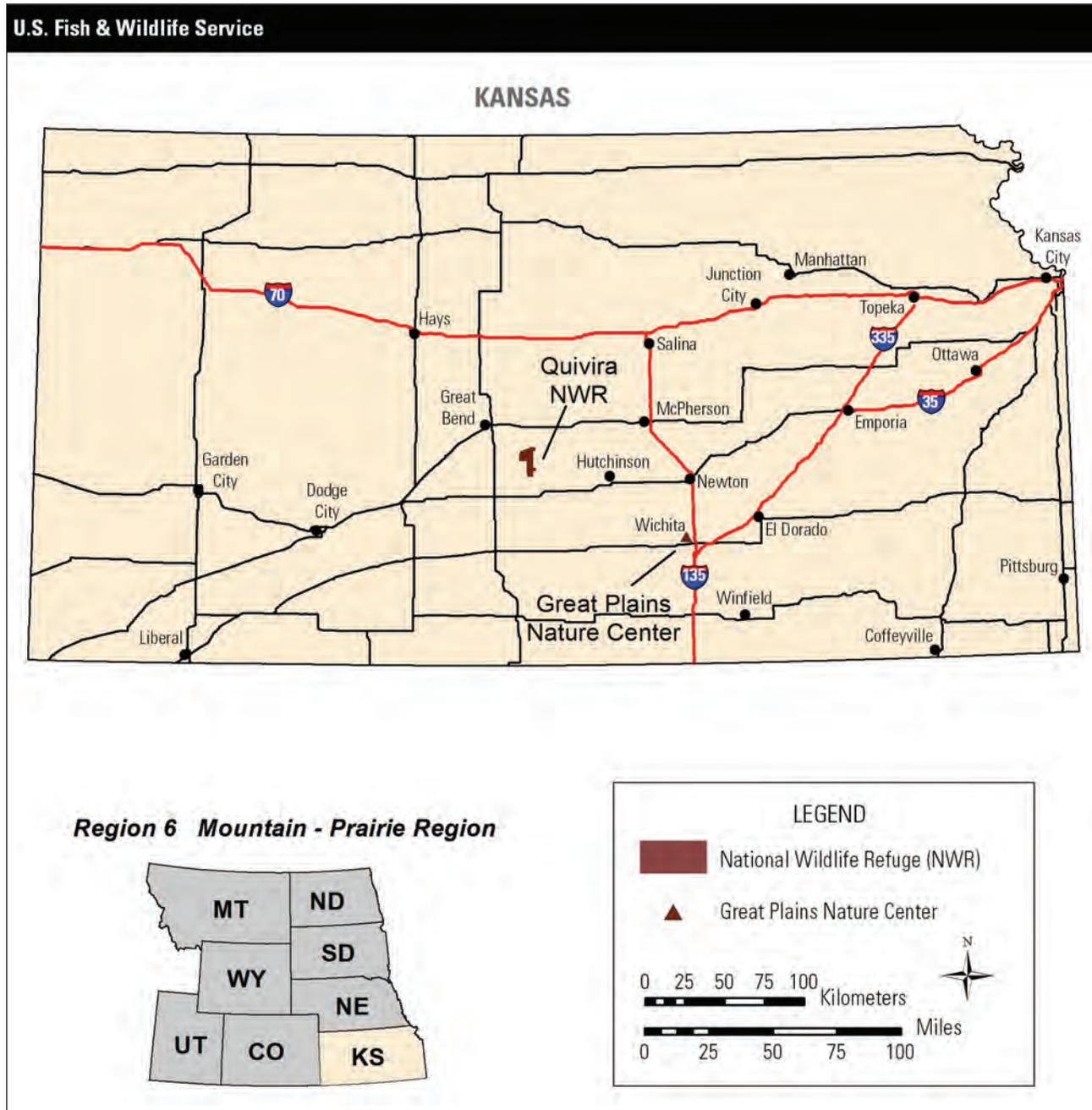


Figure 1. Quivira National Wildlife Refuge and Great Plains Nature Center, Kansas.

1.1 Purpose and Need for the Plan

The purpose of this draft CCP is to find 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;
- 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 Early History of Conservation

Wildlife conservation in North America is unique to the world. In recent years, it has come to be known as the North American Model of Wildlife Conservation (Geist et al. 2001). The wildlife conservation movement arose out of the conflict between market hunters and sport hunters in the mid-to-late 19th century. Market hunting increased in response to the growth in urban population fueled by the Industrial

Revolution. Between 1820 and 1860, the percentage of Americans who lived in cities rose from 5 to 20 percent; this four-fold increase is the greatest that has ever occurred in America (Reiss 1995). The demand for meat and hides—along with feathers for the millinery trade—led to exploitation of game animals by market hunters. Along with the increase in urban population came a new breed of hunter—one who hunted for the chase and the challenge it provided. These sport hunters valued live game animals, whereas market hunters valued dead animals they could bring to market. The growing legion of sport hunters started a national movement that encouraged Federal and State governments to regulate the take of wildlife.

The keystone concept of the North American Model of Wildlife Conservation that allowed the Government to control the take of wildlife is the Public Trust Doctrine (Geist and Organ 2004). Though based on an 1842 U.S. Supreme Court decision in the case, *Martin v. Waddell*, it derives from Greek and Roman law and the Magna Carta. Simply stated, wildlife belongs to no one; it is held in trust for all by the Government.

The early conservation movement in this country, championed by Theodore Roosevelt, George Bird Grinnell, and others, placed emphasis on stemming the decline of wildlife populations, and programs restricting take and protecting lands were put in place. During the 1920s, conservationists realized that more was needed, and a committee comprised of Aldo Leopold, A. Willis Robertson, and other leading conservationists of the time wrote the 1930 American Game Policy. This policy called for a restoration program for habitats and populations based on scientific research and supported with stable, equitable money. Within a decade, landmark legislation fulfilled many of the needs identified by this policy, including the Federal Duck Stamp Act to pay for land acquisition for national wildlife refuges. In addition, the Pittman–Robertson Wildlife Restoration Act shifted excise taxes imposed on firearms and ammunition to pay for wildlife restoration through cooperation between us and State fish and wildlife agencies. For States to use this money, they were required to pass laws that prevented the diversion of hunting license revenues to any purpose other than the administration of the State fish and wildlife agency.

In recent decades, wildlife management has emphasized overall wildlife diversity, and The Refuge System has evolved accordingly. Today it provides refuge for most species found in the United States.



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



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 USFWS, 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;
- keep 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 find 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.

The Public and the Refuge System

The Nation's fish and wildlife heritage contributes 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.

1.4 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.

A detailed description of these and other laws and Executive orders that may affect a CCP, or our carrying out of a CCP, is in Appendix A—Key Legislation and Policy. Our policies for planning and for the day-to-day management of refuges are in the Refuge System Manual and the “Fish and Wildlife Service Manual.”

1.5 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, The National Wildlife Refuge System” (Refuge System 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 looked to the recommendations in this document for guidance during CCP planning.

Partners in Flight North American Landbird Conservation Plan

The Partners in Flight (PIF) Program began in 1990 to address the declining population levels of many migratory bird species. This program is challenged with managing human population growth while keeping functional natural ecosystems. PIF worked to find 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 PIF 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 Mixed-grass 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 (USFWS 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.

United States 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.

Endangered Species Recovery Plans

The USFWS is 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 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 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.

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,



Barry Jones/USFWS

Windmill located in the Reno Unit of Quivira Refuge.

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

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 beyond applying an ecosystem approach to 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

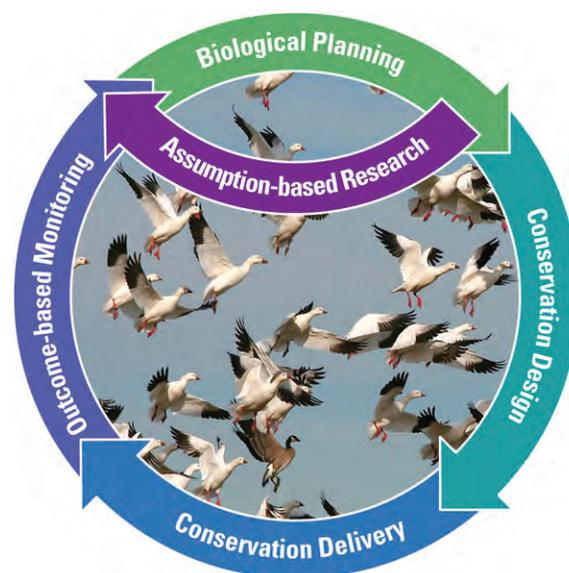


Figure 2. Basic strategic habitat conservation process.

habitat conservation, a new way of thinking and doing business that incorporates biological goals for focal species populations, makes strategic decisions about the work needed, and constantly reassesses (figure 2).

Strategic habitat conservation helps us to apply adaptive management across large landscapes. We used the framework of strategic habitat conservation to find the first generation of landscape conservation cooperatives. These cooperatives are partnerships between us and Federal agencies, States, tribes, non-governmental 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

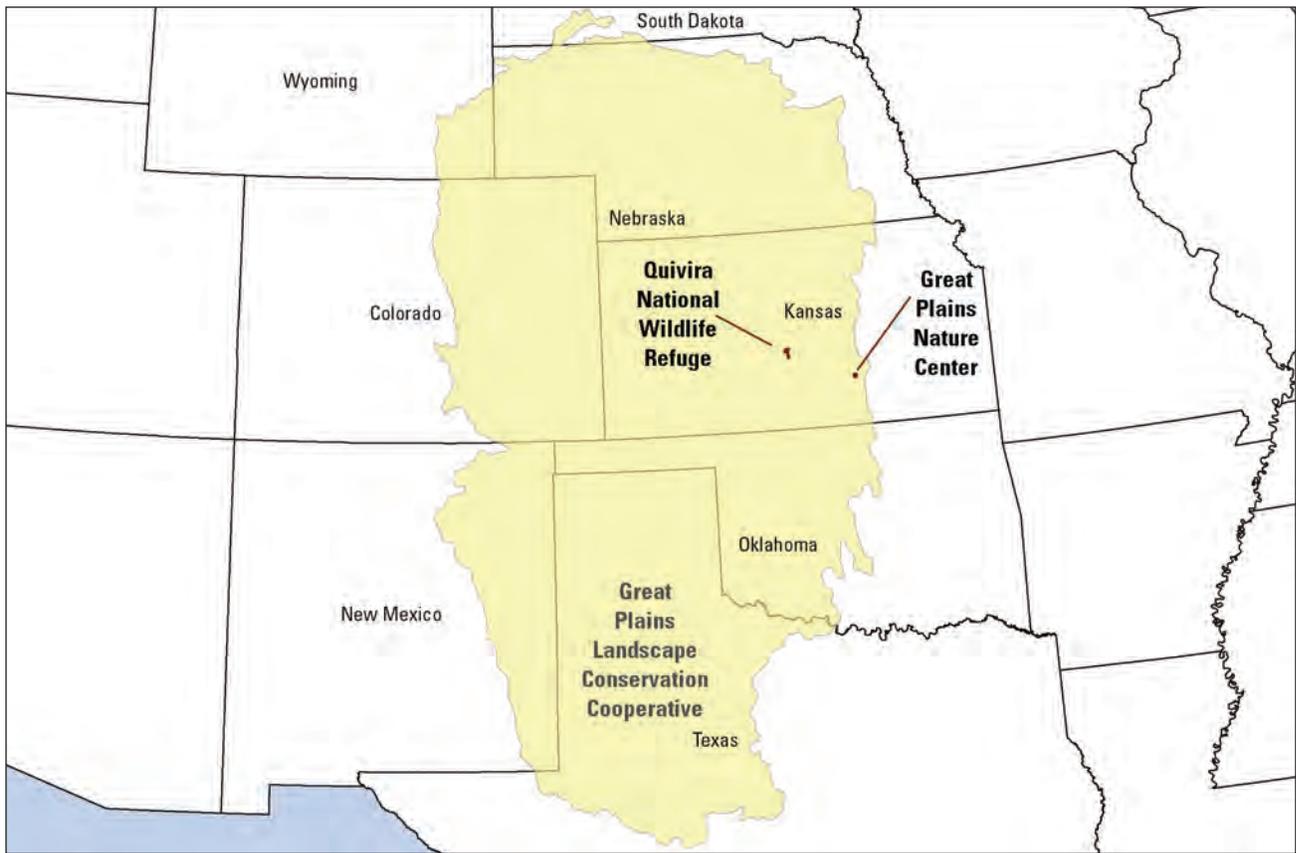


Figure 3. Great Plains Landscape Conservation Cooperative with Quivira National Wildlife Refuge, Kansas.

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.

1.8 Planning Process

The Improvement Act requires that we develop a CCP for Quivira Refuge. The final plan for the Qui-

vira Refuge should be completed in 2013 and will guide our refuge management for the next 15 years. We prepared this draft CCP and EA in compliance with the Improvement Act and part 602 (National Wildlife Refuge System Planning) of the "Fish and Wildlife Service Manual." The actions described in this draft CCP and EA meet the needs of the Council on Environmental Quality regulations that implement the National Environmental Policy Act of 1969



Long-billed Dowitcher



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

(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 EA development (figure 4).

We began in September 2009 by creating a planning team comprised primarily of our staff from the Quivira Refuge and our 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 B—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 the draft CCP and 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



Silky Prairie Clover

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

<i>Date</i>	<i>Event</i>	<i>Outcome or purpose</i>
<i>September 22–23, 2009</i>	<i>Preplanning meeting</i>	<i>Toured the refuge, formed into an initial planning team, started the mailing list, and discussed the planning schedule and data needs.</i>
<i>October 5, 2009</i>	<i>Work plan</i>	<i>Completed the work plan.</i>
<i>October 30, 2009</i>	<i>Planning team invitation letters mailed</i>	<i>Service Regional Director invited tribal nations and the KDWP to be on the planning team.</i>
<i>February 2010</i>	<i>Planning update</i>	<i>Mailed the first planning update to those on our mailing list. The update described the planning process and announced upcoming public scoping meetings.</i>
<i>February 24, 2010</i>	<i>Notice of intent</i>	<i>Published the notice of intent to prepare a CCP in the Federal Register (volume 75, number 36, pages 8394–8395).</i>
<i>March 8–10, 2010</i>	<i>Public scoping meetings</i>	<i>Held public meetings in Stafford, Great Bend, and Wichita, Kansas. The public had an opportunity to learn about the CCP process and provide comments.</i>
<i>March 9–10, 2010</i>	<i>CCP kickoff and vision and goals meeting</i>	<i>Reviewed the refuge purposes, identified refuge qualities and issues, and developed a draft vision statement and goals for the refuge.</i>
<i>March 22–23, 2011</i>	<i>Hydrogeomorphic method analysis project update</i>	<i>Reviewed the progress and findings of the hydrogeomorphic analysis project.</i>
<i>November 2–3, 2011</i>	<i>Alternatives development planning meeting</i>	<i>Discussed management alternatives.</i>
<i>March 13–14, 2012</i>	<i>Environmental consequences and choosing proposed action workshop</i>	<i>Reviewed the environmental consequences for the alternatives, and to select a proposed action alternative.</i>
<i>May 1–2, 2012</i>	<i>Objectives and strategies work session</i>	<i>Developed objectives and strategies for the proposed action alternative.</i>
<i>May–June 2012</i>	<i>Draft plan preparation</i>	<i>Prepared the draft CCP and EA.</i>
<i>November 2012</i>	<i>Draft plan internal review</i>	<i>Team and other Service staff reviewed the draft CCP and EA and provided comments to help clarify the analyses and provide consistency.</i>
<i>January–March 2013</i>	<i>Draft plan preparation</i>	<i>Completed the draft plan for public review.</i>

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, this draft CCP and EA to comply with the public involvement needs of NEPA. Table 1 lists the specific planning steps taken to date for this draft CCP and EA.

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. See “Appendix C—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 infor-

mation 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 (HGM) analysis project update session. The Osage Nation reviewed our 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 we received at scoping meetings and by correspondence to make a final list of issues to address in this draft CCP and EA. We developed alternatives that would best address issues. We also considered suggestions for changes to our current refuge management.

Selecting an Alternative

After the public has reviewed and commented on this draft CCP and EA, we will present this document along with a summary of substantive comments to our Regional Director for Region 6 of the Service. She will consider the environmental effects of each alternative along with the information we gathered from the public.

Our Regional Director will select a preferred alternative for management of the refuge. She will either disclose her decision in a finding of no significant impact that we will include in the final CCP or she may request added analysis. If approved, the actions in the preferred alternative will become the final CCP.

After we ready the final CCP for publication, a notice of availability will be published in the Federal Register, and we will mail copies of the final CCP or an accompanying summary to those on our mailing list. Subsequently, we will carry out the CCP with help from our partner agencies, organizations, and the public.

Chapter 2—The Refuge



Dan Severson/USFWS

Whooping Crane

The issues and a discussion of their effects on resources are summarized in this chapter. Our planning process seeks to resolve issues that have the greatest effect on refuge resources and programs, and it ranks these issues for further consideration over the life of the plan.

This chapter also discusses the establishment of Quivira Refuge and how its development guides our planning.

2.1 Establishment, Acquisition, and Management History

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.

After Quivira Refuge was established, 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).

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

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

Water Management History

In 1957 the Service 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 agricultural irrigation demands, insufficient water quantities are delivered to the refuge to exercise all habitat management options. Water leaving the refuge is not metered, largely because water rights are absent downstream where water enters the Arkansas River.

2.2 Purpose

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 National Wildlife 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

2.3 Special Values of the Refuge

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.

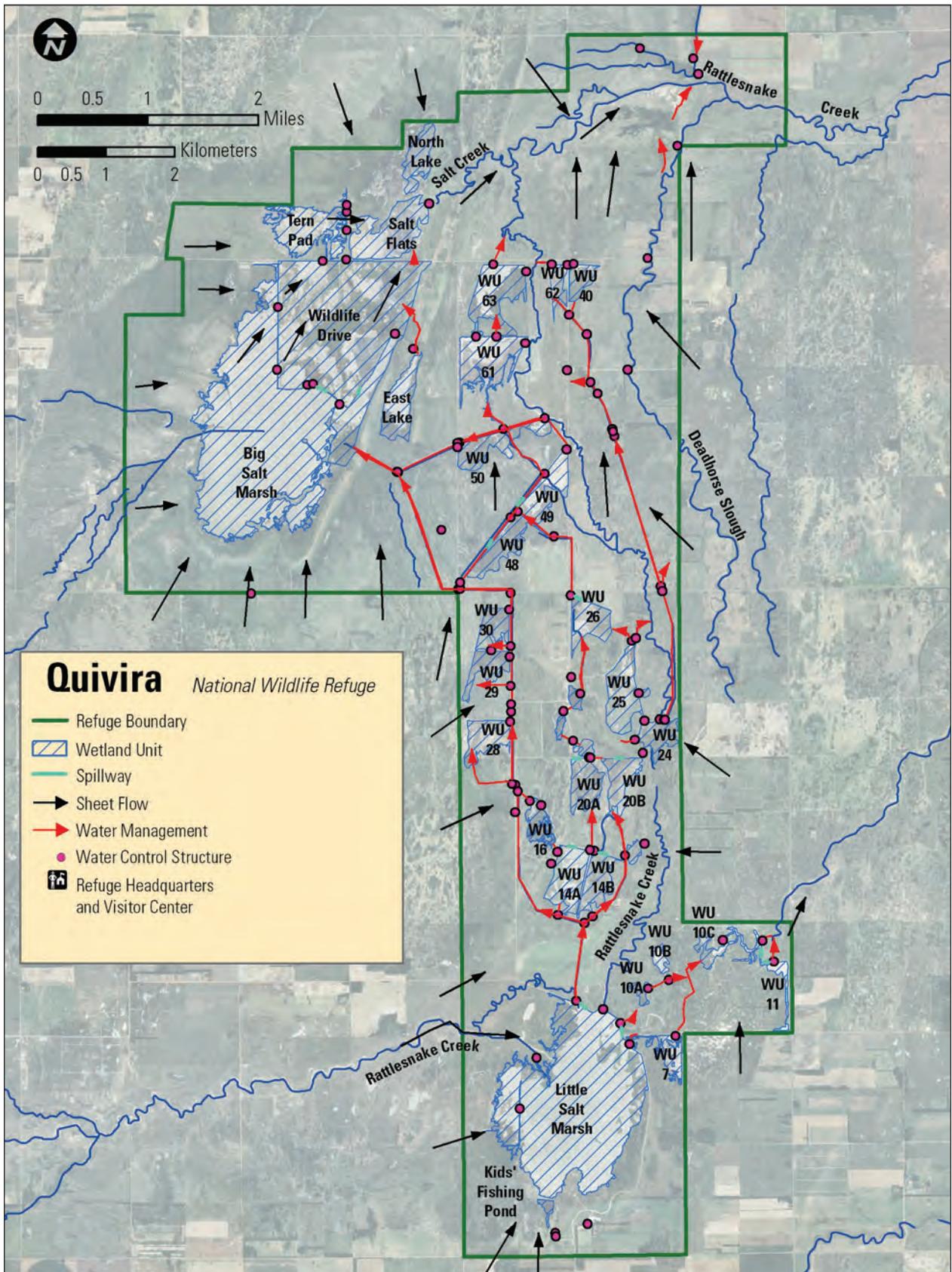


Figure 5. Water control structures, Quivira National Wildlife Refuge, Kansas.

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 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 co-manages the GPNC in Wichita, which complements and supports the purposes of the refuge.

Cultural Resources

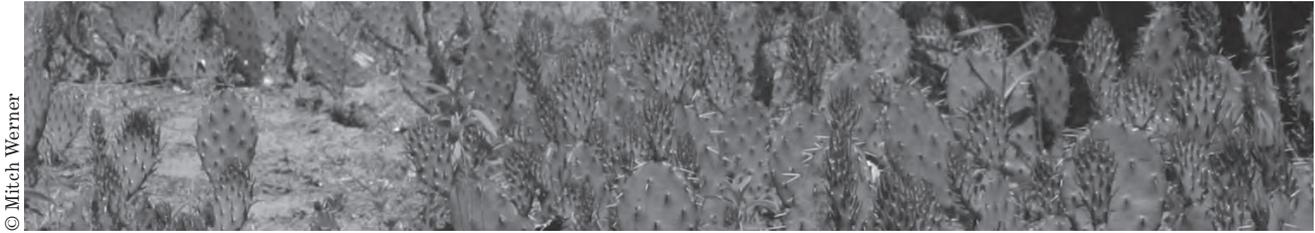
The area is rich in Native American history, as generations of people came here for both food and water. As such, the potential exists for cultural resources to be found on Quivira Refuge.

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.



© Mitch Werner

Prickly Pear

2.4 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.

2.5 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.

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

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 water table would also likely affect grassland and meadow habitats.



USFWS

White-tailed Deer

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.

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—Alternatives



© Bob Gress

Lesser Yellowlegs

This chapter describes the management alternatives considered for Quivira Refuge. Alternatives take different approaches toward sustaining native populations and the habitats on which they depend. They are designed to achieve the refuge’s purposes, vision, and goals; the mission of the Refuge System; and our overall mission. We developed alternatives to address the issues, concerns, and problems that we identified, with help from the public, during public scoping and throughout the development of this draft CCP.

3.1 Development of Alternatives for the Refuge

We assessed planning issues described in chapter 2, existing biological conditions described in chapter 4, and external relationships that affect the refuge. With this information, we formulated several alternatives, each, of which, broadly describes different

approaches for meeting the long-term goals listed in chapter 2. We then evaluated how well each alternative would achieve these goals.

Alternative A, the no-action alternative, captures our current intent and activities at Quivira Refuge. Because it did not originate in this planning process, alternative A may not meet all the goals of this CCP. It does, however, provide a baseline for comparing the other alternatives. Alternative B looks at managing for focal species and is our proposed-action alternative. There is more detail on our proposed action in chapter 6. No-action and proposed-action alternatives are both required by NEPA. Alternative C would restore the refuge closer to presettlement conditions but would also likely limit future management capability.

Table 4 in section 3.7 summarizes the actions that would be carried out under each alternative, as well as the potential consequence of those actions. Detailed information on consequences may also be found in chapter 5.

To help us in comparing alternatives, we created a map that shows the location of general habitat types on the refuge (figure 6).

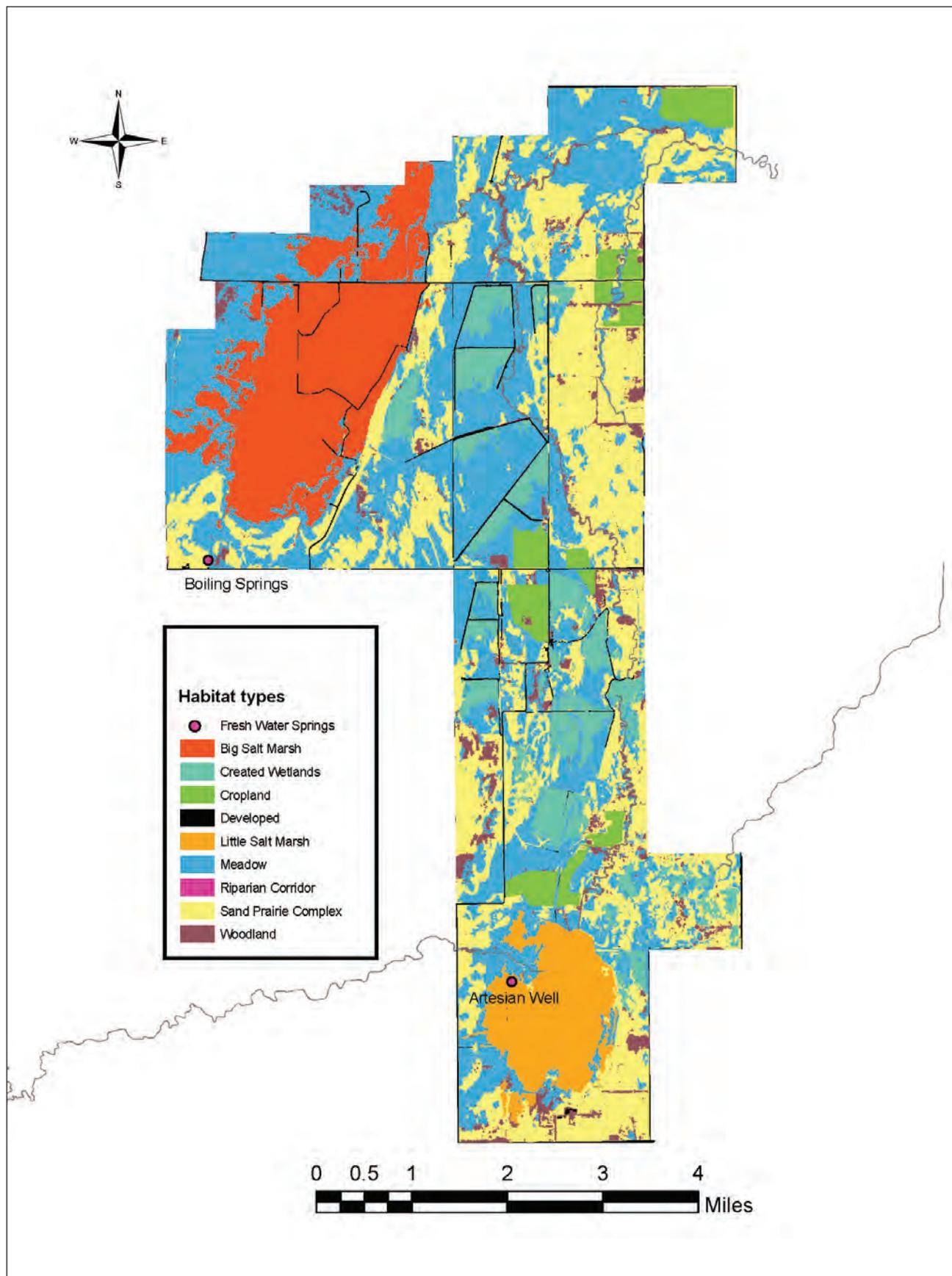


Figure 6. Habitat types, Quivira National Wildlife Refuge, Kansas.

We did not consider, and then drop, any alternatives from detailed study. Some management perspectives, however, such as the spatial extent of suitable shrub and tree coverage, were carefully considered and addressed outside of alternative development elsewhere in this draft CCP and EA.

Our three alternatives have some consistencies. The following key elements will be included in our management of Quivira Refuge regardless of the alternative selected:

- We will make sure that management of the refuge complies with all Federal laws and regulations that provide direction for managing units of the Refuge System.
- All wildfires will be managed in accordance with Federal Wildland Fire and Service policy. The initial action on a human-caused wildfire will be to suppress the fire at the lowest cost with the fewest negative consequences with respect to firefighter and public safety. Under alternative A, all wildfires would be managed with the intent to suppress. Under alternatives B and C, a naturally occurring wildfire may be concurrently managed for one or more refuge objectives. Further, objectives can change as the fire spreads across the landscape. Thus, under alternatives B and C, wildfire would be viewed as playing a more natural role in the environment. Prescribed fire may be used in all habitat types at any time of the year based on refuge objectives, and related to hazardous fuel reduction or habitat management.
- We will attempt to control invasive species through an integrated pest management (IPM) approach that uses biological, chemical, cultural, and mechanical treatment methods.
- We will allow use of various strategies, such as methods that involve rest, water level control, prescribed grazing, burning, mechanical, chemical, and cultural-related activities, to appropriately accomplish refuge goals and alternatives.
- We will protect and manage all cultural resources.
- We will support our own research efforts and those of others to help achieve management objectives.
- As needed, we will observe for, and respond to, signs of wildlife diseases such as cholera, chronic wasting disease, avian influenza, and botulism.
- We will promote strong and diverse partnerships to help meet the objectives and goals of the refuge.
- We will maintain current water rights throughout the refuge.
- Our approach to climate change adaptation in the next 15 years would be similar for all alternatives, however there are resulting differences in management capacity (constraints) and ecosystem resiliency (adaptability) potential as reported throughout the document under various goals and topic headings. Many of our actions address key findings of climate change adaptations listed by Staudinger et al. (2012). At some level, all alternatives would promote sustainability of ecosystems, biodiversity of organisms, and wildlife-dependent ecosystem services. None of the alternatives would manage to stabilize natural conditions, instead, all manage system transitions and promote strategies that closer mimic or support natural processes. All alternatives would reduce or alleviate environmental stressors or vulnerabilities, such as grassland fragmentation and the effects of invasive species, which may be magnified with climate change. All alternatives would carry out an adaptive management process that involves the experimentation and modification of management actions and monitoring to increase success in achieving goals and objectives. For example, timing of management actions may require adjustments for success with changing climate conditions. Regardless of the alternative, there remains

uncertainty in the effects of climate change, such as how system variability and vulnerability will change and affect land use and environmental regulations at landscape scales that collectively influence refuge management planning. For example, we are uncertain of how water use and rights issues within the watershed and western Kansas aquifers will be affected with climate change and what the consequences will be for refuge resources and management (for example, Rosenberg 2010, Schlager and Heikkila 2011). Over the time of this plan, knowledge will be gained of anticipated future changes that inform management strategies and decisionmaking.

3.4 Alternative A (Current Management—No Action)

Alternative A is the no-action alternative, which represents the current management of Quivira Refuge. This alternative provides the baseline against which to compare the other alternatives. It also fulfills a need of NEPA. Under alternative A, our management activity would continue unchanged. We would not develop any new management, restoration, or education programs at the refuge. Current habitat and wildlife practices benefiting migratory species and other wildlife would not be expanded or changed. Habitat management would remain focused primarily on benefiting migratory birds. Our staff would keep monitoring, inventory, and research activities at current levels. Budget and staff levels would remain the same with little change in overall trends. Programs would follow the same direction, emphasis, and intensity as they do now.

Landscape Conservation Actions

This section includes actions for climate change and land protection under alternative A.

Climate Change

We would manage habitats to promote resilience through the conservation of native communities. Baseline checking of habitat conditions that might show the effects of climate change would continue. We would support an existing weather station, and monitoring of plant and wildlife community factors

would occur as part of planning and to support certain larger landscape efforts (for example, midwinter waterfowl survey). Management would reduce current environmental stressors, such as grassland fragmentation and the spread of invasive species. Otherwise, our staff would continue to mostly rely on our partners such as the USGS, GPLCC, and the Service Climate Change Team, for climate change-related information, research, monitoring programs, and modeling.

We would attempt to reduce the carbon footprint of our existing facilities. We completed a major project to reduce the carbon footprint in June 2011 through the American Recovery and Reinvestment Act. During that project, we installed a ground source HVAC and photovoltaic system panels (28 kilowatts) at the headquarters building. Activities in the near future would likely include modest improvements to facilities, including weather proofing and upgrading furnaces, doors, and windows. Our increased use of webinars and other virtual meeting devices would decrease that part of our carbon footprint related to travel.

Land Protection

These actions involve a variety of issues and programs.

Refuge Boundary

We have already acquired all lands within the refuge boundary. No expansion of the current refuge boundary is planned.

Private Lands Programs

Our staff would continue to promote cooperative work between landowners, the Natural Resources Conservation Service of the U.S. Department of Agriculture (NRCS), KDWPT, and our other partners on various types of land protection and management easements or agreements throughout Kansas.

Oil and Gas Activities

We own most mineral rights within the fee-title boundary of Quivira Refuge. Mineral rights would be reclaimed, as allowed, when mineral rights are abandoned.

Emerging Conservation Issues

Our staff would continue to seek information and support communications about current and potential future conservation issues affecting the refuge, while periodically assessing the role of the refuge at different landscape scales. For example, Ecological Services has been given responsibility for leading USFWS activities related to wind and energy development, including those potentially influencing the



Rachel Laubhan/USFWS

Insects flourish in the habitat surrounding the Big Salt Marsh on Quivira Refuge.

whooping crane, but we need to understand USFWS positions and related factors.

Native Ecological Community Conservation Actions

This section includes actions for a variety of habitats and activities under alternative A.

Big Salt Marsh

The hydrology of the BSM would be allowed to fluctuate with natural climate variations, and use of Rattlesnake Creek water would be limited. As a result, dynamic fluctuations in water quantity and quality would occur within, and among, years. In most years, surface water would be allowed to evaporate in late summer, and ground water discharge would 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 would have water during the spring, and then slowly begin drying in late spring and continue drying through the summer.

This management would contribute to restoring characteristics of a natural saltmarsh, including higher salinities over time and habitat dominated by a mosaic of open salt flat and saltgrass that are attractive to many nesting shorebirds. Occasionally, water from Rattlesnake Creek would be diverted into the BSM partly to allow proper management of units 57 and 58 and some canal waters, and for flood control. Also, with a declining water table and other future uncertainties of water availability in the watershed because of circumstances largely outside of our control, it is possible that managing the hydrology of the BSM may become more reliant on Rattlesnake Creek water in the future. Therefore, while the intent of this alternative is to decrease use of Rattlesnake Creek water, the ability to periodically use this water source remains important.

Prescriptive fire and grazing would be used to support and restore native vegetation communities. Herbicides would be used to remove invasive plants and prevent new infestations that often result with dynamic seasonal water level fluctuations. Chemical and mechanical treatments would be used to increase the extent of mudflat habitat primarily for use by foraging waterbirds in spring, summer, and fall. Existing roads, dikes, and water control structures would remain.

Little Salt Marsh

The LSM would continue to be used to serve the dual roles of providing waterbird habitat at strategic times within, and among, years as well as to store water from Rattlesnake Creek to facilitate management of other refuge wetlands. In general, the marsh would be drawn down in spring to provide mudflats and shallow water for spring migrants and to moderate the potential adverse effects of periodic high flows in April through June. The marsh would then be allowed to refill during summer so that water could be transported to other areas of the refuge, typically beginning in late August, to provide habitat for fall bird migration. Use of water from the LSM in the fall also helps achieve desired water levels in the marsh, which creates added habitat for fall waterbird migration.

Riparian Corridor

Rattlesnake Creek, Salt Creek, and Dead Horse Slough provide most of the riparian habitat on the refuge. We manage Rattlesnake Creek primarily for water transport, with recognition that ancillary benefits are provided to many native plants and wildlife

species. Water is diverted out of Rattlesnake Creek in various locations under the current water right (figure 5). Our staff would continue to work with the Rattlesnake Creek Partnership and pursue other avenues to protect the annual water right of the refuge. Invasive saltcedar dominates exposed soils next to watercourses and limited chemical, fire, and mowing are used to control it. We also control other invasive species, and other management strategies are used to maintain habitat within the riparian corridor, such as with use of grazing and mechanical treatments.

Created Wetlands

We manage created wetlands as seasonally flooded, or moist-soil, wetlands with hydrologic regimes that vary in flooding depth, coverage, timing, and duration within, and among, years. These habitats would be at least partially flooded sometime between September and April most years and would be generally allowed to dry during the growing season to promote plant germination and growth. Periodic irrigation may be required to maintain growth and promote the availability of food and cover resources as conditions become dry over the growing season. Our staff would continue to use management

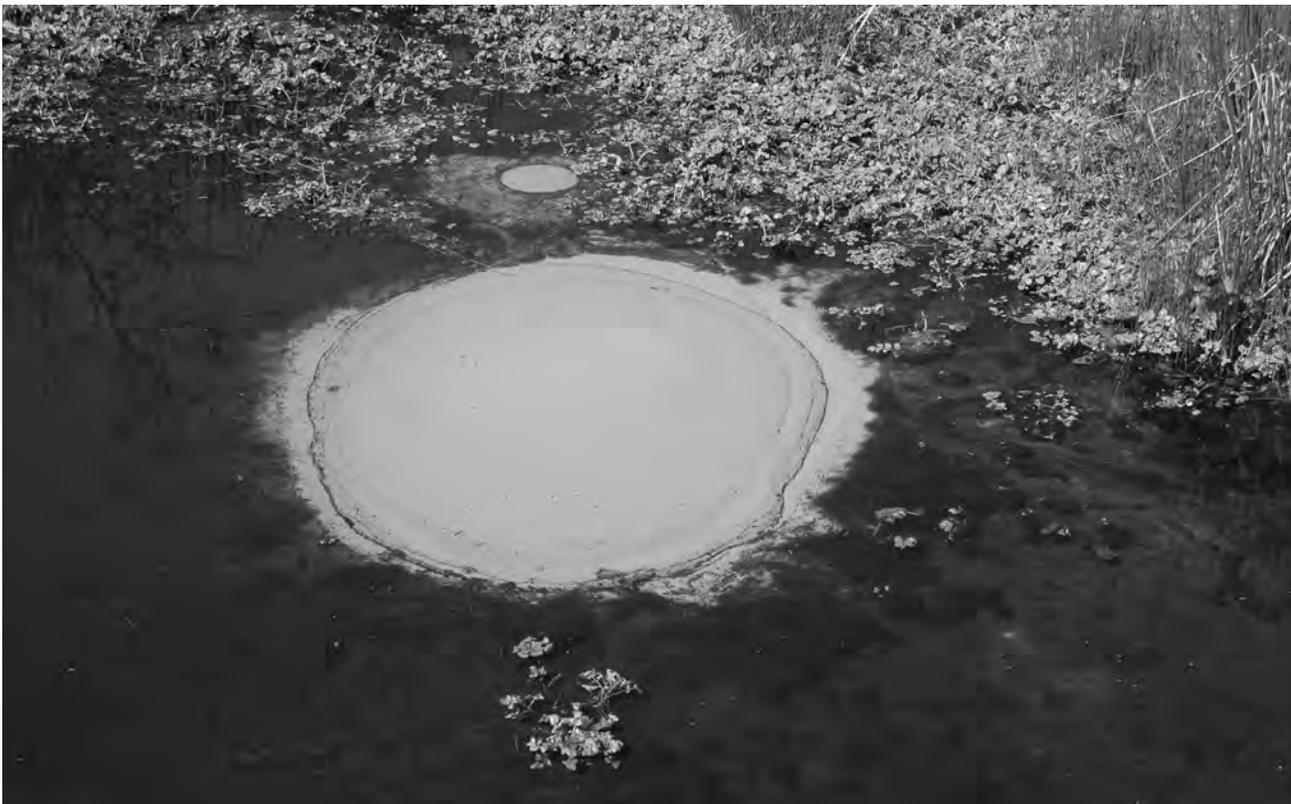
tools such as grazing, prescribed fire, mechanical and chemical treatments and water manipulation to accomplish objectives, with a primary focus on foraging habitat for migratory birds and, to a lesser extent, nesting habitat. Our staff would aggressively control wetland invasive plants, such as Phragmites and saltcedar, to decrease spread.

Freshwater Springs

Freshwater springs are an essential resource on the refuge, and we would manage them to sustain current functions and values, including protecting current population of State-threatened Arkansas darters in an area south of the BSM. This area is traditionally known as Boiling Springs because ground water bubbles up to the surface as though it were hot.

We would continue to use fencing to exclude grazing from the artesian well site and to remain extra careful in spot spraying chemicals to control invasive species in the area. We would allow fire as part of prescriptions applied at larger spatial scales while considering the needs of meadow and sand prairie habitat next to springs.

At the Boiling Springs, an existing pipe and pump from an oil well that was removed before would remain. Our staff would continue to check water



Barry Jones/USFWS

Boiling Springs

quality of the Boiling Springs, but further evaluation of current habitat and fish community relations is needed to help in making future decisions about the management of the springs.

Meadow

Characteristics of ground and surface water are main drivers of meadow community composition and structure that are influenced by climate, watershed land use, and habitat conditions at various scales. We apply limited direct, or intentional, management to influence the structural conditions and functions of many meadows on the Quivira Refuge. However, the Marsh Road Meadow is actively managed through haying and prescribed fire to provide habitat for rails, cranes, and bobolinks.

Our staff would continue to improve the health and productivity of the Marsh Road Meadow by conducting actions to periodically reduce litter buildup to increase nutrient cycling and the temporal and spatial diversity of vegetation structure and composition. Most prescriptions involve fire, mechanical, and grazing treatments to decrease the invasion of woody vegetation, or to prevent the conversion of herbaceous meadow habitat to wooded habitat, and to manage a proper balance of vegetation structure and cover that supports the annual life needs of various species. Chemical may also be used to control invasive species such as Phragmites or saltcedar that cannot be controlled effectively using only other means.

Woodland

When evaluating alternatives, woodland habitat generally refers to shelterbelts and larger tree, or land claim, plantings, but excludes small clumps, or scattered, trees and shrubs in other habitats. Our staff would continue to reduce and control invasive woody vegetation, primarily in areas where trees are encroaching into open prairie and wetland habitat. Tree rows and groves of both native trees, like cottonwood, and nonnative trees that were planted or have invaded prairie and wet meadow communities would continue to be removed, and lands would be restored to the proper native community type. Our staff would continue to evaluate potential management trade-offs related to certain woodlands that provide essential benefits to select species, and may subsequently decide to conserve some limited woodland areas that do not jeopardize the grassland size needs of focal species. Similarly, planted tree rows on, or near, refuge boundaries that have a minimal effect on native prairie or wetlands would be a lower priority for removal.

Sand Prairie Complex

When evaluating alternatives, the sand prairie complex includes scattered woody vegetation and relatively small, temporal-seasonal wetlands without water control structures that are parts of a larger grassland area defined in figure 6. We would continue to manage the sand prairie complex to support native plant communities characteristic of the associated soil types, thereby keeping a high level of habitat diversity in terms of both structure and composition that would be closer to presettlement conditions, as described in chapter 4. Thus, with respect to woody vegetation, we would continue to promote small, scattered native shrub stands that are mostly plum at various seral stages. Overall, an open sand prairie community would be conserved through the periodic use of fire, grazing, mechanical, and chemical treatments.

Cropland

We would manage current cropland through cooperative farming agreements with local farmers to produce annual seed cover crops. However, as cooperators voluntarily withdraw from farming (current rate of approximately 40–80 acres annually), our staff would continue to convert these lands to reconstructed native communities comprised of native grasses and forbs proper for the associated soil type. Following initial seeding, we would actively manage reconstructed native communities with mechanical methods, fire, grazing, and herbicides to encourage the establishment and maintenance of native species. We expect that all cropland would be reconstructed to some level within the next 15 years, however, achieving conditions similar to those characteristic of native communities might take decades longer.

Migratory Birds

We would continue to focus on migratory birds and primarily on wetland management to provide migration, resting, and nesting habitat for a diversity of waterbirds, especially waterfowl, cranes, shorebirds, and rails. We would continue to manage upland habitats for the migratory and nesting needs of native wildlife communities characteristic of open sand prairie. However, as shown above, some limited woody habitat would be kept to help various wildlife species, including herons for their rookeries, bald eagles for their nesting and roosting, and some other species of conservation concern for their nesting and migration. Our staff would continue to conduct annual population counts, or landscape-level checking, of migratory birds, including the Christmas and

midwinter waterfowl, shorebird, sandhill crane, whooping crane, bald eagle, and interior least tern bird surveys. We would continue with other measures to support migratory birds, including the implementation of seasonal or area closures to decrease disturbance to nesting bald eagles, interior least terns, and whooping cranes.

Fish

We would conserve native fish communities where possible, paying particular attention to the Arkansas darter, plains killifish, and other native fish of concern in areas of the BSM, riparian corridor, and freshwater springs. Carp are present throughout the Rattlesnake Creek basin, and control is an ongoing challenge. Our staff would continue to control carp and other undesirable fish, primarily through the periodic drying of wetlands. On rare occasions when drying is extremely difficult or impossible, but water levels are low, such as is common with the Kid's Fishing Pond, a limited use of chemical is allowed. Fish stocking of the Kid's Fishing Pond would continue for recreational and educational purposes. Our staff would avoid stocking, and introducing conditions favorable to, nonnative fish.

Threatened and Endangered Species and Species of Concern

We would continue to manage habitats in support of Federal and State threatened and endangered species, Federal candidate species, and State Species in Need of Conservation, especially those species with designated critical habitat on Quivira Refuge lands and those that most commonly depend on refuge resources. For several species, we provide favorable habitat without specifically focusing on those particular species, such as with mudflat–shallow water habitat used by migrating piping plovers that are rarely observed at Quivira Refuge during migration.

Our staff would continue to support applicable threatened and endangered species recovery plans. Nesting interior least tern and western snowy plover use similar areas on the refuge and our management of habitats to support both species would continue. Similarly, we would continue to promote roosting and foraging habitat for whooping cranes. Monitoring programs for these species when they live on the refuge would continue, and activities would be controlled to protect quality conditions for these birds, such as reducing disturbance. As required, our staff would consult with our, and KDWP's, endangered species staff before conducting management actions that may affect listed species. Area closures would

continue to be imposed to protect federally listed species using the refuge.

In general, our practices conducted on Quivira Refuge result in habitat conditions that should be suitable for most of the State Species in Need of Conservation that occur in Stafford County, though several are not known to regularly use the area. In particular, we would continue to manage meadows around the BSM in a way that promotes use by black rail and bobolink, including our periodic use of prescribed fire and haying to manage the composition and structure of vegetation and promote nutrient cycling. Treatments would not occur in meadows during the main nesting period for these species without evaluation and by following existing policy.

Wildlife Native to the Region

We would conserve wildlife native to this region of the Great Plains by supporting native habitat communities, both resident and migratory. We would continue proper uses of fire, grazing, mechanical methods, rest, and invasive species control to provide more favorable habitat for native species, including some like the greater and lesser prairie-chicken and the long-billed curlew, that historically used the refuge or its vicinity more extensively in the past.

Wildlife Health

We would manage habitat for conditions that decrease adverse health conditions for wildlife. Monitoring for contaminant levels would occur periodically to make sure that conditions are within a normal range for the ecosystem, and we would regularly watch for signs of disease outbreaks. Our staff would continue working with those who are conducting formal surveillance monitoring programs for avian influenza and chronic wasting disease. We would cooperate with regional and national monitoring programs to respond to new wildlife disease threats. We would not, however, allow the trapping of nuisance animals.

Inventory, Monitoring, and Research

We would continue wildlife and habitat inventory, monitoring, and research efforts in the short term, but our staff would periodically evaluate and appropriately revise these efforts, while making sure that refuge goals and objectives are being addressed. We would gather, review, and synthesize information relevant to biology and management of refuge lands for use in planning and decisionmaking. This would include ongoing inventory of refuge biological resources, development of a vegetation cover map, and new protocols to improve the checking of water

quantity and quality, nesting interior least terns, and vegetation conditions. Annual and periodic surveillance and survey types conducted in recent years include: shorebird, midwinter waterfowl, marshbird, midwinter eagle, spring and fall whooping crane, spring sandhill crane, interior least tern and snowy plover, refuge breeding bird, Christmas bird, deer, Monarch butterfly (tagging), Emerald ash borer, invasive plant species, and water quality.

Cooperative research with other agencies and educational institutions would continue to expand knowledge of refuge biological resources and to inform refuge management. We would allow research activities that are compatible with refuge goals and objectives; involve good communication with our refuge staff; provide information related to refuge resources and management; and address a current or future conservation or societal issue, such as human and wildlife health.

Visitor Services Actions

Recreational uses help visitors focus on wildlife and other natural resources, and provide opportunities to become aware of resource issues, management plans, and how the refuge contributes to the Refuge System mission.

We encourage national wildlife refuges to provide wildlife-dependent recreation where feasible and compatible with the purposes of refuges. This is defined as a compatible use of a Refuge System unit involving hunting, fishing, wildlife observation and photography, environmental education and interpretation. Other activities may be allowed to facilitate compatible wildlife-dependent recreation.

Hunting

Hunting programs on the refuge would not change. No new areas, expansions of season, and no new species would be open to hunting. Only approved, nontoxic shot would be used or possessed while hunting upland gamebirds and migratory gamebirds on the refuge. We would limit the area open to migratory bird hunting to no more than 40 percent of available habitat (code of law: 16 USC 668dd(d)(1)(A)). These restrictions make sure that some habitat without direct disturbance from hunting is available to migrating waterfowl. No hunting would be allowed when whooping cranes are present on the refuge. We would make an accessible waterfowl hunting blind available by reservation. We would continue to prohibit commercial outfitting.

Fishing

We would generally allow fishing on all waters according to State-established seasons and regulations. Year-round use of the Kid's Fishing Pond would be permitted with a one-fish limit for children age 14 and under and for adults with an eligible child who is also fishing, unless otherwise posted for management or safety reasons.

We would not allow bait collecting or the use of live fish bait, except for night crawlers.

We would not allow frogging and the hunting of turtles or other reptiles and amphibians.

Wildlife Observation and Photography

Observation blinds, elevated viewing platforms, an up-to-date bird species list, and portable viewing and photography blinds all support wildlife observation and photography on the refuge. We would support seasonal closures to protect sensitive wildlife areas and reduce disturbance to fish and wildlife. We would expand by working directly with the "Wetlands and Wildlife Scenic Byway" committee to increase public awareness, and provide increased opportunities. Bicycling, horseback riding—on established roads only—and dog walking (under owner's control) would be allowed.

We would evaluate commercial photography requests, and requests from commercial led birding tours on a case-by-case basis and authorize through special use permits.

Environmental Education and Interpretation

Quivira Refuge and the GPNC would continue to have interactive and static displays about area flora, fauna, ecology, and history. We would keep two areas of marked pedestrian trails at the refuge: Migrants Mile and the LSM and Headquarters area.

We would provide curriculum-based programs for all school grade levels to help in meeting State educational standards. Onsite and offsite programs would continue at the GPNC that focus on "at risk" youth and other underserved audiences. Interpretive programs would be provided at Quivira Refuge and the GPNC on a variety of refuge management and wildlife-oriented subjects, both by request and as scheduled activities.

Our staff would continue to promote use of the GPNC's classrooms and Quivira Refuge's environmental education classroom for appropriate school and other environmental education programs, as well as for public interpretive programs and workshops.

Other Uses

All areas would remain open on the refuge unless otherwise closed for management or safety reasons, such as when terns or bald eagles are nesting.

Allowable Uses

Would include firewood cutting and dog training by individuals outside of the nesting season.

Requested and Proposed Uses

Other requested and proposed uses would be evaluated, with necessary approval, for appropriateness and compatibility with the purposes of the refuge in accordance with our policies, see appendix D.

Prohibited Uses

Uses that are specifically prohibited on the refuge include: amphibian, crayfish and reptile collecting; antler collecting; berry, fruit, roots, and mushroom harvesting; wildflower collecting; geocaching; commercial photography; boating; camping; recreational trapping; dog field trials; unauthorized vehicle use on roads and trails; off-road vehicle use; and commercial guiding for hunting.

Public Outreach Actions

We would provide onsite and offsite outreach programs to local civic and environmental organizations and emphasize refuge management issues, endangered species, and other pertinent subjects. Our staff would recruit, train, and use volunteers locally to help achieve management and public use goals.

Our staff would continue to work with Friends of Quivira Refuge and Friends of the GPNC to promote public awareness and outreach of the Service and the refuge. We would contribute articles to the quarterly Friends newsletters to update readers on refuge and GPNC management and activities.

We would hold special events several times annually to promote Quivira Refuge, the GPNC, and their respective missions, activities, and goals. We would continue to develop and staff our information booth at the Kansas State Fair.

We would keep and update the Quivira Refuge Web site to reflect refuge operations, hunting information, events, and wildlife sightings.

Cultural Resources Actions

No known cultural sites exist on the refuge. Our regional archeologist recently inspected referenced

areas of interest in the Santana Research Natural Area at least twice and found that these areas were not designated archeological or historic sites. We would protect found cultural resources in accordance with Federal and State laws, policies, and guidelines. Our staff consults with the regional archeologist during the planning phase of proposed projects to decide on the need for an archeological site clearance from the Kansas State Historic Preservation Office before substantial dirt or surface alteration.

Visitor and Employee Safety and Resource Protection Actions

This section includes actions for visitor and employee safety and resource protection under alternative A.

Visitor and Employee Safety

Station safety plans would be kept current and provide emergency contacts, safe operating procedures, and up-to-date training for all employees. Annual review of the station safety plan would be conducted and the plan would be available to all employees, contractors, and visitors, on request. All public use facilities at the refuge and GPNC would be made safe and accessible to everyone. The refuge bridges, trails, roads, and parking lots would be kept to provide safe access and travel. The refuge would keep directional, regulatory, and safety signs along routes of travel.

Emergency shelters would be provided at the refuge and GPNC for employees and visitors.

Security cameras would be used to provide more security for the employees and visitors at the Quivira Refuge headquarters.

The refuge would keep up-to-date Memorandum of Understandings for mutual aid and emergency response with Stafford, Reno, and Rice counties to provide added enforcement for emergencies, disasters, and public safety on and off refuge. The Service-owned GPNC would continue to rely on law enforcement and fire protection provided by the City of Wichita Police Department and security provided by Protection One or a similar contracted alarm system company. Refuge and GPNC fire extinguishers and Automated External Defibrillators would continue to be inspected monthly, with annual professional inspections being conducted. Annual fire drills, annual tornado drills, quarterly safety meetings, and frequent safety briefings for the employees would be conducted. The refuge and GPNC would continue to keep all safety plans current.

The refuge would watch for signs of diseases that could potentially influence the health and safety of visitors and employees such as West Nile virus and avian influenza. The refuge would follow the Region 6 mosquito control plan and pandemic influenza plan. Quarterly water testing for coliforms, nitrates, nitrites and annual testing of lead and copper would continue to be conducted for drinking water at the headquarters and visitor center, the environmental education center, the residences, and bunkhouses.

Job hazard analysis would be kept up to date for hazardous operations performed by employees and proper training provided. The refuge would continue to employ a designated collateral duty safety officer that would oversee the safety operations at the refuge and the GPNC. Annual safety inspections by the collateral duty safety officer and tri-annual inspections by the regional safety office would be conducted at the refuge and the GPNC. Public events and associated activities would continue to be conducted with safety as a high priority.

Resource Protection

The entire refuge would be open to foot travel, unless otherwise posted as closed for critical nesting habitat, presence of whooping cranes, or for any other reason. The refuge would keep the employment of two commissioned, dual-function officers that would provide approximately 25–49 percent of their time conducting law enforcement activities. The focus would be on compliance checks for hunters and anglers on and in proximity to the refuge, keeping regulatory signage, and enforcement of the refuge hunting closure on the entire refuge when whooping cranes are present on the refuge.

Law enforcement would enforce the refuge-specific closures. Refuge officers would also check and enforce the compliance of special use permits and activities. Law enforcement and the refuge's visitor services staff would work together to inform the media and the public of regulation changes.

Administration Actions

This section includes actions for staff and budget and facilities and infrastructure under alternative A.

Staff and Budget

Staff and budget actions include those at both Quivira Refuge and the GPNC.

Quivira Refuge

Our budget at the refuge is adequate to support current staff and facilities. A list of permanent and temporary staff, as well as recommended staff increases, can be found in section 4.9 Administration and in table 17. We also hire one-to-five seasonal biological aids and technicians and range technicians each year as our budget allows. We also use the Youth Conservation Corps (YCC) program, generally with three enrollees annually for 8 weeks. Quivira Refuge also provides office space for a regional refuge zone biologist and a Partners lands biologist.

Great Plains Nature Center

We would continue to support the GPNC through its partnership with the City of Wichita Department of Park and Recreation and the KDWP. Our staff level at the GPNC would remain the same.

Present Limitations and Future Potential

Our capacity for active management at the refuge is constrained by limited staff and budgeting. Our current staff levels are insufficient to meet program mandates, which would result in limited management on some units. More staff would be needed to meet the minimum staff needs as identified in the Refuge Operating Needs System (RONS) database and in a separate law enforcement needs list. The top priority in RONS for Quivira Refuge is to add one permanent, full-time maintenance worker. The regional law enforcement staff plan identified adding one permanent full-time refuge officer. We would seek money through grants and initiatives to supplement staff and projects at the refuge.



The Great Plains Nature Center draws an ever-increasing visitation from the city of Wichita and beyond.

Facilities and Infrastructure

We would keep facilities, infrastructure, vehicles, and other equipment in good working condition and use annual and deferred maintenance money to achieve our goals. We would not, however, allow the trapping of nuisance animals.

We have 25 miles of canals, 24 miles of dikes and 103 water control structures on the refuge that are used for water delivery and wetland management. We would continue to support more than 14 miles of roads and 33 parking lots for public use and 27 miles of roads for our management purposes. We would also keep more than 97 miles of barbwire fence and 54 miles of electric fence for the grazing program.

Our buildings on the refuge include an office, a visitor center, a maintenance shop, three storage buildings, one pole barn, an environmental education classroom, two residences, two bunkhouses and two vault toilets.

The GPNC has a large visitor center building with classrooms, offices, and an auditorium; a separate storage garage; and a fenced compound.

The RONS database identifies a deferred maintenance projects list, which is a potential source of more money.



We would 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 would increase our attention and understanding of the connectedness of habitats and the effectiveness of our management. To achieve this alternative, relatively minor changes in our operations; inventory, monitoring programs, and research; staff; and infrastructure would likely be required.

Focal Species or Resources

National wildlife refuges are managed for “wildlife first,” however, Quivira Refuge is isolated within a fragmented watershed with disrupted processes. It is too small to successfully meet the life cycle needs of all native wildlife that historically occurred on these refuge lands yearly. Therefore, we manage habitat conditions to optimize productivity and sus-

tainability, which requires dynamic fluctuations in hydrology and periodic disturbance.

Our approach ultimately helps a greater diversity of native wildlife over the long term, as habitat conditions are in a constant state of flux.

To make sure that critical habitat resources are provided to as many species as possible, our planning team developed a list of priority management species termed “focal species or resources” that can be used as indicators of habitat quantity and quality over time (table 3). We developed this list using various regional and national conservation plans and species of concern lists, while applying refuge location and natural resources for context. We considered factors such as: (1) relevance to the refuge purposes and proper policies and mandates; (2) a species status as native or nonnative; (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 (figure 7).

We are now working on technical guidance for the implementation of a surrogate species approach for managing species. Surrogate species is a commonly used scientific term for system-based conservation planning that uses a species as an indicator of landscape habitat and system conditions. Surrogate species are used for comprehensive conservation planning that supports multiple species and habitats within a defined landscape or geographic area.

Different criteria are used to create focal species and surrogate species, and the two terms are not interchangeable. Therefore, definitions and criteria

described in the Quivira Refuge CCP and EA for focal species were developed independently of the surrogate species approach. When the Service finishes the surrogate species approach, we will implement it as appropriate.



Interior Least Tern

USFWS



Bald Eagle

USFWS

Table 3. 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
<i>Ducks, Geese, and Swans</i>							
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
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
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
15	Northern Pintail*	c	u	c	c	WWW	WW GG
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
<i>Grouse and Quail</i>							
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
<i>Loons and Grebes</i>							
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	
<i>Pelicans and Misc.</i>							
34	American White Pelican	c	c	c	o	WWW	

Table 3. 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
<i>Hérons, Egrets, and Ibis</i>							
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)
<i>Birds of Prey</i>							
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			r	o	G	G
50	Rough-legged Hawk	u		r	u	WW GG	WW GGG
51	Prairie Falcon	r	r	o	o		W
<i>Rails and Cranes</i>							
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	
<i>Shorebirds</i>							
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 3. Focal species by life event and habitat at Quivira National Wildlife Refuge, Kansas.

	<i>Species Common Name</i>	<i>Recent Seasonal Abundance¹</i>				<i>Management Priority by Habitat Association and Life Event²</i>		
		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		
<i>Gulls and Terns</i>								
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		
<i>Pigeons and Doves</i>								
96	Yellow-billed Cuckoo*	o	u	r			SS	
<i>Owls</i>								
97	Short-eared Owl*	r		r	o			G
<i>Woodpeckers</i>								
98	Red-headed Woodpecker*	c	c	c			TTT	
<i>Flycatchers</i>								
99	Western Kingbird*	c	c	u			SSS	TTT
100	Eastern Kingbird*	c	c	u			TTT	
101	Scissor-tailed Flycatcher*	o	o	o			S	

Table 3. 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
<i>Shrikes and Vireos</i>							
102	Loggerhead Shrike*	u	u	u	u	SS TT	
103	Bell's Vireo*	u	u	o		SS	
<i>Larks</i>							
104	Horned Lark*	o	o	o	o	G	G
<i>Thrushes, Pipits, Waxwings, and Misc.</i>							
105	Sprague's Pipit	r		r		G	
<i>Longspurs</i>							
106	Lapland Longspur	r		o	u		GG
107	Chestnut-collared Longspur	r			r	G	
<i>Wood Warblers</i>							
108	Yellow Warbler*	u	u	o		SS (riparian area)	SS TT
109	Common Yellowthroat*	c	c	u	o	GGG	WWW GGG
<i>Sparrows and Towhees</i>							
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
<i>Grosbeaks and Buntings</i>							
118	Blue Grosbeak*	u	u	r			SS
119	Dickcissel*	c	c	r			GGG
<i>Blackbirds and Allies</i>							
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
<i>Finches</i>							
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.

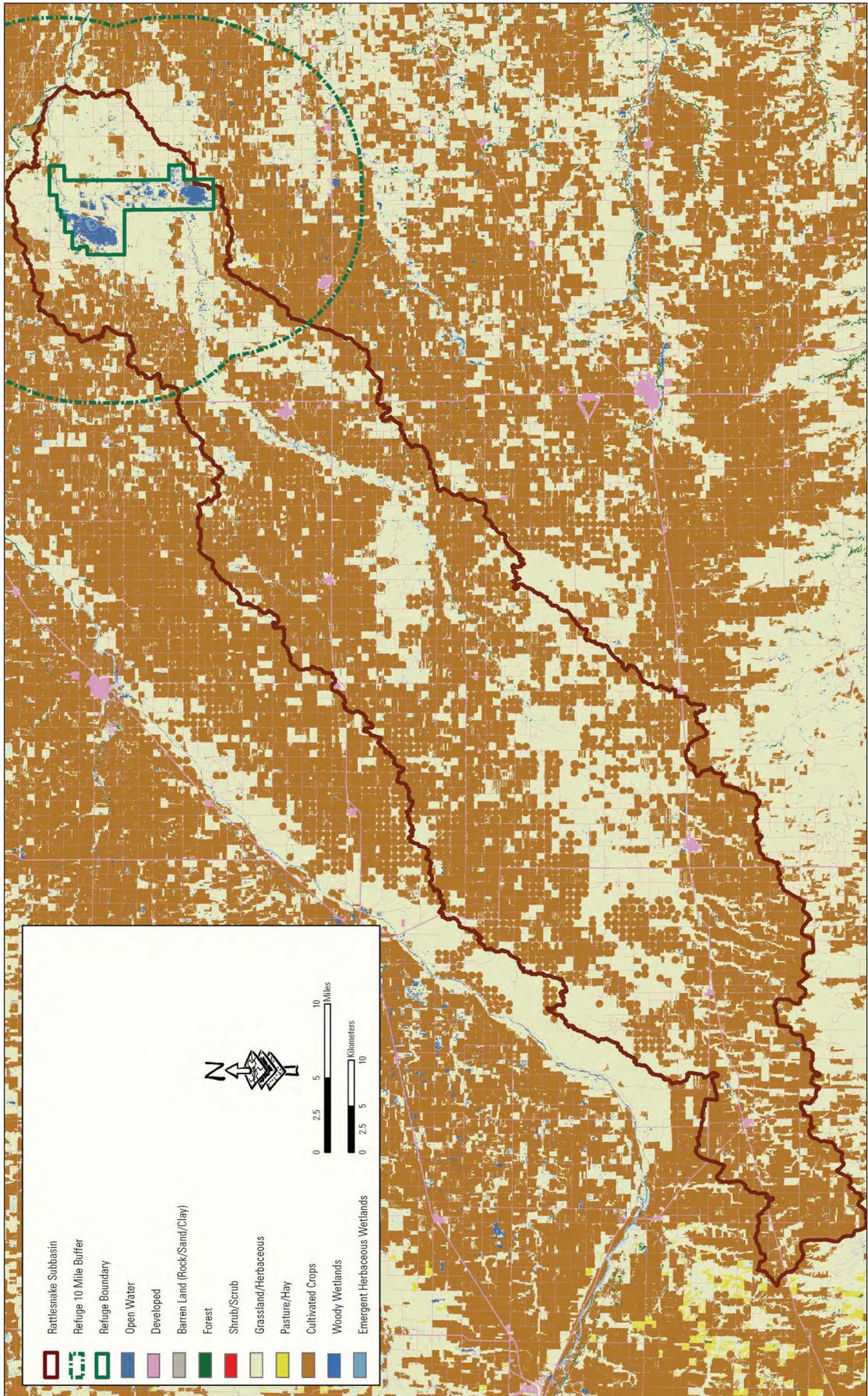


Figure 7. Land use and habitat outside the boundaries of Quivira National Wildlife Refuge, Kansas.

Landscape Conservation Actions

This section includes actions for climate change and land protection under alternative B.

Climate Change

Would be the same as under alternative A.

Land Protection

Our actions would be the same as under alternative A. We would also increase work with adjacent private landowners through the Partners for Fish and Wildlife (Partners) program in a newly established focus area that is comprised of Quivira Refuge and Cheyenne Bottoms Wildlife Area. We would rank areas, when possible, based on providing quality habitat for focal resources with a secondary emphasis on restoring natural processes. However, conducting projects would depend on the level of interest and objectives of private landowners.

Native Ecological Community Conservation Actions

This section includes actions for a variety of habitats and activities under alternative B.

Big Salt Marsh

We would mimic a more natural hydroperiod that promotes the sustainability of native plant communities that meet the requisites of focal species. Hydrology, or the quantity, timing, and duration of flooding, would be largely determined by climate elements such as precipitation and temperature and by ground water discharge. Our intentional diversions of Rattlesnake Creek water into the BSM would be infrequent and used primarily to overcome the limitations of our existing water management infrastructure on the refuge. For example, we may periodically divert water through water control structures on the east side of the BSM through units 57 and 58 and along the east side of Wildlife Drive to Salt Creek because this is the only way to actively dewater units 57 and 58 and some Rattlesnake Creek canal water and a way management handles flood flows in this area.

Also, because we face a declining water table and other uncertainties about water availability in the watershed, it is possible that our management of the BSM may become more reliant on Rattlesnake Creek water in the future. Therefore, while this alternative



Aron Flanders/USFWS

Dickcissel

would seek to decrease regular use of Rattlesnake Creek water in this area of the refuge, we would keep our ability to periodically use this water source. We would evaluate the need, and the ability, to change ditches and structures to improve natural hydrology as long as focal species and their associated habitats are not compromised. We would be able to use prescribed fire, chemicals, mechanical methods, and prescriptive grazing to restore native plant communities and provide for focal species.

Little Salt Marsh

Would be the same as under alternative A.

Riparian Corridor

Our actions would be the same as under alternative A, but we would place a greater emphasis on restoring the native plant communities and structure needed to support focal resources.

Created Wetlands

Our actions would be the same as under alternative A, except drawdown, flooding, and rehabilitation treatments would more specifically consider the needs of focal species and their associated habitats. Our staff would evaluate opportunities and conduct actions, as our budget allows, to improve water management capabilities and efficiencies that would help us to promote seasonal wetland plant productivity and diversity.

Freshwater Springs

Our actions would be the same as under alternative A, except that we would evaluate the effects of removing or changing the artesian well pipe, human-altered features, and current environmental conditions in the Boiling Springs area. If our evaluation

shows that changes would likely be positive for the native plant community and threatened and endangered (T and E) fish habitat needs, then we would act to improve conditions. Grazing, fire, chemical, and mechanical treatments would be limited to the best methods for controlling invasive species while supporting native communities and the needs of focal resources.

Meadow

Our actions would be the same as under alternative A, except that we would place more emphasis on restoring hydrology and native plant communities that provide structure and foods that support focal resources. For example, we would seek to restore sheet flow and ground water movement in meadows as long as it doesn't negatively affect other communities, such as created wetlands. We would use prescribed grazing and prescribed fire to restore or support the native plant community composition and structure required for focal resources. Initially, we would apply chemical and mechanical treatments more extensively to control woody invasive species, and then we would rely on prescribed fire, grazing, and mechanical treatments, such as haying, to support desirable plant communities.

Woodland

Our actions would be the same as under alternative A, except that we would place more emphasis on developing prescriptions that would increase benefits for focal resources.

Sand Prairie Complex

Our actions would be the same as under alternative A, except that management decisions would be based on creating habitat conditions that meet the life history needs of focal resources at a finer level. We would evaluate and possibly remove infrastructure that improves sheet flow but does not compromise other community types. We would place temporary fences to aid grazing in controlling undesirable vegetation and to create structure for focal species.

Cropland

Our actions would be the same as under alternative A, plus go-back areas, which are areas that were farmed before and that have been allowed to revegetate without human intervention, would be "interseeded" and managed more intensively using prescribed grazing, fire, and mechanical or chemical

treatments to restore native plant community composition and structure.

Migratory Birds

Emphasis on obligate and endemic grassland and meadow species that are focal resources would be increased.

Fish

Our actions would be the same as under alternative A, plus we would evaluate creating and keeping suitable habitat for focal resources that are of conservation concern in proper areas, like sloughs and segments of the Rattlesnake Creek channel. Our staff would work with partners to conduct habitat management and restoration actions and, if appropriate, reintroduce species. We would conduct more intensive monitoring programs on habitats and focal species to quantify population health.

Threatened and Endangered Species and Species of Concern

Our actions would be the same as under alternative A, plus we would carry out strategies in proper habitats that explicitly address the needs of species of concern, as well as State- and federally listed fish, amphibians, and reptiles.

Wildlife Native to the Region

Our actions would be the same as under alternative A, with the recognition that this alternative would add detailed structural habitat needs for focal species.

Wildlife Health

Our actions would be the same as under alternative A, plus we would watch water quality and quantity more closely to detect changes that may adversely affect refuge resources and we would allow trapping—after a trapping plan has been approved—with a special use permit, if necessary, to help us control mammalian predators, such as skunks and raccoons, that negatively affect focal resources or that pose a disease risk. We would: allow the use of body gripping traps, commonly known as Conibear® traps, and live traps; continue to prohibit leg-hold traps; and set areas and seasons for trapping that avoid conflicts with whooping cranes and hunters and use methods that promote the safety of visitors and refuge staff.

Inventory, Monitoring, and Research

Our actions would be the same as under alternative A, plus we would develop more monitoring protocols so that we can better help focal wildlife and habitat resources. We would advocate for research that informs or complements refuge management or landscape-level monitoring programs and studies.

Visitor Services Actions

This section includes actions for a variety of activities under alternative B.

Hunting

We would expand hunting on Quivira Refuge by increasing the area open to hunting and adjusting traditional hunting zone boundaries to protect endangered species. For all hunting seasons, the refuge manager would have the authority to close any area at any time to protect endangered species like the whooping crane. We would evaluate decisions and details related to the hunting program, including but not limited to changes in hunting season frameworks, on how they directly and indirectly affect wildlife populations and behaviors and on how they provide quality public hunting experiences

Migratory and Upland Birds

Hunting for migratory and upland birds would be the same as under alternative A, except that the hunting area would be modified to reduce conflict with traditional whooping crane use areas. We would only close specific units when whooping cranes are present in, or near or next to, those units. The recent movements and behavior of whooping cranes would be among multiple factors that we would consider when closing areas to hunting. The entire area open to waterfowl hunting would consist of no more than 40 percent of the refuge, based on Quivira Refuge's legislative authorities and as required by the Administration Act. Based on our past experience, this change would result in an increase in the number of days that the public could hunt waterfowl on the refuge. Upland bird hunting areas would not necessarily be the same areas as those for waterfowl hunting.

Deer

We would establish a new, limited archery hunting season for white-tailed deer. We would set herd health and population targets in consultation with KDWPT that would be used to define bag limits and areas open for hunting. We may also consider limited muzzleloader and shotgun seasons if we find that

population targets would not be met with archery-only hunting. We would also consider visitor safety in determining which areas would be open to hunting and which types of hunting would be offered.

Upland Game (Turkey, Prairie-chicken, Furbearers)

We would establish a new turkey hunting season and a furbearer hunting season. The area open for hunting would be established by our refuge management in consultation with KDWPT, and we would set bag limits based on refuge populations and wildlife health targets. Under this alternative, prairie-chicken hunting would be allowed only if our refuge staff finds that refuge populations are deemed to be of sufficient health.

Fishing

Our actions would be the same as under alternative A, except that we would only stock fish in the Kid's Fishing Pond or to reestablish native fish. Frogging for bullfrogs, only, would be allowed. All activities at Kid's Fishing Pond would require adult supervision.

Wildlife Observation and Photography

Would be the same as under alternative A.

Environmental Education and Interpretation

Our actions would be the same as under alternative A, except that we would emphasize focal resources and how we manage for them in environmental education and interpretation programs. The environmental education and interpretation programs are continuously being enhanced, modified, or adapted to meet changes in methods and content at both Quivira and the GPNC. We would also allow and encourage virtual geocaching to increase the appreciation of our resources at Quivira Refuge.

At the GPNC, we would continue to evaluate the exhibits and displays found in the Koch Habitat Hall and update them, as needed and as money becomes available. We would continue to evaluate the facility as it fits the needs of the partner agencies and make changes, as needed and as money becomes available.

Other Uses

Our actions would be the same as under alternative A, except that we would allow commercial photography and commercial tours for birding only, both with a special use permit.

Public Outreach Actions

Our actions would be the same as under alternative A, plus we would install a tower camera at the nesting bald eagle and BSM areas to help visitors understand and appreciate our resources on Quivira Refuge. We would set up a moveable camera to aid wildlife viewing on the refuge and the public would have a better idea of the wildlife to be seen when looking toward the BSM area. Camera-related activity would be noted on the Web, through social media and in public programs.

Setting up a tower camera would also encourage more visitation to the refuge and our Web page.

Cultural Resources Actions

Our actions would be the same as under alternative A, except that we would also increase the interpretation of cultural resources by adding exhibits in the visitor center and in the environmental education center and we would install better signage through-

out the refuge. We would also work with tribal partners to provide more correct and diverse interpretation products.

Visitor and Employee Safety and Resource Protection Actions

This section includes actions for visitor and employee safety and resource protection under alternative B.

Visitor and Employee Safety

Would be the same as under alternative A.

Resource Protection

Our actions would be the same as under alternative A, except that our refuge hunting areas would be modified and we would establish new regulations on when and how to close areas when whooping cranes are present.



Barry Jones/USFWS

This observation tower at the Little Salt Marsh is part of the extensive infrastructure maintained on Quivira Refuge.

Administration Actions

This section includes actions for staff and budget and facilities and infrastructure under alternative B.

Staff and Budget

Would be the same as under alternative A.

Facilities and Infrastructure

Our actions would be the same as under alternative A, plus we would ask for another cold storage building and fire cache to fully carry out this alternative. The bunkhouse in the center of the refuge would be replaced with a facility in a new location near our headquarters. Water quality at the bunkhouse is poor, and consolidating all residences would reduce the footprint of our administrative sites and provide a nicer living area. We would also issue special use permits to trap and remove beavers and other burrowing animals that threaten our infrastructure, including water control structures, roads, dikes, and canals (see above wildland health section, alternative B, for details).

We would ask for more space at the GPNC for a larger classroom, a multipurpose room, and more offices. Money would mostly come from sources outside the Government. We would also ask for another storage building and a larger equipment compound.

To the extent possible, we would promote self-sustaining natural processes with less regard to the effects on focal species relative to alternative B, though we understand that complete ecological restoration is impossible. Our key values for restoring natural ecological processes include achieving the long-term sustainability of native communities and lowering maintenance costs. We find that it is widely accepted that native plant communities tend to be more resilient to climate change and other environmental stressors than nonnative and highly managed ecosystems. Native wildlife species, including our trust resources, are also able to adapt to such changes. Our efforts, such as prescribed fire, grazing, and invasive species control, would be focused on supporting native plant community composition and diversity, and we would presume that native wildlife would benefit from these activities. Relative to our other alternatives, habitat conditions would be allowed to fluctuate more with climatically driven

wet and dry cycles, however, we would still need to mitigate the effects of past land uses on the refuge and in the watershed that have permanently altered some ecological processes.

Considerable time would be required up front for us to assess current ecological functions, find key elements that should be restored, and evaluate potential restoration options that could be conducted given biological, economic, social, political, and legal constraints.

Our ability to restore surface and subsurface hydrology is the one factor most likely to influence restoration potential. First, to maintain water rights to conserve natural resources, we would need some water control structures to remain on Quivira Refuge to divert Rattlesnake Creek water. Second, we cannot alter, or fully mitigate for, some infrastructure and actions known to change hydrologic processes, such as county roads that bisect important flow paths on the refuge and water uses by others that deplete ground water in the watershed. While these are major constraints, opportunities would still exist to improve ecological functions. For example, we could alter water amounts and movements to mimic natural, seasonal patterns of flooding, and we could remove or change dikes and trails on the refuge to restore hydrologic connectivity and sheet flow in certain refuge areas.

We would carry out this alternative in stages over many years, and changes in our research and monitoring programs, staff, operations, and infrastructure on the refuge would be required. Our success would be greatly influenced by our ability to develop new and expanded partnerships with stakeholders in the Rattlesnake Creek watershed.

Landscape Conservation Actions

This section includes actions for climate change and land protection under alternative C.

Climate Change

Our actions would be the same as under alternative A, plus we might increase ecosystem resilience by restoring ecological processes on a greater part of the refuge. However, we may have less control over the area's hydrology when we remove or change some infrastructure, which may influence the amount of available wetland habitat within, and among, years.

Land Protection

Our actions would be the same as under alternative B, except that we would rank areas based on

restoring ecosystem processes and place less emphasis on providing resources for focal resources.

Native Ecological Community Conservation Actions

This section includes actions for a variety of habitats and activities under alternative C.

Big Salt Marsh

We would manage water the same as under alternative B, except that we would focus more on the restoration and sustainability of native plant communities than on focal resources. We would use fire and grazing prescriptions to restore native plant communities and then on supporting native plant community composition and nutrient cycling. We would use patch burns, which involve the use of prescribed fire to make certain areas more attractive to grazing by cattle or bison and to create a diversity of habitat in the landscape, and we would evaluate the grazing by native ungulates, like bison, as a possible prescription. We may need to remove interior fences, and we would only use chemical and mechanical treatments during the plant restoration phase.

We would manage infrastructure the same as under alternative B, except that we would evaluate our ability and need to change the infrastructure that we own, such as roads, dikes, ditches, and water control structures, for improving the sustainability of native communities and natural hydrology instead of for focal resources. For example, we would consider the modification or removal of the wildlife drive dike or road to Mandalay.

Little Salt Marsh

Our actions would be the same as under alternative B, except that we would focus more on restoring processes for the long-term sustainability of native plant communities than on supporting annual habitat needs for focal resources.

Riparian Corridor

Our actions would be the same as under alternative B, except that we would evaluate our infrastructure for managing created wetlands, and we would change or remove features that we find to be nonessential or obstructive to natural hydrologic flow paths. We would evaluate adding more diversion points as a strategy to mimic natural hydrologic patterns in sloughs and in Rattlesnake Creek. We would

restore natural hydrology and processes in certain areas to support the sustainability of native communities with the assumption that native wildlife would benefit from our efforts.

Created Wetlands

Our actions would mimic a more naturally functioning system that may require less active water management by refuge staff. Our current infrastructure used to manage created wetlands would be evaluated, and features that are nonessential or that hinder natural hydrologic flow paths would be removed or modified to restore hydrology and to improve native plant communities.

We would consider adding diversion points as a strategy to increase our flexibility in restoring hydrology. Most created wetlands would be restored to native habitat types based on an HGM analysis conducted for Quivira Refuge (Heitmeyer et al. 2012).

Freshwater Springs

Would be the same as under alternative B.

Meadow

Our actions would focus on restoring the natural processes and native vegetation characteristic of meadows in this region. We would base hydrology on ground water discharge, sheet flow, and precipitation. The infrastructure that we own, such as roads, dikes, ditches, and water control structures, would be evaluated, and features that are considered nonessential would be removed to improve natural hydrology. Our restoration success would be affected, in part, by limitations in our ability to mitigate onsite and offsite hydrologic effects that are beyond our control, like the presence of county roads and changes in the water table.

We would use fire and grazing prescriptions to restore native plant communities and then to support the processes, like nutrient cycling, necessary to support native plant community composition. We would consider using patch burns and grazing by native ungulates, like bison, and we may remove interior fences. We would use chemical and mechanical treatments extensively up front to combat invasive species, but we would only use it later when prescribed fire and grazing are not effective.

Woodland

We would remove woodlands, such as larger shelterbelts and planted tree groves (figure 6), and we would restore these areas to their proper habitat

types as described in an HGM analysis for Quivira Refuge (Heitmeyer et al. 2012) and in chapter 4.

Sand Prairie Complex

Our actions would be the same as under alternative B, except that we would focus on restoring natural functions and native plant and wildlife communities.

We would use fire and grazing prescriptions up front to restore native plant communities and then use prescriptions to support environmental conditions and native plant community composition. Because we would manage for natural processes, we would expect sand blowouts and active sand dunes to develop, which we would consider to be parts of this habitat type. Interior fences may be removed and patch burn grazing by native ungulates, like bison, may be used to support native communities. We would use chemical and mechanical treatments extensively during the plant restoration phase, but use these later only when fire and grazing are not effective.

We would remove or alter, as in breach, infrastructure such as refuge roads and ditches when necessary to restore hydrology and to promote native plant communities. As a result, it is possible that prairie or upland vegetation might replace wetland vegetation. Initially we would use existing fencing to accomplish plant restoration, but, when restoration is complete, nonessential interior fencing would be removed.

Cropland

Our actions would be the same as under alternative B, except that we would devote more resources to restoration activities and restore cropland to native communities more quickly.

Migratory Birds

Actions would involve a variety of habitats.

Wetland

Our actions would be the same as under alternative A, except that some created wetland habitat would be removed and surface water would be reduced in the LSM during some years. This would reduce habitat for nesting and migrating waterbirds in most years. The amount of shallowly flooded shorebird habitat would fluctuate annually and, in most years, would be reduced.

Herbaceous Upland

Would be the same as under alternative B.

Woodland

We would remove woodland on the refuge because it is not a naturally occurring habitat type and would not have been present during the presettlement period.

Fish

Our actions would be the same as under alternative B, except that we would remove the Kid's Fishing Pond by restoring it to its original habitat as much as possible. We would restore riparian habitat, including the hydrology of waterways on the refuge, which could increase native fish populations by improving streamflows in the Rattlesnake and Salt Creeks. In addition, we would consider reintroducing native fish into Dead Horse Slough. By restoring freshwater springs, we would expect to enhance the protection and sustainability of existing native fish populations.

Threatened and Endangered Species and Species of Concern

Our actions would be the same as under alternative B, except that our prescriptions would be based more on restoring the processes necessary to promote native communities than on providing habitat for species. While we are uncertain about how habitat conditions will develop, it is possible that we would reduce habitat for interior least tern and western snowy plover nesting in some years and would reduce spring and fall migration habitat for whooping cranes. We would also consider introducing bison and other extirpated native species to the refuge.

Wildlife Native to the Region

Would be the same as under alternative B, except that we would use larger scale prescriptions to promote plant community characteristics.

Wildlife Health

Our actions would be the same as under alternative A, plus our staff would watch for a broader suite of environmental conditions that are related to diseases in this area of the Great Plains. We would conduct more wildlife health surveillance through proactive health checks, and we would manage refuge habitats to decrease adverse health issues. Our restoration of the cropland and removal of the woodland habitat types may reduce disease potential because these habitat types often harbor high concentrations of wildlife. In our evaluation of bison



Rachel Laubhan/USFWS

Eastern Racer

introduction, we would need to consider increased wildlife health issues, such as disease transmission among bison and other herbivores.

Inventory, Monitoring, and Research

Our actions would be the same as under alternative B, except that we would monitor populations to decide if, when, and how hunting and trapping would be allowed on the refuge. Habitat-monitoring programs would increase as we conduct restoration to decide how we might use grazing, fire, and invasive species control.

Visitor Services Actions

This section includes actions for a variety of activities under alternative C.

Hunting

Hunting opportunities would be same as under alternative B, except that we would base all hunting seasons and bag limits on keeping refuge populations at proper sizes based on habitat conditions and wildlife health and not just in accordance with State-determined seasons. Sandhill crane, deer, turkey, and prairie-chicken hunting would be permitted if refuge populations allow it and if it is necessary to address health concerns, as decided on by our refuge staff. We would employ special regulations to address issues specifically related to the refuge deer herd. We would allow furbearer hunting with shotgun or archery only if refuge populations allow it or for

health purposes. Our staff would continue to close the refuge to migratory bird hunting when whooping cranes are present to reduce the risk of killing them. For deer, furbearer, and upland game hunting, we would only close specific units if whooping cranes are present to prevent disturbing them.

Fishing

Our actions would be the same as under alternative B, but only if populations allow them or for health management purposes. We would also more aggressively control nonnative fish, reptiles, and amphibians. We would reduce fishing opportunities in Darrynane Lake, as we would likely remove the structures that provided deeper water habitat there. We would remove the Kid's Fishing Pond.

Wildlife Observation and Photography

Our actions would be the same as under alternative A, except that we would restrict entry during the nesting season to selected roads to reduce disturbance. We would also close the Wildlife Drive during the nesting season and, during the next 15 years, evaluate the need to remove the Wildlife Drive infrastructure because it may negatively affect the environment. Our tour route would be much more limited, when compared to the other alternatives, because our management units would be larger. If we reintroduce bison, viewing opportunities would become more limited because we would remove the hunter access road and, possibly, the Wildlife Drive and we may need to install taller boundary fences. Visitors would have to go around the outside boundary to observe wildlife. Our only open roads would be State, county, and township roads.

Environmental Education and Interpretation

Would be the same as under alternative B, plus we would decrease, or remove, developments such as trails that facilitate the dispersal of invasive plants or that would otherwise negatively affect biological populations through disturbance or other actions.

Other Uses

Our actions would be the same as under alternative A, except that we would decrease, or remove, developments such as trails that facilitate the dispersal of invasive plants or that would otherwise negatively affect biological populations through disturbance or other actions.

During the nesting season, we would close the Wildlife Drive and entry would be restricted to selected roads to reduce disturbance and improve safety.

Public Outreach Actions

Would be the same as under alternative B.

Cultural Resources Actions

Would be the same as under alternative B.

Visitor and Employee Safety and Resource Protection Actions

This section includes actions for visitor and employee safety and resource protection under alternative C.

Visitor and Employee Safety

Would be the same as under alternative A.

Resource Protection

Our actions would be the same as under alternative A, except that we would only stop waterfowl and sandhill crane hunting when whooping cranes are

present. We would leave all other areas open when whooping cranes are present unless a specific unit or area is closed for protection. We would increase efforts to enforce regulations related to closed areas because more areas would be closed when compared to alternatives A and B.

Administration Actions

This section includes actions for staff and budget and facilities and infrastructure under alternative C.

Staff and Budget

Our actions would be the same as under alternative A, plus we would need two more permanent, full-time biological staff to conduct increased biological inventorying and wildlife population and habitat checking. We would need more permanent staff to more aggressively control invasive species and to restore native plant communities. More positions would be needed to manage bison and horses if they are reintroduced to conduct health checks and other necessary activities.

Facilities and Infrastructure

We would set priorities for infrastructure that impedes natural hydrologic flows, and is not necessary, for removal or modification. We would restore lands affected by these changes to habitat types identified in the HGM analysis for Quivira Refuge as best we can. We would remove many interior fences because grazing regimes would change to allow for a much more natural movement of herbivores. Trapping to remove nuisance animals would be the same as under alternative B.

If we reintroduce native herbivores, taller boundary fences would be required and access on interior roads would be reduced because interior fences would be removed to allow for natural movement. We would require bison handling facilities.

3.7 Summary of Alternatives and Consequences

Table 4 summarizes the management actions and environmental consequences for alternatives A–C.

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Landscape Conservation Goal. Actively protect, preserve, manage, and restore the functionality of the diverse ecosystems of the Rattlesnake Creek watershed.		
Climate Change—actions		
<p>Conserve native communities.</p> <p>Rely on partners, Great Plains landscape conservation cooperatives, Service Climate Change Team for climate change-related information, research and monitoring programs, and modeling.</p>	<p>Same as alternative A.</p>	<p>Same as alternative A, plus restore native plant communities and processes on a greater part of the refuge.</p>
Climate Change—environmental consequences		
<p>Refuge-specific information would be used to improve management strategies or to evaluate changes.</p> <p>We may detect and consider shifts in some plant and wildlife species distributions and conditions, but likely would not differentiate between various factors influencing community changes.</p>	<p>Same as alternative A.</p>	<p>Shift in management focus may result in more support of ecosystem resilience.</p> <p>We may not be in a position to resist, or prolong, community changes over time.</p>
Land Protection—actions		
<p>Promote NRCS, KDWPT, and Partners work with landowners on various types of land protection and management easements and agreements throughout Kansas.</p> <p>Periodically assess roles of the refuge at different landscape scales.</p> <p>Communicate conservation issues.</p> <p>On abandonment of oil wells, reclaim mineral rights.</p>	<p>Same as alternative A, plus would increase work with Partners programs in newly established focus area.</p> <p>Rank areas based on providing quality habitat for focal species with a secondary emphasis on restoring processes.</p>	<p>Same as alternative B, except would rank areas most beneficial to restoring processes, with a secondary emphasis on providing resources for focal species.</p>
Land Protection—environmental consequences		
<p>A potential negative effect is the risk that we promote landscape programs when, in some cases, land management on private lands conflicts or adversely affects the achievement of our objectives.</p> <p>Knowledge of landscape changes would help us interpret changes observed or measured on the refuge, to keep or improve public interactions, to keep or improve relevancy in educational programs, and to promote management efficiency.</p> <p>Socially, the limitation and gradual elimination of oil wells would be a benefit because visitors do not want to see oil-related activities on the refuge. Reduced economic activity on the refuge may affect the local economy over time.</p>	<p>Same as alternative A, plus collaborating on common concerns would improve effectiveness of management.</p>	<p>Same as alternative B, except restoring ecological processes would improve ecosystem resiliency over other alternatives.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
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.		
Big Salt Marsh—actions		
Manage the BSM and adjacent salt flats largely depending on natural climate and hydrology and minimal use of Rattlesnake Creek water, allowing dynamic fluctuations in water quantity and quality to occur within, and among, years.	Manage under a more natural hydroperiod, while providing native plant communities that meet requisites of focal species.	Restore the natural hydroperiod and native plant communities to the extent possible within certain constraints.
<i>Water Management</i> —Base hydrology on ground water discharge and minimal use of Rattlesnake Creek water.	<i>Water Management</i> —Base hydrology on ground water discharge and minimal intentional diversion of Rattlesnake Creek water.	<i>Water Management</i> —Same as alternative B, except focus more on restoring natural conditions and focus less on focal species.
<i>Fire</i> —Base prescriptions on the restoration of native plant communities.	<i>Fire</i> —Base prescriptions on the restoration of native plant communities and on providing for the needs of focal species.	<i>Fire</i> —Base prescriptions on restoring native plant communities followed by prescriptions that are related to environmental conditions and keeping native plant community composition. Evaluate patch burn grazing.
<i>Chemical and Mechanical Treatments</i> —Use to decrease undesirable plant species and encourage more favorable conditions for native communities.	<i>Chemical and Mechanical Treatments</i> —Restore native plant communities and provide for the needs of focal species.	<i>Chemical and Mechanical Treatments</i> —Restore native plant communities.
<i>Grazing</i> —Use to restore native vegetation.	<i>Grazing</i> —Increase prescriptive grazing to promote restoration of native plant communities and provide for the needs of focal species.	<i>Grazing</i> —Increase prescriptive grazing to restore native plant communities. After completing restoration, use grazing to keep native plant community composition. Evaluate reintroducing bison.
Infrastructure—no change in current infrastructure.	Infrastructure—Evaluate to improve natural hydrology as long it does not compromise focal species management.	Infrastructure—Same as alternative B, except focus more on restoring natural conditions and focus less on focal species.
Big Salt Marsh—environmental consequences		
Dynamic fluctuations in water conditions would promote nutrient cycling and wetland productivity. Carp would be controlled to improve water quality and sunlight penetration through the water column and reduce competition with migratory birds for invertebrate resources. Natural salinity to the marsh would be restored over time and limit the growth of emergent cattail and Phragmites. Promoting natural marsh cycles would allow us to educate about inland saltmarsh systems.	There would be improved natural hydrology to better help focal species. The periodic drying of the marsh would allow wind to naturally scour basins, which is an important process for increasing wetland productivity.	There would be improved natural hydrology but there would be fewer benefits for focal species in some years. Would likely provide less water for hunting and waterfowl early in the season.

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Big Salt Marsh—environmental consequences (continued)		
<p>Seasonal declines in water levels would increase shallow water–mud-flat habitat to help shorebirds during late-spring and summer migration, but water would not be available in some years for waterfowl migration in September and October.</p> <p>Burning would prevent woody vegetation encroachment, recycle nutrients, prevent litter buildup, and support an early successional stage.</p> <p>Saltcedar—not affected by increased salinities—may increase as new seedlings establish when water levels decline in the summer.</p>		
Little Salt Marsh—actions		
<p>Manage primarily as a water storage wetland to convey water to all the other wetlands throughout the refuge except the BSM area.</p>	<p>Use as storage, but allow fluctuations for productivity, restoring native plant communities, and habitat for T and E, migratory birds, and herptiles.</p>	<p>Same as alternative B, except focus more on restoring natural conditions and focus less on focal species.</p>
Little Salt Marsh—environmental consequences		
<p>Would hold water to flood created wetlands, though it would lose capacity through sedimentation. Could be the last source of water for wildlife in a drought.</p> <p>Would become fresher as salt is slowly diluted through managing as a flow-through marsh, not an overflow sump.</p> <p>Would be attractive to many migratory birds, primarily for roosting and some foraging if water levels are held low in the spring and fall.</p> <p>Carp infestation would recur because of its connection to the creek.</p> <p>Cattails would continue to dominate the shoreline as water levels are kept relatively stable during most of the year and salinities continue to decline. Phragmites and saltcedar would continue to expand without more herbicide control efforts.</p> <p>Would continue to be the most popular fishing location and has an accessible fishing pier. Fishing would still be of low quality because carp dominate and Phragmites and cattail affect the accessibility of shorelines.</p>	<p>Same as alternative A, except the benefits to focal species may increase slightly.</p>	<p>Same as alternative B, except management would encourage natural conditions to the extent possible. In the short term, this would result in less water available for fall flooding, but it is possible that less would be needed as created wetlands would also be altered. The highest periodic flooding would occur after rainfall events in the spring, followed by drying in the summer and fall, while still providing roosting habitat for whooping cranes in the early spring and fall. Nesting by least terns would not increase, but would be occasional depending on favorable habitat conditions.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Riparian Corridor—actions		
<p>Manage for water transport with ancillary benefits to wildlife</p> <p>Control invasive plant species with grazing, fire, mowing, tree cutting, chemicals, and rest.</p> <p>Protect current annual water rights.</p>	<p>Same as alternative A, plus emphasize restoring native plant communities and the structure needed to support focal species.</p> <p>Evaluate changing ditches and structures to improve natural drainage, do not compromise created impoundments.</p>	<p>Same as alternative B, except focus less on focal species.</p> <p>Evaluate more diversions and modifications to current nonessential infrastructure to promote the sustainability of natural systems.</p>
Riparian Corridor—environmental consequences		
<p>Would continue to transport nonnative, invasive species.</p> <p>Would provides ancillary help to wildlife.</p> <p>Would discourage cattle from congregating and causing damage by removing invasive trees.</p>	<p>Same as Alternative A, except would place greater emphasis on restoring native plant communities.</p>	<p>Same as Alternative B, except would remove or change features deemed to be nonessential or obstructive to mimic natural hydrologic patterns and support the long-term sustainability of native communities. Native wildlife, presumably, would benefit.</p>
Created Wetlands—actions		
<p>Manage as seasonally flooded wetlands with hydrologic regimes that vary in flooding depth, coverage, timing, and duration within, and among, years.</p> <p>Aggressively control wetland invasive plants to prevent their establishment and spread.</p> <p>Use grazing, prescribed fire, mechanical and chemical treatments, and water manipulation to accomplish objectives for foraging migratory birds and some nesting.</p>	<p>Same as alternative A, except use drawdown, flooding, and rehabilitation treatments for specific focal species.</p> <p>Find opportunities to improve water management capabilities and efficiencies.</p>	<p>Seek modifications to promote the restoration of natural processes and native communities in certain areas.</p> <p>Alter infrastructure to restore sheet flow and natural hydrology, within constraints.</p>
Created Wetlands—environmental consequences		
<p>Without active management, the extent and quality of seasonally flooded wetland resources would be substantially less in most years.</p> <p>High productivity would be sustained with the periodic drying and flooding.</p> <p>Would continue to successfully conserve biological communities, but its extent would not be understood, which would be of highest concern.</p> <p>Could positively influence the predictability and long-term success of implementation with a planning process that more efficiently informs management.</p>	<p>Controlling hydrology within refuge boundaries may increase the long-term probability of sustaining native communities that occurred in presettlement times.</p> <p>Improved planning activities and more fully develop biological knowledge would likely increase the conservation of resources of highest concern.</p> <p>Would likely require more time to collect, synthesize, and assess information in the continual planning process.</p>	<p>Having less control over hydrology within refuge boundaries would pose the greatest risk by increasing reliance on watershed conditions to achieve refuge purposes, goals, and objectives at a time when water quantity and quality are of greater concern. The availability and reliability of required resources for many species might be more dynamic within, and among, years.</p> <p>More temporally to seasonally flooded habitat could replace more permanently flooded habitat and cause species associated with those habitat types to shift accordingly. This change would likely favor many shorebird species over some diving waterfowl species.</p> <p>Time and costs for controlling invasive species could increase.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Freshwater Springs—actions		
<p>Sustain in part to protect the current population of Arkansas darters.</p> <p>Evaluate habitat conditions in relation to fish community conservation.</p> <p>Check water quality for adverse effects from increased public contact and evaluate for closure.</p>	<p>Same as alternative A, except would restore hydrology and native plant communities and manage to sustain focal species.</p>	<p>Same as alternative A, except would restore hydrology and native plant communities and manage to sustain T and E species habitat.</p>
<p><i>Water Management</i>—Keep existing pipe and pump from removed oil well or pad.</p>	<p><i>Water Management</i>—Evaluate the potential effects of removing well relative to native plant community and T and E habitat needs. Remove well if effects would be positive.</p>	<p><i>Water Management</i>—Same as alternative B.</p>
<p><i>Grazing</i>—Generally do not allow, however, it may occur periodically when managing adjacent community types.</p>	<p><i>Grazing</i>—Limit to situations when treatment is most effective in controlling invasive species, stimulating plant growth, and creating structure necessary for focal species.</p>	<p><i>Grazing</i>—Use only if needed to keep native plant community or to alter vegetation structure to meet the life requisites of T and E species.</p>
<p><i>Fire</i>—Use only indirectly, as when prescriptions are based on the criteria for adjacent plant communities in the unit.</p>	<p><i>Fire</i>—Use when it is the best method for controlling invasive species, keeping native plant community structure, and creating structure for focal species.</p>	<p><i>Fire</i>—Use only if needed to keep native plant communities or to alter vegetation structure to meet the life requisites of T and E species.</p>
<p><i>Chemical and Mechanical Treatments</i>—Use minimally.</p>	<p><i>Chemical and Mechanical Treatments</i>—Limit to when grazing and prescribed fire are not effective or are unsuccessful in controlling invasive species and creating structure required by focal species.</p>	<p><i>Chemical and Mechanical Treatments</i>—Use only if fire and grazing are unsuccessful in meeting the life requisites of T and E species.</p>
<p><i>Infrastructure</i>—No change.</p>	<p><i>Infrastructure</i>—Depending on evaluation, may remove well to improve natural hydrology. Evaluate changing enhanced ponds near springs.</p>	<p><i>Infrastructure</i>—Same as alternative B, except have ecological restoration in mind instead of the needs of focal species.</p>
Freshwater Springs—environmental consequences		
<p>Fresh water would benefit some wildlife and fresh-to-saline conditions may encourage diversity.</p> <p>Exotic, invasive woody vegetation would increase and green sunfish and possibly other species would be supported in larger ponds that are adverse to the Arkansas darter.</p> <p>Would reduce exotic, invasive trees, which may improve the availability or quantity of water.</p> <p>Existing pipe would remain with unknown effects, full habitat potential may not be realized.</p> <p>Habitat evaluation for fish community conservation would inform future management, but actions would be limited.</p>	<p>Arkansas darter habitat conditions would be protected and enhanced.</p>	<p>Same as alternative B, except emphasis would be on restoring natural ecological conditions that may or may not help species other than the Arkansas darter.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Freshwater Springs—environmental consequences (continued)		
<p>Increased visitor use would increase threats to conservation.</p> <p>There would be no anticipated economic or social issues.</p>		
Meadow—actions		
<p>Restore and improve health and productivity.</p> <p>Decrease woody vegetation invasion to prevent conversion and manage for a proper balance of vegetation structure and cover that helps various species.</p> <p>Periodically reduce litter buildup, improve nutrient cycling, and increase the diversity of vegetation structure and composition by using fire, mechanical, and grazing treatments.</p> <p>Influence hydrology by climate, ground water fluctuations like aboveground and belowground flooding, and wetland flooding and drying. Target certain meadow sites.</p>	<p>Same as alternative A, except emphasize restoring hydrology and native plant communities and focus on focal species.</p>	<p>Restore natural hydrology and plant communities, though changes in hydrology within the watershed may limit options.</p>
<p><i>Water Management</i>—Conduct, but with limited ability to control sheet flow. Manage water in created wetlands and ground water discharge as indirect influences.</p>	<p><i>Water Management</i>—Same as alternative A, but emphasize restoring sheet flow and ground water movement in balance with other communities.</p>	<p><i>Water Management</i>—Restore hydrology to the extent possible, including removing or altering infrastructure that inhibit sheet flow and interrupt ground water flow paths.</p>
<p><i>Grazing</i>—Conduct in select areas. Prescription targets vary, but include the removal of litter, breakup of soil duff, stimulation of growth, and promotion of nutrient cycling.</p>	<p><i>Grazing</i>—Base prescription on a combination of restoring or keeping native plant community composition and on structure required for focal species.</p>	<p><i>Grazing</i>—Target prescriptions to restore native plant communities followed by supporting plant communities by more closely emulating natural patterns. Evaluate the introduction of bison.</p>
<p><i>Fire</i>—Base prescription on restoring and keeping native plant communities by removing litter, promoting nutrient cycling, and controlling invasive species.</p>	<p><i>Fire</i>—Base prescription on a combination of restoring or keeping native plant community composition and on structure required for focal species.</p>	<p><i>Fire</i>—Target prescriptions to restore native plant communities followed by supporting plant communities by more closely emulating natural patterns. Evaluate patch burn grazing.</p>
<p><i>Chemical and Mechanical Treatments</i>—Use to control invasive woody species and excessive litter accumulation.</p>	<p><i>Chemical and Mechanical Treatments</i>—First use more extensively to control invasive species and then add other treatments to keep native plant community composition and structure required by focal species.</p>	<p><i>Chemical and Mechanical Treatments</i>—First use intensively to combat invasive species and to restore native communities then limit to cases where fire and herbivory are not effective.</p>
<p><i>Infrastructure</i>—No change.</p>	<p><i>Infrastructure</i>—Find and carry out changes that would improve sheet flow and ground water discharge while not compromising other community types.</p>	<p><i>Infrastructure</i>—Remove or alter infrastructure necessary to restore hydrology and promote native plant communities. Remove interior fences.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Meadow—environmental consequences		
<p>Existing infrastructure management may cause changes and conversion to other community types.</p> <p>Reduced levels in the ground water table and changes in surface runoff may cause conversion to other community types. Sheet flow restoration or the removal of past alterations would be minimal.</p> <p>Infrastructure would limit the full biological potential of meadows to support native communities.</p>	<p>Same as alternative A, except expect an improvement in the support of focal species.</p> <p>May see improved awareness of the connectedness of different habitats and species relationships because this is a highly transitional habitat type.</p>	<p>Restoration of natural processes and native vegetation would improve sheet flow and other characteristics necessary for increasing productivity.</p> <p>Effects on ground water levels might highly influence community changes.</p>
Woodland—actions		
<p>Reduce invasive woody vegetation, especially in encroachment areas.</p> <p>Evaluate trade-offs with other areas to sustain native sand prairie communities and meet other conservation concerns, and rank activities accordingly.</p>	<p>Same as alternative A, except emphasize prescriptions that would help focal species.</p>	<p>Remove and restore area to habitat types identified in the HGM report.</p>
Woodland—environmental consequences		
<p>Water table changes would likely have some effect on plant restoration following tree removal. Changes and consequences would be unknown and likely be influenced by watershed management.</p> <p><i>Biological</i>—Would reduce the abundance and, possibly, the richness of wildlife here, which would increase those levels in open prairie habitat.</p> <p>Reducing Russian olive and saltcedar would improve soil and water conservation.</p> <p><i>Social</i>—Would expect mixed reactions from different interest groups. Would be no foreseeable effect on waterfowl hunters.</p> <p>Remaining woodland would not help those species that draw visitors or promote their observation.</p> <p>Would increase the awareness of “wildlife first” and refuge roles and responsibilities.</p>	<p>Same as alternative A, except would improve benefits to focal species.</p> <p>May affect hunters by affecting proposed deer and turkey hunting.</p>	<p>Same as alternative A, except would be made similar to presettlement conditions consisting of few, isolated trees and no tree groves. Would favor native species associated with relatively small groves of native trees and shrubs, and the abundance. Richness of species that now use nonnative shelterbelts would likely be reduced.</p> <p>May affect hunters by affecting proposed deer and turkey hunting.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Woodland—environmental consequences (continued)		
<p>Economical—Costs would increase in the short term with reduction followed by habitat restoration. Subsequent costs would decrease in part because of a reduction in invasive species and woody encroachment control. Costs related to water use and availability would decrease with the substantial reductions in tree cover, especially saltcedar along the riparian corridor.</p> <p>Cultural and historic—Would bring communities closer to what occurred in presettlement times.</p>		
Sand Prairie Complex—actions		
<p>Control woody vegetation and conserve the unfarmed areas by using fire, grazing, and mechanical and chemical treatments.</p> <p>Reduce occurrence and control encroachment of invasive woody species to what is believed to have occurred historically.</p> <p>Manage upland sand prairie to support native communities, while keeping a high level of habitat diversity.</p> <p>Evaluate trade-offs and set priorities for woody vegetation to sustain native communities, but also consider supporting other conservation concerns.</p>	<p>Same as alternative A, except: reduce woody vegetation, to help focal species.</p>	<p>Same as alternative A, except restore natural functions and native plant and wildlife communities.</p>
<i>Water Management</i> —None.	<i>Water Management</i> —Same as alternative A.	<i>Water Management</i> —Same as alternative A.
<i>Grazing</i> —Prescriptions would vary by target such as cattail control, vegetation composition and structural diversity, and soil disturbance.	<i>Grazing</i> —Same as alternative A, except focus on helping focal species.	<i>Grazing</i> —Base prescriptions on restoring and supporting native plant communities, including the creation of sand blowouts and active sand dunes. Evaluate the use of bison.
<i>Fire</i> —Target prescriptions to control invasive species, stimulate growth, and remove litter.	<i>Fire</i> —Same as alternative A, except focus on helping focal species.	<i>Fire</i> —Base prescriptions to support native plant communities. Consider patch burn grazing.
<i>Chemical and Mechanical Treatments</i> —Use as needed to control invasive species.	<i>Chemical and Mechanical Treatments</i> —Same as alternative A, except focus on helping focal species.	<i>Chemical and Mechanical Treatments</i> —Use only when fire and herbivory are ineffective.
<i>Infrastructure</i> —No change.	<i>Infrastructure</i> —Remove to improve sheet flow. Use temporary fences to control vegetation and create structure for focal species.	<i>Infrastructure</i> —Remove or alter to restore hydrology and promote native plants. Fence for restoration, then remove what is not essential.

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Sand Prairie Complex—environmental consequences		
<p>Woodlands would threaten ecosystems and the presence, abundance, nesting success, and local composition of grassland birds through avoidance, lower species density or nest success, and increased predation and parasitism.</p> <p>Shrubs would affect grasslands like trees do. Native grasses may out-compete cheatgrass with the effects of cattle and trees removed and tall shrubs mowed.</p> <p>Might see wider range of habitat and wildlife use and more wildlife diversity and abundance, but focal species may not be adequately managed. Species of little concern would likely benefit more.</p> <p><i>Economical</i>—Reducing trees and shrubs would decrease costs.</p> <p><i>Cultural and Historic</i>—Would approach presettlement conditions.</p>	<p>Same as alternative A, except species that are of conservation concern would benefit more.</p> <p>Treatments costs would be unknown but would differ from alternative A. They would be less than under alternative C.</p> <p>More specific monitoring measures and subsequent feedback would measure progress and help develop recommendations.</p>	<p>Would restore communities and functions better than alternative B.</p> <p><i>Social</i>—Would expect mixed reactions from different interest groups if bison were introduced and areas were to be closed to the public for safety reasons.</p> <p><i>Economical</i>—Costs would likely increase initially to change infrastructure and reduce invasive species. Monitoring programs would increase to evaluate the effects of infrastructure changes.</p> <p>For bison, would consider adding boundary fences, removing most fencing within the refuge, coordinating the burning program, screening for health and culling the herd, constructing and maintaining a handling facility and water tanks, and moving bison safely and logistically. While there may be added costs, tourism may increase.</p>
Cropland—actions		
<p>Manage current acreage with cooperative farming agreements using annual seed cover crops. Convert farmed lands to native communities as cooperators voluntarily withdraw.</p> <p>Gradually reseed to restore native community. Actively manage planted areas. Aggressively control invasive plants.</p>	<p>Same as alternative A, except reseed and restore areas that were farmed before and that have been allowed to revegetate without human intervention to native communities.</p>	<p>Same as alternative B, except restoring cropland to native communities would occur quicker because more resources would be devoted and our cooperators would be informed.</p>
Cropland—environmental consequences		
<p>Would harvest restored areas for seed. Would not affect food for regional and national waterfowl population goals. Presume that removal would improve conditions.</p> <p>High deer densities would be tied to winter wheat crops and waste grains. Visitors may be drawn to these areas, as many are near roads and would have lots of deer and waterfowl that would, however, also use the rest of the refuge.</p> <p>Farming would encourage annual invasive species establishment and spread because of equipment and disturbances to bare ground.</p>	<p>Same as alternative A except more areas would be reseeded instead of being left to naturally go back to a native community. This would speed the recovery of cropped acreage, but would cost more in time and money than alternative A.</p> <p>There would be few negative or positive effects related to public use because these areas do not have the same types of wildlife use and public viewing opportunities as cropland.</p>	<p>Would accelerate restoration and consume more time and money than alternatives A or B, resulting in faster restoration of native communities. Effects would be the same as under alternative B, except benefits to wildlife would occur sooner.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Migratory Birds—actions		
<i>Wetlands</i> —Manage to provide migratory habitat and emphasize waterfowl, cranes, shorebirds, and rails, as well as nesting interior least tern and snowy plover and migratory whooping cranes.	<i>Wetlands</i> —Same as alternative A.	<i>Wetlands</i> —Same as alternative A.
<i>Herbaceous Uplands</i> —Manage to provide migratory and nesting habitat and emphasize grassland and meadow wildlife communities.	<i>Herbaceous Uplands</i> —Emphasis obligate grassland and meadow birds and focal species.	<i>Herbaceous Uplands</i> —Same as alternative B.
<i>Woodlands</i> —Keep some to provide habitat for rookeries and for indirect benefits to neotropical migrants.	<i>Woodlands</i> —Keep less than under alternative A.	<i>Woodlands</i> —Remove.
Migratory Birds—environmental consequences		
<p>Would promote a wide diversity and abundance of migratory birds.</p> <p>Would reduce habitat for heron rookeries, raptor perching, some neotropical migrant resting and foraging, and other tree- and shrub-associated species use. Would increase the migration and nesting activities of endemic grassland birds. May decrease predation of eggs, young, and adult birds.</p> <p>Benefits would decrease for certain generalist species that have benefited from human modifications to the landscape, but they may be supported by habitat conditions occurring beyond refuge boundaries.</p> <p>Would support species recovery plans and various regional and national bird conservation plans.</p>	<p>Same as alternative A, except for an increase of potential benefits to endemic and obligate grassland species and waterbirds adapted to environments with fewer trees and shrubs. Would be reduced benefits for tree- and shrub-dependent species.</p>	<p>Would likely decrease the overall abundance of migratory birds because of potential changes in hydrology, refuge infrastructure, and management.</p> <p>Wading bird rookeries would likely exist off of the refuge, and other tree-nesting species would decline on the refuge. Conditions removed here would continue to be commonly found, and increase, on both the regional and State levels.</p> <p>Provided water would be managed at the watershed level. Would support long-term ecosystem sustainability and productivity and would continue to provide long-term benefits to migratory birds.</p>
Fish—actions		
<p>Control undesirable fish like carp primarily with periodic drying. Use chemicals rarely when drying is difficult or impossible.</p> <p>Conserve native fish communities while supporting native habitats.</p> <p>Reduce invasive plants.</p> <p>Avoid stocking and introduction that favor nonnative fish over native fish, except for at the Kid's Fishing Pond where stocking is for public use and education.</p>	<p>Same as alternative A, except would evaluate creating and keeping suitable habitat in targeted areas to support native species.</p> <p>Would work with partners to carry out habitat management actions and to reintroduce species.</p>	<p>Same as alternative B, except that the Kids' Fishing Pond would be restored to its original habitat as much as possible.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Fish—environmental consequences		
<p>Would improve water quality with the control of carp and other undesirable fish. Species would continue to enter via Rattlesnake Creek inflows and through upstream migration via Salt Creek and Rattlesnake Creek.</p> <p>Would encourage a more natural range of high salinity and other water quality conditions in the BSM area to support native fish that tolerate high salinity.</p> <p>Would conserve the Boiling Springs freshwater habitat to support a source population of State-threatened Arkansas darters.</p> <p>Would avoid the stocking of nonnative fish to reduce the likelihood of introducing foreign or unwanted diseases and pathogens to resident aquatic species.</p> <p>Crayfish populations would continue to predate on, and compete for, food and shelter with some wildlife species and provide food and shelter for others.</p>	<p>Same as alternative A, except would improve the conservation of native fish populations by reintroducing native fish and by evaluating, creating, and keeping more suitable habitat in targeted areas both on and off the refuge through partnerships.</p> <p>Would further reduce the likelihood of introducing diseases and pathogens to existing refuge populations of aquatic species by not allowing the use of live fish bait.</p> <p>Would allow frogging—bullfrogs only—which may introduce changes in fish populations and other associated links in the ecosystem, though the level of take is not expected to have major effects.</p>	<p>Same as alternative B, except that improvements in water quality and restored hydrology would be expected to help fish populations native to prairie streams.</p> <p>Sport and nonnative fish populations would likely decline with the removal of Kid's Fishing Pond because regular stocking would no longer occur.</p> <p>Conditions would vary in wet and dry years. The extent and duration of deep, permanent water on the refuge connected to Rattlesnake Creek would likely be reduced, thus adversely affecting nonnative or sport fish occurrence and survival. However, some of the natural sloughs and ponds and riffle pools that have areas that are periodically isolated from the creek may function better to conserve native prairie fish populations. Also, there may be improved habitat for certain life cycle events of native fish in certain year or overall.</p> <p>Because of reduced water control, there may be occasional issues related to carp or other undesirable fish.</p>
Threatened and Endangered Species and Species of Concern—actions		
<p>Keep existing designated critical habitat for T and E species.</p> <p>Maintain federally designated critical habitat for whooping cranes.</p> <p>Maintain State-designated critical habitat for snowy plover, Arkansas Darter, and interior least tern, which is also federally listed.</p> <p>Support T and E species recovery implementation plan actions.</p>	<p>Same as alternative A, except would develop prescriptions that explicitly address the habitat needs of species of concern as well as State- and federally listed fish and herptiles.</p>	<p>Same as alternative B, except prescriptions would be based more on keeping native communities and processes than on providing for the habitat needs of species. May provide reduced habitat for interior least tern, snowy plover, and whooping crane.</p> <p>Would evaluate the introduction of bison and other extirpated species.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Threatened and Endangered Species and Species of Concern—environmental consequences		
<p>Reduce woody vegetation would improve habitat conditions for all listed species except, possibly, the eastern spotted skunk.</p> <p>Predation of eggs, young, and adults may decrease.</p>	<p>Same as alternative A, except a shift in management focus and more quantitative checking of management effects may increase potential benefits for species.</p>	<p>Same as alternative A, except limited control may make habitat availability less dependable within, and among, years. Reintroduced species may benefit.</p> <p>Provided water would be managed at a watershed level and may support long-term ecosystem sustainability and productivity and species benefits.</p> <p>Would manage the BSM to more closely mimic presettlement times, benefiting some species over others.</p> <p>Traditional least tern nesting areas would likely flood less because water would not be kept artificially high in the spring, the basin would have more room to store rainfall, and artificial dikes and roads that impede water-flow would be removed.</p>
Wildlife Native to the Region—actions		
<p>Support native habitat communities. Manage habitat in ways that indirectly help species.</p>	<p>Same as alternative A, except add a greater level of management for focal species.</p>	<p>Same as alternative B, except increase scale. Base prescriptions more on processes and plant community characteristics.</p>
Wildlife Native to the Region—environmental consequences		
<p>Species diversity would be supported at regional, landscape, and national levels.</p> <p>Species associated with woody habitat would decrease within refuge boundaries, while native endemic species associated with open grassland would increase.</p>	<p>Same as alternative A, except that benefits to endemic and obligate grassland species and wetland species adapted to environments with less coverage of trees and shrubs would increase.</p>	<p>Same as alternative B, except the overall abundance would likely be mixed depending on species and conditions. Wildlife populations would likely experience more dynamic fluctuations within, and among, years.</p> <p>Long-term ecosystem sustainability and productivity would be maximized and provide long-term benefits to wildlife.</p> <p>If patch burning occurs, it may benefit species diversity.</p>
Wildlife Health—actions		
<p>Promote habitat conditions that decrease adverse health conditions.</p> <p>Watch for wildlife disease outbreaks regularly using formal or informal protocols and encourage testing for diseases or contaminants of potential concern. Support actions to address observed signals and symptoms and regional health trends.</p>	<p>Same as alternative A, except emphasize water quality and quantity to detect changes that may adversely affect refuge resources.</p> <p>Allow trapping of nuisance animals with a special use permit.</p>	<p>Same as alternative A, except watch a broader suite of environmental conditions related to diseases.</p> <p>Increase wildlife health surveillance including proactive health checks.</p> <p>Trapping of nuisance animals would be the same as alternative B.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Wildlife Health—environmental consequences		
<p>Would keep contaminant levels within a normal range for the ecosystem.</p> <p>Changes in deer distribution may occur and contact rates should decline. The potential effects of chronic wasting disease may decrease.</p>	<p>Same as alternative A, except emphasize water sampling to improve the early detection of potentially adverse conditions, and possibly prevent substantial wildlife die-offs. Would regularly sample water and, possibly, soil in and near streams and tributaries, ditches, and oil wells on the refuge to track trends in contaminant levels.</p> <p>Changes in hunting regulations may improve wildlife health conditions, specifically for the current high-density deer population.</p> <p>Trapping could help control disease and nuisance animals, which would directly help wildlife. There would be a small economic benefit to trappers, who would most likely be locals.</p>	<p>Same as alternative A, except a broader suite of environmental conditions would be watched, further improving wildlife health.</p> <p>A possible reduction in the control of water may result in a decrease in managing disease and health concerns.</p> <p>Management for ecosystem sustainability may increase resiliency, barring human-caused disasters such as an oil spill.</p> <p>If bison are introduced, wildlife health issues, such as disease transmission among bison and other herbivores, may increase.</p> <p>Trapping effects would be the same as alternative B.</p>
Inventory, Monitoring, and Research—actions		
<p>Continue to evaluate current activities and end or revise.</p> <p>Organize, review, and synthesize information relevant to biology and the management of the refuge and develop a vegetation cover map.</p> <p>Develop new protocols to improve monitoring programs for water quality, nesting least terns, and vegetation conditions in a manner that is practical and useful.</p> <p>Encourage informative research. Allow activities compatible with goals and objectives, involve good communication with refuge staff, provide information related to refuge resources and management, and may address a current and potential future conservation or societal issue.</p>	<p>Same as alternative A, except emphasize developing monitoring protocols that would provide the information necessary to improve decisions. Base research on need or on cooperation in landscape-level monitoring programs and studies.</p>	<p>Same as alternative B, except use better monitoring programs for habitat and populations before allowing uses like hunting.</p>
Inventory, Monitoring, and Research—environmental consequences		
<p>Would inform about factors within refuge boundaries, and provide indications of how management may influence conditions.</p> <p>Monitoring programs would involve relatively broad-scale measures and, perhaps, less intensive sampling.</p> <p>Would support management and resources of concern and support the interests of conservation programs and groups, educational institutions, and local economies.</p>	<p>Same as alternative A, except that monitoring measures related to species-habitat needs would be more specific. Bell's vireo or upland sandpiper would likely benefit as a result of this finer level of checking.</p> <p>More specific monitoring measures and subsequent feedback would be involved to measure progress and to help with recommendations.</p>	<p>Same as alternative B, except those activities related to biological factors would be more extensive.</p> <p>Activities would be needed to evaluate the accomplishments of restoration activities before and after program implementation.</p> <p>Monitoring programs would be more costly.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

Alternative A—no action	Alternative B—proposed action	Alternative C
Visitor Services Goal. See that visitors enjoy quality, wildlife-dependent recreational opportunities.		
Hunting—actions		
<p>Migratory Birds—Permit for mourning dove, snipe, rail, and waterfowl in accordance with State seasons. Allow on no more area than what is approved now. Do not permit when whooping cranes are present. Make waterfowl hunting blind accessible by reservation</p> <p>Upland Game—Permit for pheasant, quail, rabbits, and squirrel in accordance with State seasons.</p> <p>Deer, Turkey, Sandhill Crane, Prairie-chicken, Furbearers—Do not permit.</p>	<p>Migratory Birds—Same as alternative A, except change hunt area to reduce conflict with whooping crane use areas. Close specific units when whooping cranes are present, similar to Cheyenne Bottoms.</p> <p>Upland Game—Change the hunt area to reduce conflict with whooping crane use. Do not tie upland game areas specifically to waterfowl hunting areas. Close specific units if whooping cranes are present.</p> <p>Deer—Select an area open for hunting and set limits based on herd health and population targets. Establish with help from the State. Close specific units if whooping cranes are present.</p> <p>Turkey—Select an area open for hunting. This would be established with help from the State. Close specific units when whooping cranes are present.</p> <p>Sandhill Crane—Do not allow.</p> <p>Prairie-chicken—Allow if refuge population can support it or for health purposes, as decided by staff. Close specific units when whooping cranes are present.</p> <p>Furbearers—Allow only with shot-gun or archery if refuge population can support it or for health purposes.</p>	<p>Migratory Birds—Same as alternative A, except permit if refuge populations allow or for health purposes. Close when whooping cranes are present.</p> <p>Upland Game—Allow if refuge populations can support it or for health purposes. Close specific units when whooping cranes are present.</p> <p>Deer—Allow if refuge population can support it or for health purposes, as decided by staff. Employ special regulations. Close specific units when whooping cranes are present.</p> <p>Turkey—Allow if refuge population can support it or for health purposes, as decided by staff. Close specific units when whooping cranes are present.</p> <p>Sandhill Crane—Allow if refuge population can support it or for health purposes. Close when whooping cranes are present.</p> <p>Prairie-chicken—Allow if refuge population can support it or for health purposes, as decided by the State. Close specific units when whooping cranes are present.</p> <p>Furbearers—Allow only with shot-gun or archery, if refuge population can support it or for health purposes.</p>
Hunting—environmental consequences		
<p>Deer—White-tailed deer should continue to increase until artificial controls, such as hunting, or natural controls, such as disease, change this trend.</p> <p>May exceed habitat carrying capacity threshold and deer health and habitat may decline. High deer populations may negatively affect native forbs and shrubs.</p> <p>Chronic wasting disease in deer may come closer to the refuge.</p> <p>Would offer spectacular deer viewing.</p> <p>High deer populations could become a traffic safety concern.</p> <p>Increased poaching could affect law enforcement.</p> <p>Would not allow the retrieval of deer that were originally shot off the refuge.</p>	<p>Migratory Birds—Changes in water management in response to hunting would provide higher-quality, moist-soil habitat that would attract more waterfowl.</p> <p>Deer—Would develop hunt plan to involve archery-only or youth-archery-and-muzzleloader-only seasons, with limited entry by draws for all hunt seasons. Would explore all possibilities for hunting deer and consider visitor safety.</p> <p>Would want to know if selected harvest strategies could result in reduced deer count, though such information may be hard to get.</p> <p>Would create more opportunities for hunting on public lands.</p> <p>Deer would become more wary and difficult to closely observe and photograph.</p>	<p>Priority would be on the protection of resources. There would continue to be no migratory bird hunting when whooping cranes are present.</p> <p>All other hunting, including upland game hunting, would continue but would be closed in specific units when whooping cranes are present. There would be more upland bird hunting with little-to-no risk to whooping cranes.</p> <p>Migratory Birds—Waterfowl and other migratory bird hunting should decline with less consistent water conditions in the fall.</p> <p>Deer, Turkey, Prairie-chicken, Furbearers—Would be the same as under alternative B.</p> <p>Added costs would be the same as under alternative B.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Hunting—environmental consequences (continued)		
<p><i>Whooping crane protection</i>—Increased whooping crane use may limit hunting, leading to continued hunter frustration.</p>	<p>Hunters and nonhunters may interact more because of an increase in hunting.</p> <p>Youth and muzzleloader hunting could increase the range of firearms used on the refuge and increase safety issues for hunters and nonhunters, while also allow for more opportunities for various hunters, more harvest, meeting the goal for increased youth hunting, and decreasing deer densities.</p> <p>The retrieval of deer that were originally shot off the refuge could be allowed. Requests for hunters to enter the refuge to retrieve deer may result in many calls during nonworking hours, leading to hunter frustration. Costs may increase when employees return to work to retrieve a deer.</p> <p><i>Turkey, Prairie-chicken, and Furbearers</i>—Would promote the mission of the Refuge System and provide more opportunities without jeopardizing wildlife populations.</p> <p><i>Whooping crane protection</i>—More law enforcement, signage and communications would be required. The popular salt flats and North Lake areas would be closed to hunting but a similarly sized area less prone to closure would be opened to negate effects.</p> <p>There would be more parking areas and roads for access and more costs related to changing hunt areas, signage, parking lots, brochures and adding law enforcement.</p>	<p><i>Whooping crane protection</i>—Whooping crane use may shift with the unpredictability of conditions from year to year, which would also affect hunting. Would increase public awareness of cranes using kiosks, signage, and public programs.</p> <p><i>Bison protection</i>—If restored to Quivira, hunting opportunities may have to be altered to prevent bison-hunter interactions in the field. Refuge policy prevents the hunting of captive herds of ungulates on refuges, so a hunting season on bison would not be allowed.</p>
Fishing—actions		
<p>Allow fishing on all waters according to State-established seasons and regulations.</p> <p>Allow yearlong use of the Kids' Fishing Pond with a one-fish limit only to children age 14 and under and for adults with an eligible child fishing with them, unless otherwise posted for management or safety reasons.</p> <p>Do not allow frogging and the hunting of turtle or other herptiles.</p> <p>Do not allow bait collecting and the use of live fish bait. Permit night crawlers.</p> <p>Do not allow crayfish fishing.</p>	<p>Same as alternative A, except there would be no stocking outside of Kids' Fishing Pond.</p> <p>Only allow the frogging of bullfrogs.</p>	<p>Allow fish and herptiles if their populations support it or for health purposes.</p> <p>More aggressively control nonnative fish and herptiles.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Fishing—environmental consequences		
<p>Would be low quality because of carp infestations.</p> <p>Would draw mostly local people who would return often. Those from outside the local area may come during the annual Kid's Fishing Day.</p> <p>Many of the other waters on the refuge undergo periodic drying to manage wetlands for migratory birds, which reduces, or stops, the possibility of establishing other fishing areas that could be kept except for possibly at Darrynane Lake.</p> <p>No live fish bait, except for night crawlers, would be permitted to avoid introducing exotic or invasive fish into the refuge. Enforcing no bait collecting would be difficult if crayfish fishing were allowed.</p>	<p>Fishing activities would likely increase with the periodic removal of carp.</p> <p>More bait fish would be available because there would be no bait fish collecting.</p> <p>The harvesting of bullfrogs could be sustained.</p> <p>Economic and social activities would be the same as under alternative A.</p>	<p>Quality would improve with the control of carp and the restocking of native fish.</p> <p>Would require more monitoring programs for fish, reptile and amphibian populations for sustainability.</p> <p>More aggressive control on nonnative fish, reptiles, and amphibians would increase costs.</p> <p>Depending on the activity, permits may have to be issued for some fishing, such as for turtling, or for frogging.</p> <p>Costs related to stocking the Kid's Fishing Pond would decrease.</p>
Wildlife Observation and Photography—actions		
<p>Encourage wildlife observation and photography except in seasonally closed areas.</p> <p>Keep the auto tour route, the observation towers, scopes, and two photography blinds.</p> <p>Provide from sunrise to sunset daily at the GPNC.</p> <p><i>Horseback Riding</i>—Allow only on public and county roads, not on hiking trails.</p> <p><i>Bicycling</i>—Allow on existing roads.</p> <p><i>Dogs</i>—Allow when under owners' control.</p>	<p>Same as alternative A.</p>	<p>Same as alternative A, except restrict public entry to select roads during nesting season.</p> <p>Close Wildlife Drive during nesting season and evaluate the potential environmental effects of Wildlife Drive and human use of the area during the next 15 years.</p>
Wildlife Observation and Photography—environmental consequences		
<p>Would be affected when closing areas seasonally to prevent disturbance to bald eagles and tern nesting sites and for other, changing conditions like the presence of whooping crane roosting areas.</p> <p>Horseback riding may continue to spread invasive species on access roads. But use would be low and the effects negligible.</p>	<p>Same as alternative A.</p>	<p>Same as alternative A, except more closures would be carried out during the nesting season.</p> <p>If results of an evaluation support bison management, then there would be mixed effects. For instance, areas would be closed to the public for safety reasons, but the presence of bison might provide a new attraction.</p>
Environmental education and interpretation—actions		
<p>Allow environmental education programs at both Quivira Refuge and the GPNC that provide curriculum-based programs for all school grade levels to help in meeting State educational standards.</p>	<p>Same as alternative A, except emphasize focal species.</p> <p>Enhance environmental education through improvements to facilities at both Quivira Refuge and the GPNC.</p>	<p>Same as alternative B, except may alter or remove some roads to support ecological restoration.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Environmental Education and Interpretation—actions (continued)		
<p>Allow onsite and offsite programs at the GPNC for underserved audiences like at-risk youth.</p> <p>Promote the use of both Quivira Refuge and GPNC facilities as outdoor classrooms.</p> <p>Keep current or improved staff levels and partnerships at the GPNC.</p> <p>Provide interpretive programs on request and as scheduled activities at Quivira Refuge and the GPNC.</p>	<p>Move the environmental education classroom to a site near headquarters.</p> <p>Encourage virtual geocaching.</p>	<p>Emphasize the benefits of ecological restoration through environmental education and interpretation programs.</p>
Environmental Education and Interpretation—environmental consequences		
<p>Environmental education and interpretive programs would help meeting State educational standards and teach environmental ethics and awareness.</p> <p>Programs would help foster an interest in, and a sense of stewardship of, public lands such as national wildlife refuges.</p>	<p>A growing environmental education program would require more space at the GPNC, such as a larger classroom, multipurpose room and office space.</p> <p>Moving the environmental education classroom would consolidate facilities, improve the environmental education capabilities, and further the development of a comprehensive program.</p> <p>Virtual geocaching would increase the public's appreciation of refuge resources.</p>	<p>Same as alternative B, except: environmental education and interpretive programs may be affected if facilities are modified or removed. Would attempt to replace facilities and programs in new locations. There would be an opportunity to learn more about the benefits of healthy ecosystems, natural processes, and managing for sustainable systems.</p>
Other Uses—actions		
<p>Allow all areas to remain open unless otherwise closed for management or safety reasons. Do not allow public to drive on closed roads and trails.</p> <p><i>Field trials and dog training</i>—Allow for individuals, but not for commercial operators. Do not allow during nesting season.</p> <p><i>Firewood cutting</i>—Allow in designated areas and with an approved special use permit.</p> <p><i>Commercial tours (birding)</i>—Allow with a special use permit.</p> <p><i>Amphibian, crayfish and reptile collecting; antler collecting; berry, fruit, roots, and mushroom harvesting; wildflower collecting; geocaching; commercial photography; boating; camping; recreational trapping; dog field trial; off-road vehicle use; and commercial guiding for hunting.</i>—Do not allow.</p>	<p>Same as alternative A, except allow commercial photography with a special use permit.</p>	<p>Same as alternative B.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Other Uses—environmental consequences		
<p>Restricted public vehicle access would decrease wildlife disturbance and limit road costs.</p> <p>Trained dogs that retrieve game, horseback riding, and bicycling would allow greater access and should pose little negative effect on wildlife or other public uses. Would be reevaluated if wildlife disturbances occur.</p> <p>Regulations and restrictions would continue to prevent wildlife disturbance, the removal of wildlife food and parts of plants, and commercial activities. Would have little economic effect, as few would conduct or request these activities.</p>	<p>Same as alternative A, except commercial photography would expand opportunities for photographers and enhance the public’s appreciation of wildlife.</p>	<p>Same as alternative B.</p>
<p>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.</p>		
Public Outreach—actions		
<p>Reach out to local civic and environmental organizations emphasizing management issues and philosophy, endangered species, and other subjects, both on and offsite.</p> <p>Work with Friends of Quivira and Friends of the GPNC to increase awareness and outreach. Contribute articles to the Friends newsletter. Hold events several times a year at the refuge and GPNC to promote mission, activities, and goals.</p> <p>Keep and update the refuge Web site and social media to on operations, hunting, events, and wildlife sightings.</p> <p>Develop, support, and staff information booth at the Kansas State Fair.</p> <p>Recruit, train, and use local volunteers to further goals at the refuge and GPNC.</p>	<p>Same as alternative A, plus install tower camera at the bald eagle and BSM areas to provide more observation opportunities of remote wildlife. Encourage refuge visitation and increased positive personal experiences with natural resources.</p>	<p>Same as alternative B.</p>
Public Outreach—environmental consequences		
<p>Would foster appreciation of wildlife and the outdoors and instill a sense of stewardship of lands like Quivira Refuge.</p> <p>Would encourage youth to study wildlife through the Junior Federal Duck Stamp program and to become engaged by displaying their artwork at many locations throughout the State during the year.</p>	<p>Same as alternative A, except would also provide more observation of remote wildlife, encourage refuge visitation, and increase positive personal experiences with natural resources. Tower camera viewers would not need to leave their homes to see the refuge, which might negatively affect initiatives like Get Outside and Connect with Nature. These viewers may also become more interested in seeing the action in person.</p>	<p>Same as alternative B, but would emphasize awareness of the benefits of ecological restoration and healthy natural systems.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Public Outreach—environmental consequences (continued)		
Updated Web sites and social media would provide the most current information for visitors to the refuge.	The tower camera should not negatively affect wildlife or habitat, though there would be short-term effects during installation. There would be more costs for installation and operation of the remote tower camera. Donations may be requested and used to offset costs. Outreach efforts would place more emphasis on teaching about focal species.	
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.		
Cultural Resources—actions		
Obtain permits and clearances before substantial dirt or surface alteration. Protect cultural resources in accordance with Federal and State laws, policies and guidelines. Consult regional archeologist during the planning phase of proposed projects to decide on the need for an archeological site clearance from the Kansas State Historic Preservation Office.	Same as alternative A, except increase the interpretation of cultural resources and, specifically, of Native American historic use of the refuge through exhibits and signage.	Same as alternative B.
Cultural Resources—environmental consequences		
Would protect resources according to existing rules and regulations. Would document and protect new cultural resources as discovered.	Same as alternative A, except public knowledge of historic Native American use for gathering, hunting, and salt collecting would increase.	Same as alternative B.
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.		
Visitor and Employee Safety—actions		
Keep current Station Safety plans providing emergency contacts, procedures, and training for all employees. Keep public safety in mind when providing emergency shelters, accessibility, and when supporting trails and roads. Keep and update directional and safety signage along public roads. Follow infectious disease plan and policy.	Same as alternative A.	Same as alternative A.
Visitor and Employee Safety—environmental consequences		
Would support visitor and employee safety.	Same as alternative A.	Same as alternative A, except visitor and employee dangers would be heightened if bison are introduced to the refuge. Would require employee training to work with, and around, bison and would incur more costs for employee training and safety needs.

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Resource Protection—actions		
<p>Protect critical nesting habitat and enforce hunting, fishing, and all other regulations in CFR and State laws.</p> <p>Do not allow hunting when whooping cranes are present.</p> <p>Close areas that are actively being used by nesting T and E species.</p>	<p>Same as alternative A, except alter hunting areas and establish new regulations for closed areas when whooping cranes are present.</p>	<p>Same as alternative A, except restrict waterfowl and sandhill crane hunting when whooping cranes are present.</p> <p>Increase efforts to enforce regulations related to closed areas.</p>
Resource Protection—environmental consequences		
<p>Law enforcement would adequately protect refuge resources.</p>	<p>Same as alternative A, except more species would be permitted to be taken by, hunting, fishing and trapping.</p> <p>Increased visitor use would require more law enforcement to enforce compliance with regulations. The increased workload would require one full time refuge officer and two dual-function officers to adequately enforce the increased use.</p>	<p>Same as alternative B, plus sandhill crane hunting would be permitted, which would require increased law enforcement. Because of the sandhill crane’s similarity in appearance to the whooping crane, increased staff time would be needed to more closely watch whooping crane locations to prevent an accidental shooting. Increased whooping crane education would be result from more signage, kiosk displays, and handouts.</p>
<p>Administration Goal. Provide and support facilities, strategically acquire and allocate staff, increase volunteer opportunities and partnerships, and effectively raise and use money to keep the long-term integrity of infrastructure, habitats, and wildlife resources at the refuge and Great Plains Nature Center.</p>		
Staff and Budget—actions		
<p>Support 11 permanent full-time employees, 1 permanent part-time employee, 3 temporary employees, and 2 regional employees that are not paid through the refuge.</p> <p>Find needed positions and projects in RONS database and in a separate law enforcement needs list. Top priority in RONS is one full-time maintenance worker. Law Enforcement has identified one full-time refuge officer.</p> <p>Use YCC program.</p> <p>Seek money through grants and initiatives for staff and projects.</p> <p>Continue to provide office space for a zone biologist and a Partners biologist.</p>	<p>Same as alternative A.</p>	<p>Same as alternative A, except increase biological staff with two permanent, full-time positions to expand inventory and monitoring efforts.</p> <p>Increase permanent, full-time staff by one to control invasive species because work would increase with the full restoration of native communities.</p>
Staff and Budget—environmental consequences		
<p>Budget would be adequate to keep staff and facilities.</p>	<p>Same as alternative A.</p>	<p>More staff would make implementation more successful.</p>
Facilities and Infrastructure—actions		
<p>Keep more than 21 miles of canals, 24 miles of dikes and more than 100 water control structures. Keep 14 miles of roads and 33 parking lots for public use and 27 miles of roads for management. Keep more than 97 miles of barbwire and 54 miles of electric fencing for grazing.</p>	<p>Same as alternative A, except request another cold storage building and a fire cache.</p> <p>Request more space at the GPNC for a larger classroom, a multipurpose room, and for office space. Need another storage building and a larger equipment compound.</p>	<p>Same as alternative B, except reduce trails, parking lots, roads, dikes, canals, water control structures, and fences.</p> <p>Decrease or remove developments like trails that facilitate the spread of invasive species or otherwise negatively affect biological populations.</p>

Table 4. Summary of the actions and consequences of the management alternatives for the Comprehensive Conservation Plan for Quivira National Wildlife Refuge, Kansas.

<i>Alternative A—no action</i>	<i>Alternative B—proposed action</i>	<i>Alternative C</i>
Facilities and Infrastructure—actions (continued)		
<p>Keep refuge office, visitor center, maintenance shop, three storage buildings, one pole barn, environmental education classroom, two residences and two bunkhouses. Keep GPNC visitor center, classrooms, offices, auditorium and storage garage.</p> <p>Provide both interactive and static displays at both visitor centers.</p> <p>Keep two areas of pedestrian trails at the refuge. Keep trails and structures, like bridges, signs, and boardwalks.</p> <p>Use the GPNC’s classrooms and Quivira Refuge’s environmental education classroom for education and interpretive programs and for workshops open to the public.</p>	<p>Move environmental education classroom at Quivira Refuge to a location near headquarters, but keep a restroom in the current environmental education area.</p> <p>Allow trapping only for wildlife and infrastructure purposes and with a special use permit.</p>	<p>Remove unnecessary roads and use canals only to spread waterflow over the refuge in sheet flow to mimic natural flooding and drying.</p> <p>Construct more spillways to spread sheet flow out of Rattlesnake Creek and across meadows and wetlands.</p> <p>If bison are reintroduced, fence large blocks of land to allow bison to move on their own and graze as much as possible in a natural setting.</p> <p>Trapping would be the same as alternative B.</p>
Facilities and Infrastructure—environmental consequences		
<p>Extensive water management facilities would require annual maintenance money and recurring structure replacement.</p> <p>Rehabilitation and replacement of structures would be more intensive dues to saltwater. Stainless steel would be used whenever possible as a result but at a higher cost. ABS plastic culverts would be used when possible, to combat deterioration.</p> <p>The shop bay would be too short to allow some heavy equipment to be moved inside for maintenance and repair.</p> <p>Vehicle and equipment storage would be inadequate because there is not enough room for all vehicles to be kept inside and protected from packrats. Biological controls, like barn owl nest boxes, would be kept, but a few expensive vehicle and equipment repairs would be expected.</p> <p>Non-Quivira Refuge employees would sometimes be stationed at the refuge and need storage space for vehicles and equipment.</p> <p>Would support the GPNC building and storage garage with annual maintenance money and with deferred maintenance money for large projects. Settling cracks would require maintenance.</p>	<p>Same as alternative A, except more money would be needed to buy more facilities and for their long-term maintenance.</p> <p>Trapping could help control nuisance animals, which would directly help refuge operations in preserving infrastructure. There would be a small economic benefit to trappers, who would most likely be locals.</p>	<p>Same as alternative B for buildings at Quivira Refuge and at the GPNC, but much of the other infrastructure would be reduced or removed to complete the ecological restoration.</p> <p>The initial cost may be higher, but it would result in long-term cost savings by reducing the maintenance of structures.</p> <p>Trapping effects would be the same as alternative B.</p>

Chapter 4—Affected Environment



© 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.

4.1 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 the 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 precipita-

tion 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

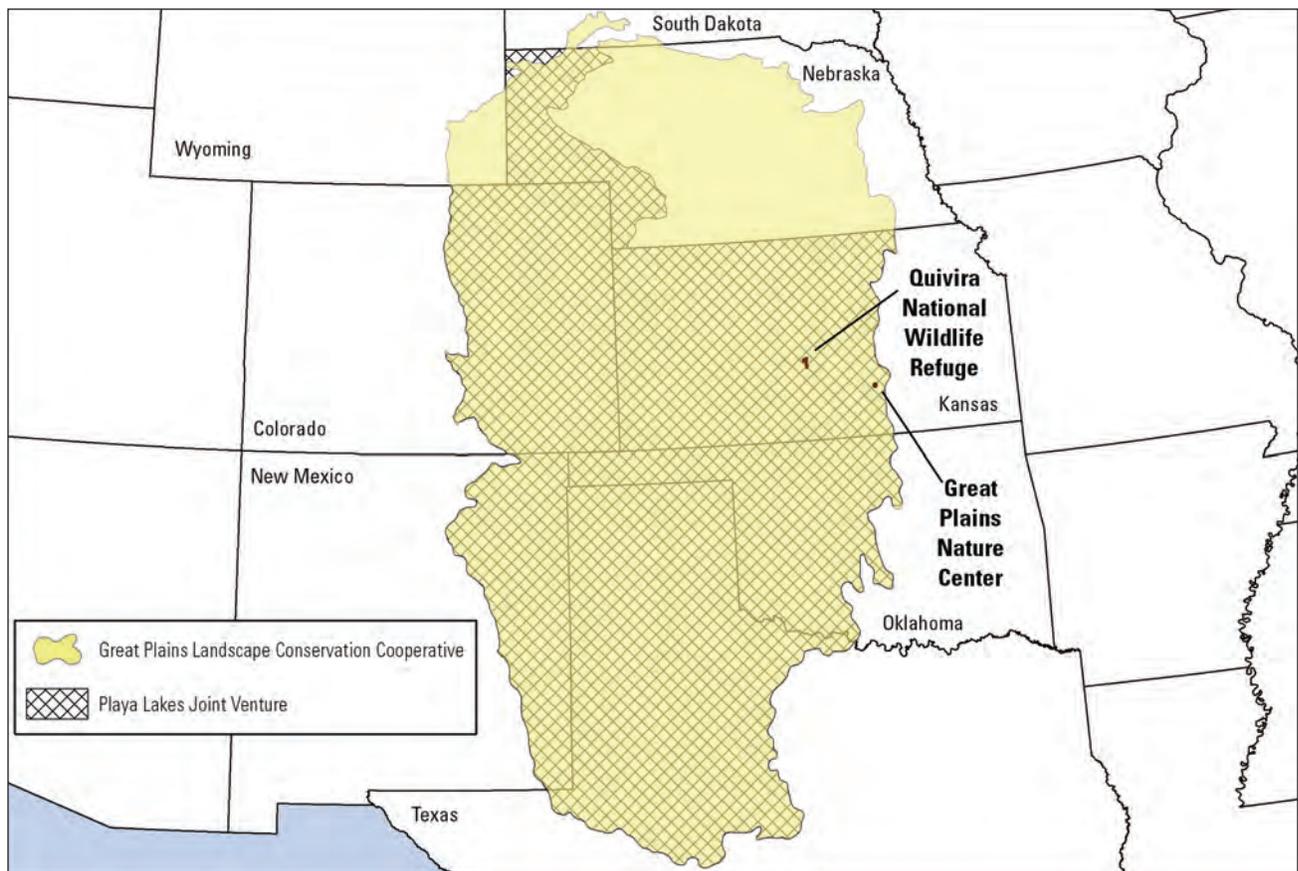


Figure 8. Playa Lakes Joint Venture region, Quivira National Wildlife Refuge, Kansas.

- decreasing water volume in wetlands in fall and winter leading to more shallow habitat
- 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.

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, particularly 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 the most relevant concerns 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.

Geology and Physiography

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



Rachel Laubhan/USFWS

Rattlesnake Creek flows into Little Salt Marsh on Quivira Refuge.

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 HGM report (Heitmeyer et al. 2012) prepared for the refuge.

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 run 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 HGM 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 specific conductance of water occurs throughout the watershed, with wide ranges possible in the area of the refuge (<750, 750–2250, and up to >2250 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 con-

centrations, 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.

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 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.

Soils

Soils are diverse (figure 9) 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 NRCS for each soil subgroup (Soil Survey Staff 2010, Heitmeyer et al. 2012).

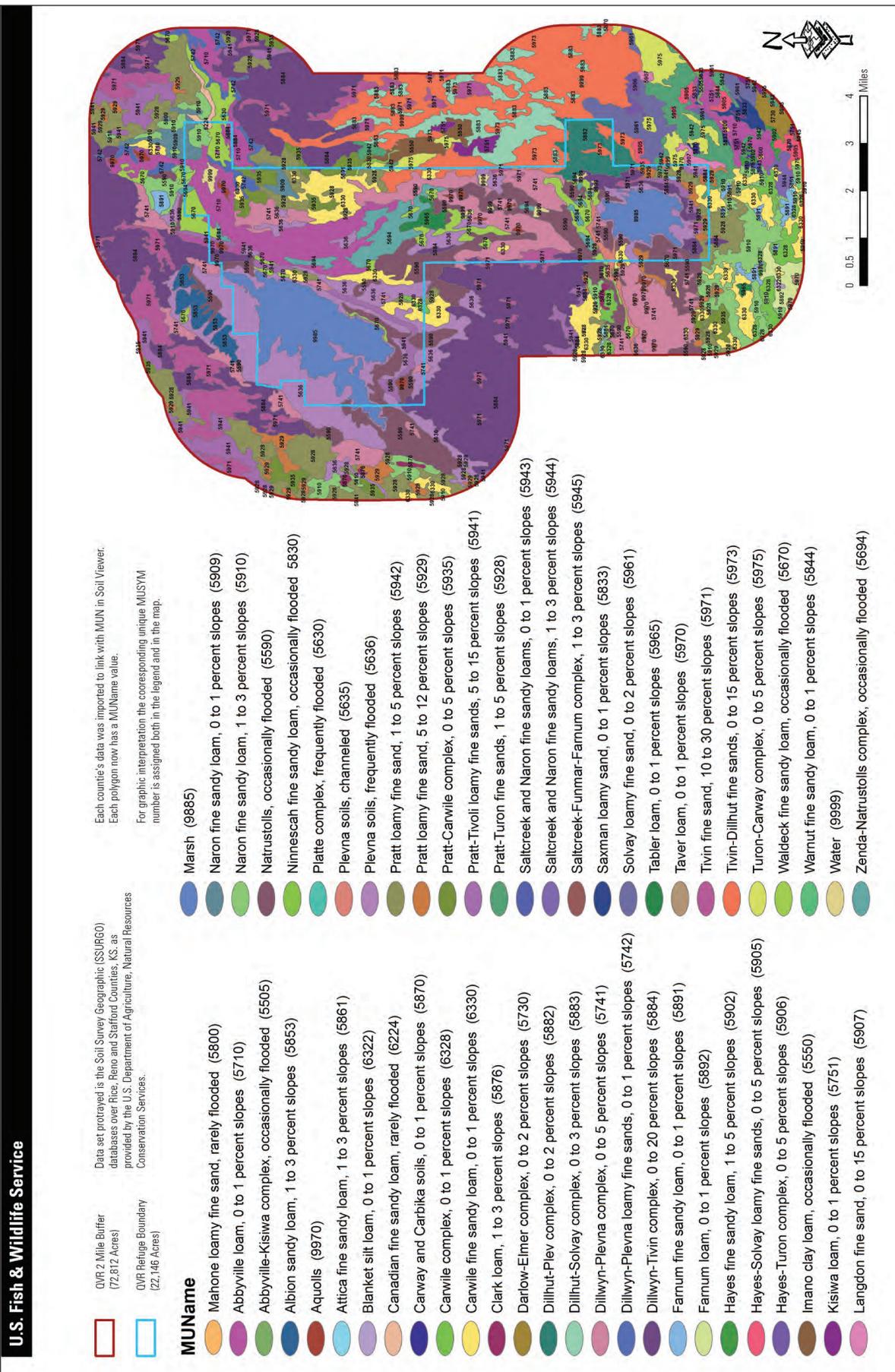


Figure 9. Refuge soil map, Quivira National Wildlife Refuge, Kansas. Source: Soil Survey Staff 2010.

4.2 Biological Resources

Evaluating refuge lands in the proper 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 interspersed 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 provided 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.

In general, populations of many species native to the area have declined because of habitat loss and degradation caused by many factors, including 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 considered multiple plans and documents at

scales ranging from local to national that were relevant to the purposes and goals of Quivira Refuge, such as our lists of species of management and conservation concern (USFWS 2008a) that consider various national and international bird conservation plans. Other locally important status reports, or designations, are included in the text. Descriptions of plant and wildlife communities that follow are not comprehensive, but include information relevant to the discussion of trade-offs among refuge management alternatives.

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).

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 5. 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 10 and table 6 (Heitmeyer et al. 2012).

Table 5. Vegetation descriptions for Quivira National Wildlife Refuge, Kansas. *Source: Küchler 1974*

<i>Küchler's classification</i>	<i>General description</i>	<i>Major plants</i>	<i>Other characteristic parts</i>	<i>Location (Kansas and landscape)</i>
Saltmarsh	dense to open stands of short-to-medium-tall grasses, few forbs	<i>Dominants:</i> saltgrass, seepweed <i>Local Codominants:</i> spikerush, three-square, prairie bulrush, prairie cordgrass, alkali santon	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 5. Vegetation descriptions for Quivira National Wildlife Refuge, Kansas. *Source: Küchler 1974*

<i>Küchler's classification</i>	<i>General description</i>	<i>Major plants</i>	<i>Other characteristic parts</i>	<i>Location (Kansas and landscape)</i>
Floodplain vegetation (western and central Kansas)	<i>Savanna:</i> tall, medium-tall, and low broadleaf deciduous scattered trees and shrubs with “impoverished” bluestem prairie understory	<i>Dominants:</i> cottonwood, peachleaved willow, and, in eastern Kansas, black willow and American elm	nearly 30 species and combined species found in eastern and western Kansas ***	floodplains and streambanks with permanent and intermittent flooding (note differences in eastern and western Kansas) ***
	<i>Freshwater marsh:</i> dense stands of tall-grasses with forbs common but not prominent	<i>Codominant in western Kansas:</i> sandbar willow <i>Dominants:</i> prairie cordgrass	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	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	<i>Dominants:</i> big bluestem, little bluestem, sandreed, switchgrass	sand bluestem, field sage-wort, 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

Table 6. 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.

<i>Habitat type</i>	<i>Geomorphic surface</i>	<i>Major soil types</i>	<i>Flood frequency*</i>
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 USDA 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).

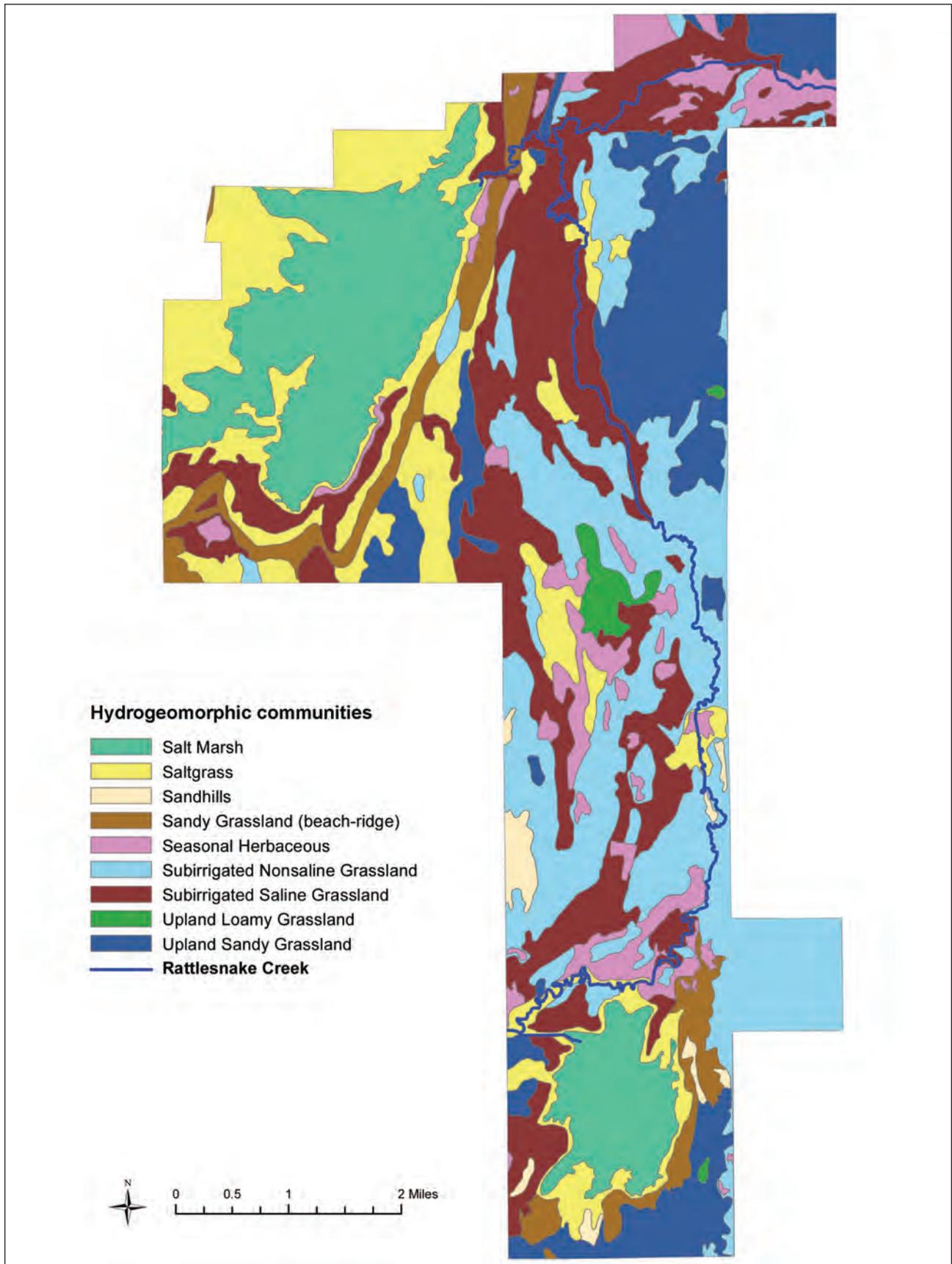


Figure 10. Potential presettlement conditions, Quivira National Wildlife Refuge, Kansas. *Source: (Heitmeyer et al. 2012).*

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, Har-

ris 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 (USFWS 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.



Rachel Laubhan/USFWS

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, red-head, 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 11) 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 12). While important shifts in plant communities mapped in 1954 and 2008 are evident (table 7), 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.

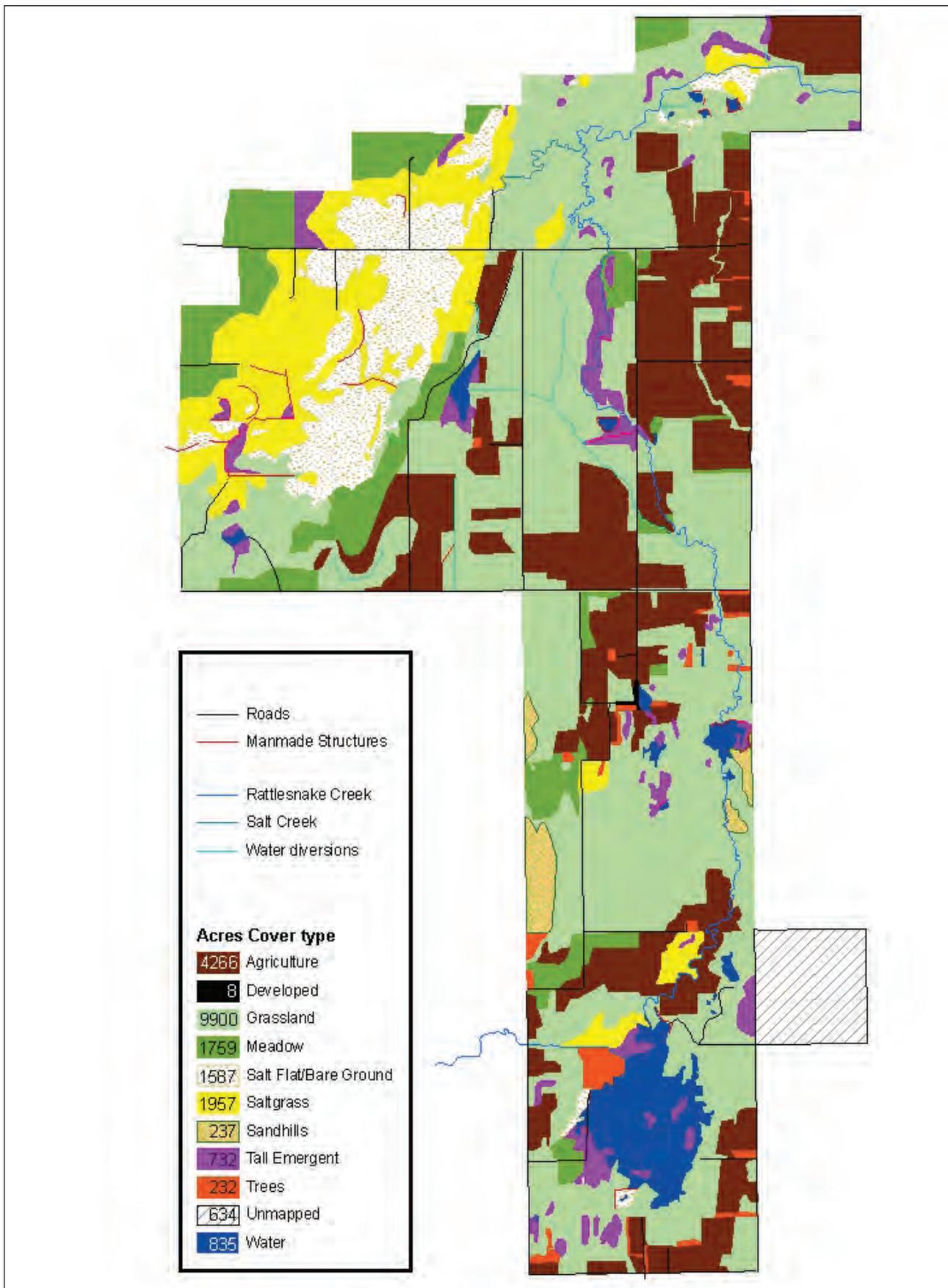


Figure 11. Vegetation cover types in 1954, Quivira National Wildlife Refuge, Kansas.

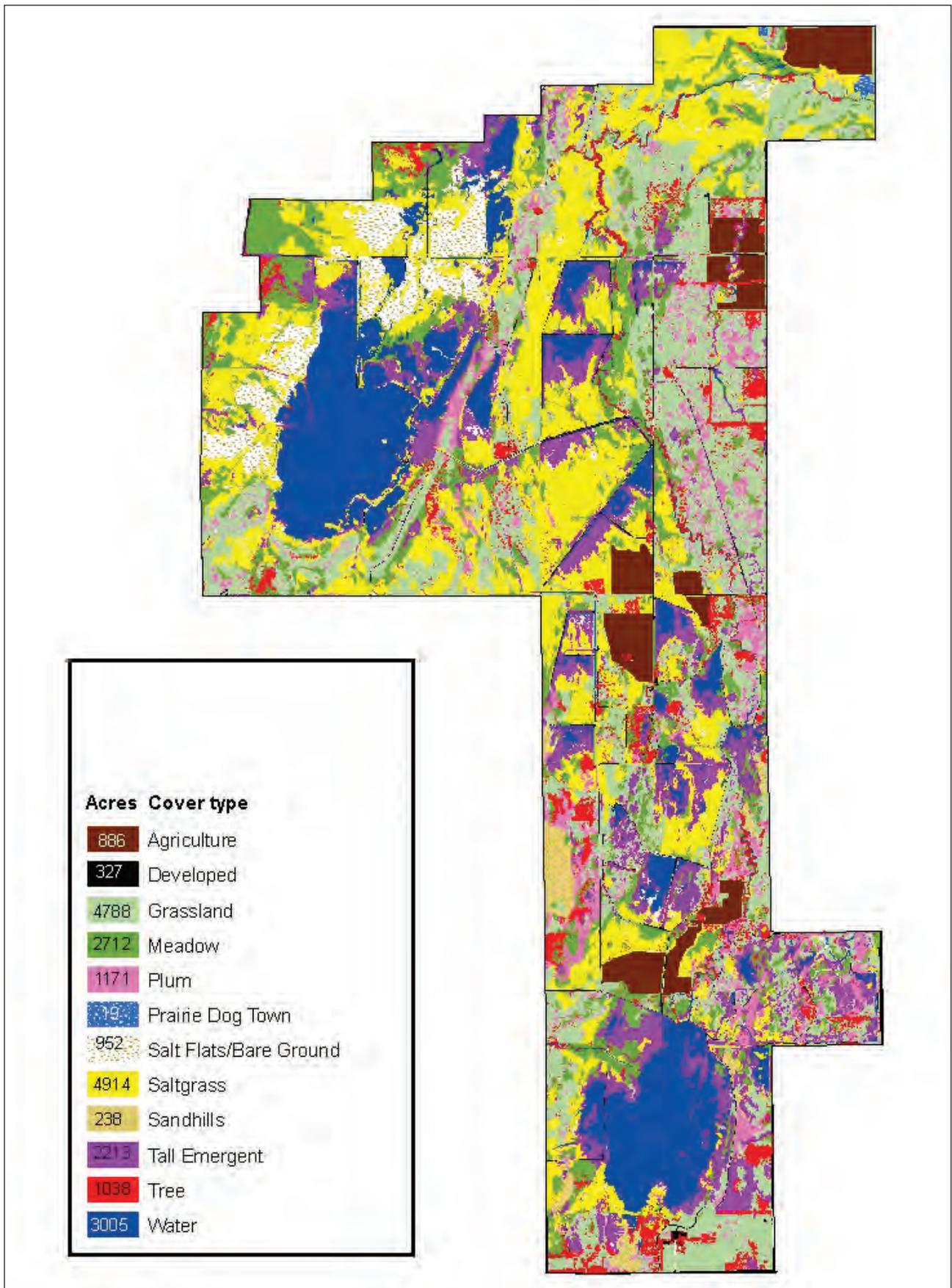


Figure 12. Vegetation cover types in 2008 (NVCS), Quivira National Wildlife Refuge, Kansas.

Table 7. Comparison of vegetation cover types between 1954 and 2011 on Quivira National Wildlife Refuge, Kansas.

<i>Cover type</i>	<i>Map*</i>	<i>Descriptions (dominant plant species)</i>
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 9)
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 [<i>Scirpus paludosus</i>], 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 the proper categories, which resulted in the identification of 43 vegetation associations (table 8) (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 8. National Vegetation Classification System (NVCS) associations, Quivira National Wildlife Refuge, Kansas.

<i>Vegetation associations</i>	<i>Acres</i>	<i>Hectares</i>
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 8. National Vegetation Classification System (NVCS) associations, Quivira National Wildlife Refuge, Kansas.

<i>Vegetation associations</i>	<i>Acres</i>	<i>Hectares</i>
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 purpose(s) 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 F. Collectively, these considerations helped us to develop a list of priority management species we call focal species (table 3).

Threatened and Endangered Species and Species of Concern

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 Quivira Refuge lands and those that most commonly depend on refuge resources (table 9).

Table 9. Threatened and Endangered Species and Species of Concern, Stafford County, Kansas.

<i>Species</i>	<i>Federal status</i>	<i>State status</i>
Whooping crane*	endangered (CH)	endangered (CH)

Table 9. Threatened and Endangered Species and Species of Concern, Stafford County, Kansas.

<i>Species</i>	<i>Federal status</i>	<i>State status</i>
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 F. Additional information is available on listed species and associated information for Stafford County (USFWS 2012c, KDWPT 2011).

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 exam-

ple, 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 F, 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 seen in small family groups, but in recent years up to 76 individual whooping cranes during the spring, and 112 during the fall, were reported using Quivira Refuge at one time. 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, 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 chapter 3 under alternative A and 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 Manage-

ment Concern (USFWS 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 (USFWS, 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. While the effects of management alternatives will be discussed more in chapter 5, 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 10).



USFWS

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

Table 10. Observed woodland bird use at Quivira National Wildlife Refuge, Kansas.

<i>Bird species</i>	<i>Woodland units</i>												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
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
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

Table 10. Observed woodland bird use at Quivira National Wildlife Refuge, Kansas.

<i>Bird species</i>	<i>Woodland units</i>												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
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 F—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 13). 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 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 one toad, four frogs, one salamander, six turtles, two lizards, and 13 snakes; see appendix F. 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 hog-nose 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 carp-sucker, 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). Crayfish burrows are also used as shelter for reptiles and amphibians (Collins et al. 2010).

Other wildlife, such as butterflies, are listed in appendix F. 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.

4.3 Cultural Resources

This section describes what is known about the cultural resources of Quivira Refuge.

Presettlement (European) History

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.

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.

When 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.



Library of Congress

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

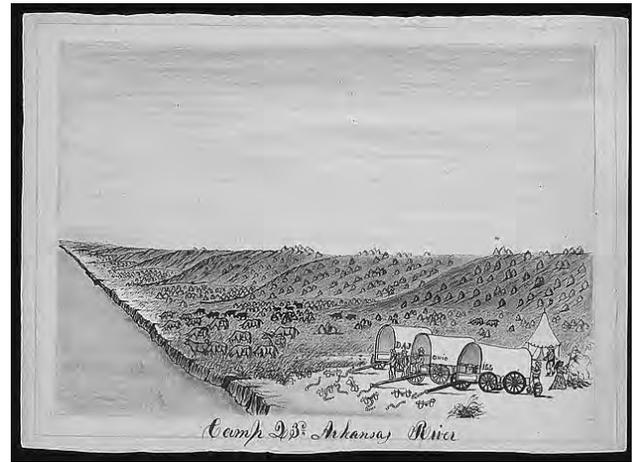
Historical Euro-Americans and Exploration

The Spanish word “Quivira” is a form of the Native American name “Kirikuru,” which is what local people called themselves when the Spanish explorer Don Francisco Vasquez de Coronado visited the region in 1541 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 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. 30 W. and en-camped on open



Library of Congress

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

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.”

Settlement and Early Land Use Changes

The General Land Survey was conducted in this region in 1871. The following year, surveyors for the 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 south-east 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 manufacturing 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 11).



George Spangerberger's Privy

Library of Congress



Library of Congress

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

4.4 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 keep 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 for refuge management to control the coverage of woody vegetation, specifically listing cottonwood, black willow, Russian olive, sand plum, dogwood, and skunkbush as potential invading species. Our activities to keep 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.

4.5 Visitor Services

Visitors to the refuge 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

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. The general hunting season runs from September 1 through February 28, with specific seasons within this period coinciding with the State seasons. An accessible hunting blind is available by reservation in Unit 30.

General hunting regulations, such as licensing needs and daily possession limits, follow applicable Federal and State regulations. Special refuge regulations are listed below:

- 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 on the refuge.
- 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 prevention of the potential 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.

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 along Rattlesnake Creek. Accessible public 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 14 years and younger, although adults may fish at the pond 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 next to the GPNC and is 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.

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 signage, 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 developed 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.

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.

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 ATVs, and the collecting of plant, animal, mineral, or any other natural materials.

See appendix D for more details.

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, 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.

4.6 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 regularly with the Friends of Quivira to plan and present educational programs and annual events. The Friends of Quivira run a nonprofit bookstore in the visitor center at the refuge.

The GPNC operates under a Memorandum of Agreement with the City of Wichita and the KDWPT. Together, they have partnerships with



© Mitch Werner

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

many corporate sponsors, such as The Coleman Company, Koch, and Spirit AeroSystems, and with educational institutions, such as Wichita State University and Friends University. This partnership also often works informally with other universities and colleges to provide work experience for interns as they are available.

The GPNC is supported by the Friends of the Great Plains Nature Center, who run 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.

4.7 Management Uses

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 keep, 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 (USFWS 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. While brief overviews of primary refuge management uses are provided below, related information is also incorporated into discussions under native community conservation sections under alternative A in chapters 3 and 5.

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. More details about water management may be found in wetland community sections under alternative A in chapters 3 and 5.

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 pre-defined 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 dis-

turbance 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 September 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, guid-

ance 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 of refuge lands were farmed before the refuge's establishment. After establishment, 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 IPM plan and with annual Pesticide Use Proposals that provide specific guidance on the use of herbicides.

4.8 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 supplemental 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, thus, affect the amount of 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.

The refuge was established in 1955 to provide and protect vital habitat for migratory waterfowl in the central flyway. Thousands of sandhill cranes, shorebirds, Canada geese, ducks, and other migratory birds pass through the refuge from September to December. Quivira Refuge's 22,135 acres feature a unique combination of rare inland saltmarsh and sand prairie (USFWS 2012b). 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 have economic significance to the refuge, and as such, these communities are additional areas of focus for the regional economic setting.

Population, Ethnicity, and Education

Table 11 lists the population estimates and trends for the 5-county area and Table 12 lists the population estimates for the communities near the refuge. In 2010, the 5-county area accounted for approximately 4 percent of the State's population (U.S. Census Bureau 2010). While the State of Kansas has experienced an increase in the number of residents since 2000, 4 of the counties in the 5-county area have experienced a decline in residents, with only Pratt County showing a slight, 0.1-percent increase in population (U. S. Census Bureau 2010a). Four of the 9 communities surrounding the Refuge have experienced declining populations (Ellinwood, Larned, Sterling and St. John), with the city of St. John showing the greatest decline, losing more than 20 percent of its population since 2000 (table 12).

Though Kansas is expected to have a growth in its population, the trend in 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 Counties are expected to show the greatest



Barry Jones/USFWS

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

decline, losing more than 20 percent of their populations by 2040, while Pratt County is expected to show the least decline, with an expected loss of 9 percent of its current population. The overall decline in population may be because of an aging population as well as migration to more urban areas. This is a trend that can be observed across many of the rural counties in Kansas (Wichita State University 2011).

Table 11. State and county population estimates in the area around Quivira National Wildlife Refuge, Kansas.

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

Source: ¹(U. S. Census Bureau 2012b) ²(U. S. Census Bureau 2010a).

Table 12. Community population estimates in the area around Quivira National Wildlife Refuge, Kansas.

	<i>Residents (2010)¹</i>	<i>Persons per square mile (2010)¹</i>	<i>Percent population change (2000–2010)²</i>
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 population of the State of Kansas with at least a Bachelor's degree is higher than the national average (29.3 percent com-

pared to 27.9 percent), this percent is lower than both the State and national averages for each of the counties within the 5-county area (ranging from a low of 18.8 percent in Reno County to a high of 22.7 percent in Pratt County). Additionally, each of the nine communities surrounding the refuge fall below the State and national averages, with the cities of Stafford and Lyons having the lowest percent of the population to have earned at least a Bachelor's degree (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 self-identifying as white in Barton County to a high of 96 percent self-identifying as white in Pratt County). Relative to the other counties in the 5-county area, Barton County had the largest percentage of individuals who identified as Hispanic or Latino (13.3 percent of the population) (U. S. Census Bureau 2012b) while Reno County had the highest percentage of individuals who identified as African-American (4.1 percent of the population) (U. S. Census Bureau 2012b).

Regional Employment and Income

Table 13 shows the median household income, poverty, and unemployment rates for the 5-county area while table 14 lists the same statistics for the communities near the refuge. The five counties and nine communities near the Refuge have median household incomes below both the State of Kansas and the national levels. As of the 2010 Census, of the five counties, Barton County had the highest median household income at \$43,763 per year, while Stafford County had the lowest at \$39,375 per year. Of the nine communities, the city of Great Bend had the highest median household income at \$42,293 per year, while the city of Stafford had the lowest at \$33,182 per year (U. S. Census Bureau 2010a).

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

Table 13. State income, unemployment, and poverty statistics and county statistics in the area around Quivira National Wildlife Refuge, Kansas.

	<i>Median Household Income (2010)</i>	<i>Percentage of Individuals below poverty (2010)</i>	<i>Percentage Unemployed (2010)</i>	<i>Change in percent unemployed (2000–2010)</i>
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 14. Community income, unemployment and poverty statistics in the area around Quivira National Wildlife Refuge, Kansas.

	<i>Median Household Income (2010)</i>	<i>Percentage of Individuals below poverty (2010)</i>	<i>Percentage Unemployed (2010)</i>	<i>Change in percent unemployed (2000–2010)</i>
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 15 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 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 percentage of total employment was 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.

Table 15. Employment by sector in the area around Quivira National Wildlife Refuge, Kansas.

<i>Industry</i>	<i>2011</i>	<i>Percent of Total</i>
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

Table 15. Employment by sector in the area around Quivira National Wildlife Refuge, Kansas.

<i>Industry</i>	<i>2011</i>	<i>Percent of Total</i>
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)

Agricultural Sector

The State of 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, animals 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, which accounted for more than 88 percent of

the total land in production in the State (U. S. Department of Agriculture 2007). In 2007, within the 5-county area, Reno County had the greatest number of farms and acreage in production (1,749 farms, and 780,893 acres). Pratt County had the fewest number of farms (538 farms) and Rice County had the smallest acreage in production (428,422 acres) (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 (USFWS 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 categorized into (1) away from home (activities taking place at least 1 mile from home) and (2) 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 residents of the State of Kansas 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 and \$197 thousand spent on equipment and \$330 thousand spent for other items (USFWS 2012a).

Connecting the Cheyenne Bottoms and Quivira National Wildlife Refuge is the Wetlands & Wildlife National Scenic Byway. 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 connects several cities and counties within the State; 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 byway, with trips 1–3 days in length being

the second most popular length of stay. In general, day visitors spent under \$100 within the local area, while visitors staying 1–3 days generally spent \$100–\$200 in the local area. Most visitors to the area were residents of the State of Kansas. According to Barton County Counselor and Administrator, Richard Boeckman, several byway communities are collaborating to improve marketing and increase tourism in the area. The byway, refuge, and Cheyenne Bottoms are all considered important assets to the local economy (personal communication).

The Public's Use of the Refuge

During 2010 and 2011, the USGS headed a National Wildlife Refuge Visitor Survey (USGS 2012a), at Quivira Refuge, and at 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 period it surveyed, 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 that same 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, or 64 percent, first learned about the refuge from friends or relatives, 21 percent first learned about the refuge from printed information, and 18 percent first learned about it from signs on the highway. Key information sources used by visitors to find their way to this refuge include signs on highways, used by 54 percent of visitors; earlier knowledge, used by 46 percent of visitors; and a road atlas or highway map, used by 44 percent of visitors.

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 actually 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 this refuge, often travelling with family and friends.

According to the USGS, visitors took part in a variety of refuge activities during the period surveyed (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 for their most recent visit included birdwatching, as mentioned 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, as noted by 91 percent of these visitors; or to view the exhibits, by 82 percent; or to stop to use the facilities, by 75 percent.

Visitor Satisfaction Levels

Of those who visited Quivira Refuge and took part in the study, overall satisfaction with the services, facilities, and recreational opportunities we provided were as follows (Sexton et al. 2012):

- 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.

All refuge services and facilities fell into the Keep Up the Good Work quadrant of the study (Sexton et al. 2012). Some of the refuge recreational opportuni-

ties fell into the Keep Up the Good Work quadrant, except for volunteer, kayak and canoe, bicycling, fishing, and hunting opportunities, which fell into the Look Closer quadrant. The average importance of fishing, hunting, bicycling, and volunteer opportunities in the Look Closer quadrant may be higher among visitors who have taken part in these activities during the past 12 months. However, there were either not enough individuals in the sample to evaluate the responses of such participants, or it is not known how many visitors 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 the Keep Up the Good Work quadrant.

Baseline Economic Activity

The 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 by the refuge in the 3-county study area is approximately \$1.015 million in value added in the local economy.

U.S. Fish and Wildlife Service Employment

Quivira 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 in 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 16 shows summary statistics for local and nonlocal visitor expenditures, with 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 per person per day.

Table 16. Total visitor expenditures, expressed in dollars per person per day, for Quivira National Wildlife Refuge, Kansas.

<i>Visitors</i>	<i>Sample size</i>	<i>Median</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>Minimum</i>	<i>Maximum</i>
Nonlocal	100	\$42	\$55	\$57	\$0	\$313
Local	30	\$29	\$45	\$55	\$0	\$250



© Mitch Werner

Painted turtles are easily viewed at Quivira Refuge.

Administration includes staff and budget and facilities and infrastructure.

Staff and Budget

Quivira Refuge staff is comprised of 11 permanent full-time employees, 1 permanent part-time employee, 3 temporary employees, and the two regional employees that are not paid through the refuge (table 17). The current staff level remains well below the minimum prescribed in the June 2008 Final Report—Staffing Model for Field Stations (USFWS 2008b), which recommended that seven more staff, including three maintenance workers, one biologist and two biological technicians, one refuge law enforcement officer be added, along with one visitor services specialist for the GPNC.

Table 17. Base staff budgeted in fiscal year 2012 and other staff stationed at Quivira National Wildlife Refuge, Kansas.

<i>Staff group</i>	<i>Position</i>
	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

Table 17. Base staff budgeted in fiscal year 2012 and other staff stationed at Quivira National Wildlife Refuge, Kansas.

<i>Staff group</i>	<i>Position</i>
	Current staff stationed at, but not paid by, Quivira Refuge
biology	Zone biologist
	Partners for Fish and Wildlife biologist

Facilities and Infrastructure

Facilities are used to support habitat and wildlife management programs and wildlife-dependent public uses that result in approximately 65,000 visitors annually at Quivira Refuge (figure 13). 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 and 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.

The environmental education classroom was created out of the original block building office built in 1958. One half of that building is an environmental education classroom and the other half is a bunkhouse that is capable of housing six seasonal employees and volunteers. It is in poor condition and difficult to remodel or improve because of its original construction.

A three-bedroom trailer was received as unused excess from the Federal Emergency Management Agency in 2009 and placed 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, and a new, concrete, accessible, aboveground tornado shelter was placed there in 2010.

We own seven 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. The remaining land at the GPNC is owned by the city of Wichita, including

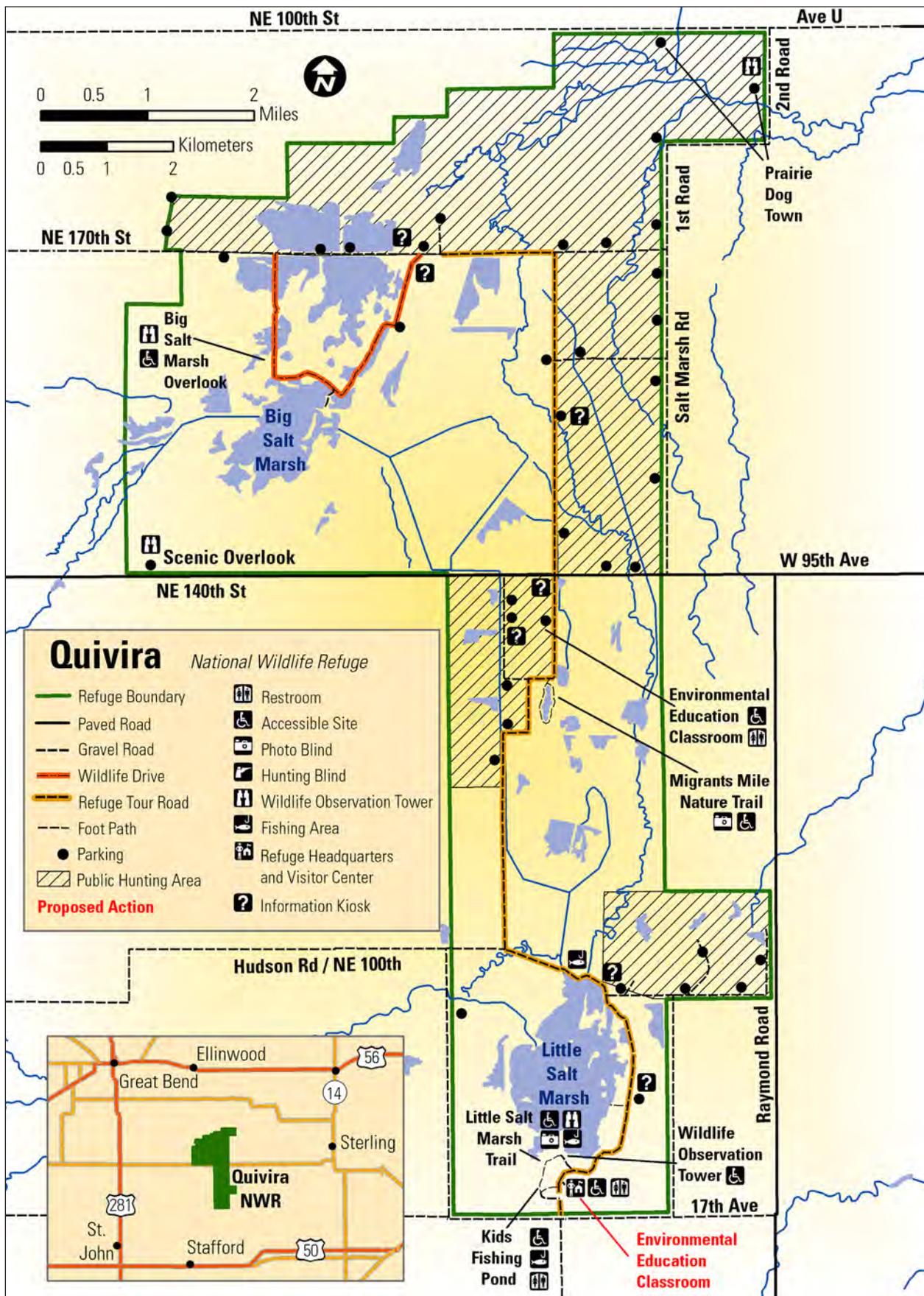


Figure 13. Public use facilities at Quivira National Wildlife Refuge, Kansas.

parking lots, Chisholm Creek Park, and associated trails.

Quivira Refuge's public use facilities are shown in figure 13. 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 keeps 55 public parking lots, ranging from graveled to grass surfaced.

Refuge facilities, including public use facilities and those used only by staff, include:

- headquarters office and visitor center building, 6,720 square feet
- maintenance shop, fire cache, and vehicle storage building, 9,200 square feet
- 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
- two 176-square foot grain bins
- 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

Chapter 5—Environmental Consequences



© Bob Gress

Snowy Plover

This chapter provides an analysis of how our management alternatives for Quivira Refuge might affect the environment. We assessed the environmental consequences of carrying out alternatives A, B, and C on the physical, biological, socioeconomic, and cultural resources of the refuge and the GPNC.

Our management actions in each alternative serve as the means for achieving our vision and goals for the refuge in response to issues raised by our managers and by the public and our partners. Because management would differ for each alternative, the environmental and social effects resulting from the implementation of each would also likely differ.

Table 4 in chapter 3, section 3.4, summarizes and compares the alternatives' actions and the associated consequences that are described below.

5.1 Analysis Methods

We evaluated effects on several levels, including whether the effects would be adverse or beneficial and whether the effects would be direct, indirect, or cumulative with other independent actions. In addition, we applied the duration of effects when estimating environmental consequences.

Direct effects are those where the effect on the resource would be immediate and the direct result of a specific action or activity. Examples of a direct effect include the effect of trail construction on vegetation along the trail or the effect of hunting on wildlife.

Indirect, or secondary, effects are those that are induced by implementation actions but that occur later in time or are farther removed from the place of action through a series of interconnected effects. Examples of indirect effects include those on down-

stream water quality from an upstream surface disturbance or the effect that recreational use along a trail may have on nearby plant communities.

A cumulative effect is defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and future action regardless of what agency (Federal or non-Federal) or person undertakes such other actions” (40 CFR 1508.7).

Effects are often described in terms of their context, intensity, and duration. The duration of effects is either short term or long term. Short-term effects would persist for a period of 3–5 years and would consist primarily of temporary disturbance because of habitat restoration or facility construction and subsequent revegetation efforts. Long-term effects would last more than 5 years after project initiation and may outlast the 15-year lifespan of this CCP. Many long-term effects consist of long-term benefits to wildlife habitat resulting from our management actions.

5.2 Effects Common to All Alternatives

The following potential effects would be similar for each of the three alternatives:

- Carrying out our management direction, such as goals, objectives, and strategies, would follow the best management practices we established for the refuge.
- Our management activities and programs would avoid and reduce adverse effects on federally threatened and endangered species to the extent possible and practicable.
- Our refuge staff, contractors, researchers, and other consultants would acquire all applicable permits, such as those for future construction activities.

The sections below describe other effects that we expect to be similar for each alternative.

Regulatory Effects

As described in chapter 1 of this CCP, we must follow Federal laws, administrative orders, and policies in the development and implementation of the

management actions and programs found in this document. Among these mandates are the Improvement Act, the Endangered Species Act, the Clean Water Act of 1977, and we must comply with Executive Order 11990–Protection of Wetlands and Executive Order 11988–Floodplain Management. The implementation of any of the alternatives described in this draft CCP and EA would not lead to a violation of these or other mandates. See appendix A for more information.

Environmental Justice

To comply with Executive Order 12898–Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations, none of our actions in this draft CCP and EA would disproportionately place any adverse environmental, economic, social, or health effects on minority or low-income populations. We are committed to ensuring that everyone has equal access to the Nation’s fish and wildlife resources, as well as equal access to information that would enable the public to meaningfully take part in our activities and in the shaping of our policy.

Cultural Resources

All the alternatives would enhance cultural resources by protecting existing resources and extending protection to newly discovered resources. There have been limited cultural resource surveys performed on the refuge, so more surveys would be required before any new construction or excavation to fully satisfy the provisions of NEPA and other applicable acts and policies related to historic and archaeological resources. Before constructing trails or facilities, we would request a review by our Region 6 archaeologist and consultation with the Kansas State Historic Preservation Office to find any negative effects that might occur.

Geology and Soils

All alternatives would positively affect soil formation processes on the refuge. Some disturbance to surface soils and topography would occur at locations selected for: (1) administrative, maintenance, and visitor facilities; (2) the removal and eradication of invasive plant species; and (3) the restoration of native habitat.

5.3 Land Conservation Effects

This section discusses the effects of alternatives pertaining to land conservation.

Climate Change

The effects of climate change would extend beyond the boundaries of any single refuge and would therefore need large-scale, landscape-level solutions that extend beyond Quivira Refuge. Available information suggests that the restoration of soils, hydrology, and other ecosystem parts improves resilience. Our collective goal is to protect and improve resilience in ecological systems and communities so that, even as climate conditions change, the natural landscape would continue to support its full range of native biodiversity and ecological processes. Building resilience includes supporting intact, interconnected landscapes, restoring fragmented or degraded habitats, and preserving and restoring ecological processes. Climate change considerations similar for all alternatives are noted in the beginning of chapter 3.

Climate Change—Alternative A

Under our current management, there has only been a general focus on the restoration of native plant communities and aspects of species–habitat relationships relative to other proposed alternatives, thus the level of ecosystem resilience achieved under this alternative may be less than under the other alternatives.

Temperature and Precipitation Uncertainty

Translating global and continental climate change models to regional scales, such as for Kansas or the refuge, are difficult. There are still major uncertainties at the regional level, especially related to precipitation (Christensen et al. 2007), although models are getting increasingly reliable. Some robust predictions suggest that warming is likely to be most pronounced in the winter, and snow season length and snow depth have a greater than 90-percent probability of decreasing. Expected increases in temperature range from 4–9 °F in western North America during this century (Christensen et al. 2007).

Although temperature increases over the next several decades appear inevitable, the resulting

effect on precipitation, moisture and wetland hydrology is highly uncertain. See the climate change section in chapter 4. Baseline checking of weather information at the refuge would continue to occur. Over the 15-year life of the plan, dramatic shifts are not expected, however, this baseline information may be useful for detecting trends across larger timeframes. The uncertainty about temperature and precipitation changes would continue to exist. We at the refuge would rely on outside entities such as USGS to help us downscale climate change models to increase the predictability of temperature and precipitation changes and to apply these predictions to our management.

Preservation of Water Rights

Monitoring water usage would help us preserve existing water rights. Regular usage of our individual water rights demonstrates beneficial use, and makes sure that the overall water amount will be available to us the future. The retention and use of these rights is important, especially if climate conditions cause a reduction of available runoff and there is greater demand for less water.

Baseline Inventory and Monitoring Programs for Natural Resources

Current management may detect and consider shifts in some plant and wildlife species distributions and conditions, but likely would not differentiate among the various factors influencing community changes. As a result, refuge-specific information used to improve our management strategies or to evaluate changes due specifically to climate factors over time is lacking.

Baseline monitoring programs for habitat conditions, weather stations, ground water levels, and river gauges would provide some ability to detect long-term trends related to climate change. These trends could include changes in vegetation composition, wetland water levels, some riverflows, and temperature. However, this information is likely to be limited in scope, site specific, and not easily related to regional or national climate change data and trends.

Working with Others

The effects of climate change are better seen, and the ability to address relative issues often seems more effective, at scales larger than the refuge. Thus we depend on our partners who work on a larger scale and who have resources allocated for climate change-related activities to help us. Our ability to proactively address climate change issues, given our



Barry Jones/USFWS

Tiger Salamander

current engagement and our climate change-related partnerships with organizations like the GPLCC, is limited. Without greater participation by our staff, research, or conservation on the ground, is less likely to directly apply to refuge issues created by climate change.

Carbon Sequestration and Reducing the Carbon Footprint

Carbon sequestration rates vary depending on plant species, soil type, region, climate, topography and management practices that can affect plant productivity. On a local scale, carbon sequestration is largely influenced by light conditions, water availability, soil water-holding capacity and its nutrient content. Local conditions could change the frequency and severity of natural disturbances such as wildfires and strong winds, which would increase the probability of carbon dioxide emissions and, hence, carbon loss from these systems. In general, the protection and restoration of grassland and wetlands under

alternative A would benefit carbon sequestration on the refuge. The largest gains in carbon sequestration could occur if cropland is restored to grassland or drained wetlands are restored (Bangsund et al 2005).

Some efforts toward reducing the footprint of facilities would occur. The reduction is likely to be modest and not well quantified.

Staff Time and Management Costs

Besides periodic reviews of information and measures already considered for refuge management, no more costs would be needed that are specifically associated with climate change monitoring programs and research. No major deviations would be made with our existing staff. By carrying out some green innovations, expenses for things like electricity; fuel, both gasoline and diesel; and propane may decrease.

Climate Change—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that it would be more likely that our refuge management would be improved to address shifts in species distributions or other community changes involving species–habitat relationships largely because of the refined focus on the habitat needs of focal species. Also, alternative B would offer more inventorying and monitoring activities that would allow greater detection of community changes as related to focal species and refuge goals and objectives. A major difference between alternative B and C is the control of water management on different areas of the refuge. Under alternative B, there may be more management options to support different species and habitat types over time.

Climate Change—Alternative C

Effects would be the same as under alternative A, except that a shift in management focus may result in more support for ecosystem resilience. However, there is some uncertainty in our ability to address shifts in species distribution and community changes partly because of unknowns about watershed management, how restoration activities might affect our management control and constraints, and what monitoring programs would be conducted to detect changes. This alternative, with relatively more constraints in water management, may be viewed as being more tolerant, or accepting, of a “new normal”

if climate change leads to substantial community shifts. Management may not be in a position to resist, or prolong, community changes on areas of the refuge over time relative to the other alternatives.

Land Protection—Alternative A

The following affect land protection activities under alternative A.

No Expansion of the Refuge Boundary

Our management would not have the added responsibilities that come with owning more land, so positive effects would be expected. Also, private landowners would not have unnecessary concerns about our expansion activities. Positive and negative effects would likely be associated with our acceptance of private landowner interests and the management of lands surrounding the refuge.

Promote Conservation on Private Lands

There are various private land conservation programs specifically paid for, organized, and focused to work with landowners to improve the conservation of natural resources while supporting different private landowner interests. Our refuge management has a common interest in conserving natural resources and acknowledges that success at a landscape level or on larger scales cannot be achieved without the support of private land managers, as shown in State of the Birds reports.

A potential negative effect is the risk that our refuge management would promote landscape programs when, in some cases, resulting land management on private lands may conflict with, or adversely affect, the achievement of refuge objectives. For example, private land initiatives that support the planting of tree rows for certain wildlife species conservation would contradict refuge goals and objectives for other species, especially if these activities were to occur next to large tracts of open habitat on the refuge.

Stay Current with Landscape-scale Activities

This would be beneficial for various reasons, such as having the necessary knowledge of landscape changes or developments to reevaluate the refuge's role in the landscape; to help interpret changes observed, or measured, on the refuge; to keep, or

improve, interactions with the public and our neighbors; to keep, or improve, the relevancy of land management in educational programs; and to promote efficiency. We would continue to work with the GPLCC and keep up with their priorities.

Reduce Natural Resource Threats Related to Oil and Gas Activities

Oil and gas activities on refuge lands create added threats to natural resources by changing surface lands, development of infrastructure with risk of oil or poor-quality water leaks and spills, laying underground pipelines in our saline environment, introducing and spreading invasive species, and possibly incurring mismanagement or violations. All of these threats have occurred on refuge lands many times, yet, fortunately, none have had well-documented, long-term negative effects. We are increasingly concerned about the age and integrity of oil pipelines and equipment, especially those that exist in the most saline environments. Most of the active oil wells are located in and around the BSM area that is used by many waterbirds, including endangered whooping cranes and interior least terns. These species are largely responsible for the refuge's designation as an Important Bird Area and Ramsar wetland. In addition, we have concerns about how oil pumping noise interferes with the social behavior of birds and their ability to communicate, especially during the breeding season. For all of these reasons, we would seek to reclaim mineral rights, which would help resources.

Limiting and gradually eliminating oil wells and their associated activities would be a benefit to our visitors who generally do not expect, and frequently question, oil-related activities on the refuge. Most oil wells have reached the end of their useful lives, especially over the past 4 years, as 6 wells have been pulled and plugged in that time. There would be reduced economic activity on the refuge, which may affect the local economy.

Land Protection—Alternative B (Proposed Action)

Effects would be the same as under alternative A, but this alternative would embrace new opportunities that have emerged to increase protection, such as the creation of a new, Partners focus area surrounding the refuge and addressing the increasing threats of conservation on a landscape scale. Also, with the various interests related to conservation initiatives, there would be an increasing need to set priorities

for, and work collaboratively on, common concerns to improve the effectiveness of our management. As such, benefits could increase.

Land Protection—Alternative C

Effects would be the same as under alternative B, except that this alternative would emphasize restoring ecological processes, and would rank those areas that would most benefit. A secondary emphasis would be placed on providing resources for focal resources. These activities would be expected to increase benefits.

5.4 Native Ecological Community Conservation Effects

This section discusses the effects of alternatives pertaining to native ecological community conservation.

Big Salt Marsh—Alternative A

Fluctuations in water level and water quality, such as salinity, would occur, and the use of Rattlesnake Creek water would be limited. Some view this management philosophy as positive, as long as long-term variability is kept within a “natural” range where levels are not toxic to wildlife. Managing dynamic fluctuations in water conditions promotes nutrient cycling and wetland productivity. By allowing periodic drying of the marsh, carp are controlled, which improves water quality and sunlight penetration through the water column and reduces competition for invertebrate resources used by migratory birds. Restricting Rattlesnake Creek water from entering the BSM in most years would help restore the natural salinity to the marsh over time, which would also limit growth of emergent cattail and Phragmites that are less tolerant of high salinities. Also, promoting natural marsh cycles would provide opportunities to educate the public about inland salt-marsh systems.

Some may view this management philosophy as suboptimal at times in the marsh cycle when condi-

tions are bad for viewing an abundance of birds and bird species in that area. In general, we would support many birds, but there are times when we would support less, such as when the marsh is mostly dry. With seasonal declines in water levels in the late spring and summer, there is increasing interspersion of shallow water–mudflat habitat that helps shorebirds during migration. But, water may not be available in some years for the waterfowl migration in September and October. However, in 2011, thousands of sandhill cranes used the dry marsh bed for roosting in October and November before the ground water flow started.

Whooping crane use of the BSM during the fall migration may be affected because of a reduced area of water during that time, although in one of the driest years in recent history, 2011, whooping cranes still used the BSM area in November. With generally lower water levels and declining levels during the summer, interior least terns and western snowy plovers are expected to use the salt flats on the edges of the BSM more for nesting, than when the marsh is kept full. Nesting on wide open salt flats generally increases nesting success partly because of the difficulty of predators finding nests. But, these same nests are subject to loss because of occasional flooding because of large rainfall events during the nesting season.

There would be no major changes to infrastructure in the BSM except to support levees and water control structures in the saline environment and to support or improve natural ground water flow. Public access would continue to be allowed via the Wildlife Drive.

The North Lake and Salt Flats areas, which are popular for hunting, were not flooded by the opening of the season in November 2010, 2011, and 2012 and these areas may not flood up until December in some years. With declining ground water levels, this may occur later and later over time, which would reduce hunting opportunities.

We would continue with prescribed fire and grazing on the margins of the BSM, in the meadows and uplands surrounding the marsh. Burning will prevent woody vegetation encroachment, recycle nutrients, prevent litter buildup and keep conditions in, or shift them to, an early successional stage. Prescriptions for burning and grazing would be to restore the native plant community.

Saltcedar will not be affected by increased salinities and may increase, with new seedling establishment annually, as water levels decline in the summer. Herbicides can control saltcedar if needed, and new establishments would need to be checked annually.

Big Salt Marsh—Alternative B (Proposed Action)

Under this alternative, we would have more opportunities to improve natural hydrology, with a higher probability of helping focal resources. Periodic drying of the marsh would allow wind to naturally scour basins, an important process for improved productivity. Hunting opportunities would change under alternative B, refer to the hunting section of this chapter.

Changes would include possibly altering the hunting boundary, eliminating hunting in portions of the BSM area, and opening other areas in created wetlands.

Big Salt Marsh—Alternative C

Under this alternative, we would have opportunities to improve natural hydrology, but there would, potentially, be fewer benefits to focal resources in some years. This alternative may improve system resiliency if more natural conditions were achieved, but much is unknown about future watershed management and the availability of water.

This alternative would likely provide less water and hunting for waterfowl early in the season, as natural hydrology would determine water levels.

Little Salt Marsh—Alternative A

Water management would continue and water control structures would be supported and replaced when needed. The LSM would continue to decline in storage capacity with sedimentation. There would be no waterfowl hunting. Public uses for wildlife observation and photography would continue.

The marsh is essential for holding water to flood all the created wetlands on the refuge, and, although it is losing capacity through sedimentation, it is still important and can be the last source of water for wildlife in a drought. Furthermore, the LSM is becoming fresher. Its salt is slowly being diluted because it is managed as a flow-through marsh and not as an overflow sump, as it was historically.

The marsh is attractive to many migratory birds, primarily for roosting and for some foraging if water levels are held low in the spring and fall. Endangered whooping cranes often use the mudflat–shallow water zones when they are available. Interior least terns nested successfully on the Rattlesnake Creek delta in 2011, and, with lower water levels and the

control of invasive species, terns may continue to use the marsh for nesting.

The LSM is a popular wildlife viewing area with enhancements such as the observation tower, photo blind and adjacent hiking trail.

Carp infestation is a recurring problem because it is connected to the creek. High carp populations are associated with high water turbidity, low wetland productivity, sedimentation, and an increasing coverage of invasive Phragmites and cattail. Cattails would continue to dominate the shoreline of the marsh, as water levels are kept relatively stable during most of the year and salinities continue to decline. Phragmites and saltcedar will also continue to expand.

It is the most popular fishing location and has an accessible fishing pier. Fishing would continue but would be a low quality public use, as carp continue to dominate the fishery and Phragmites and cattail affect the accessibility to shorelines.

Little Salt Marsh—Alternative B (Proposed Action)

Effects would be similar to alternative A, except that the benefits to focal resources may increase slightly. We would attempt to restore saltgrass habitat on the shoreline and islands following the active management of emergent vegetation.

Deer, turkey and furbearer hunting would potentially occur in the uplands and meadows around the LSM, but would be subject to closure when whooping cranes use the marsh.

Little Salt Marsh—Alternative C

Effects would be similar to alternative B, except that this alternative would encourage natural conditions to the extent possible to promote long-term system resiliency at a time of uncertainty about climate change. At least in the short term, this alternative would make less water available for fall flooding, but it is possible that less would be needed as created wetlands would also be altered. The periods of highest flooding would occur after rainfall events in the spring, followed by drying in the summer and fall, which would still provide roosting habitat for whooping cranes in the early spring and fall. Nesting by interior least terns would not increase, but would be occasional if habitat conditions are favorable.

Riparian Corridor—Alternative A

The Riparian Corridor would continue to contain and transport nonnative, invasive species, such as Phragmites, saltcedar, Russian olive, and carp. We would continue to control these invasive species, including using chemical, mechanical, and prescribed fire treatments on saltcedar.

Benefits to wildlife here are ancillary. Salt Creek provides saline habitat for plains killifish, a major source of food for interior least terns. In years when water levels are low and shoreline and beach habitat is available along the Rattlesnake Creek, interior least terns have been observed using the riparian corridor for breeding activities. We would allow some plums and shrubs of various sizes and structure within the riparian corridor because certain birds and wildlife, such as Bell's vireo, prefer cover close to stream habitat.

Our management in the next 15 years would reduce woody vegetation within the riparian corridor overall largely because presettlement vegetation of prairie streams was predominantly grassy with relatively frequent fires and grazing, and grassy riparian streams function differently from those with predominantly woody vegetation (Lyons et al. 2000).

We would support processes of bank erosion that are within an acceptable range, but discourage excessive streambank damage resulting from long-term use by cattle. Cattle are not fenced out of riparian zones but are allowed to graze those areas along with the adjacent habitats. Removing invasive trees along the riparian corridor would discourage cattle from congregating in those areas and causing damage by resting under trees for shade.

Riparian Corridor—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that we would emphasize restoring native plant communities and the structure needed to support focal resources. Some more isolated areas, such as Dead Horse Slough, might be considered for the reintroduction of fish species of concern.

Riparian Corridor—Alternative C

Effects would be the same as under alternative B, except that we would evaluate current infrastructure related to the management of created wetlands and

remove, or change, those features that are deemed to be nonessential or obstructions to natural hydrologic flow paths. We would also evaluate more diversion points as a strategy to better mimic natural hydrologic patterns in sloughs and in Rattlesnake Creek to restore natural hydrology and processes in certain areas to support the long-term sustainability of native communities. We presume that native wildlife would benefit from these actions.

Created Wetlands—Alternative A

There are many positive effects to managing the created wetlands as moist-soil producing, or seasonal, wetlands (Cross and Vohs 1988, Fredrickson and Taylor 1992, Laubhan and Fredrickson 1997, Laubhan and Roelle 2001, Laubhan et al. 2012). Among the primary advantages is the high productivity sustained with periodic drying and flooding of these systems (Mitsch and Gosselink 2003). Without actively managing these wetlands, it is likely that the extent and quality of seasonally flooded wetland resources would be substantially less in most years. Wildlife benefit from a high diversity of habitats here (for example, Skagen and Knopf 1993 and 1994, Hands 2008). Whooping cranes have been observed recently in some created wetlands where cattails have been removed and where newly flooded shallow habitat is created in the spring for example, official reports of whooping crane observations by refuge staff and the public submitted to Nebraska Ecological Services office). Western snowy plovers have recently begun to use some created wetlands after drawdowns in the spring for nesting and brood rearing (personal observation by refuge staff). It is evident that current refuge management has been and would continue to be successful in conserving biological communities at some level.

The refuge is still comprised of many habitat types that have different plant compositions of various heights and densities, have moisture conditions that collectively attract many species, and support threatened and endangered wildlife. But, we do not know how well we have done to support resources of highest concern. This is partly because there have been few feedback mechanisms built into the planning process for the purposeful consideration of how we could manage biological factors differently to achieve greater success. Relevant knowledge of some environmental factors and interactions on Quivira Refuge, such as soils, invertebrates, and the changes in certain water quality characteristics, are lacking, and information on the status and management of inland, nontidal, brackish-to-saline wetland systems in the United States is insufficient. A planning pro-

cess that more efficiently informs us could positively influence the predictability and long-term success of our implementation strategies.

The social and economic effects of managing created wetlands could be great because of the growing interest in refuge resources by nonconsumptive users (personal observation by refuge staff), such as birders who are attracted to the large amount of shorebirds migrating through here in the spring and by waterfowl hunters who want quality habitat that attracts and holds birds in the area. Many of the created wetlands are in the hunting areas, and hunters start using those areas in September for the early teal season and continue to hunt through the end of January, the end of the regular duck and goose hunting seasons. Closing all refuge hunting areas when whooping cranes are present has created substantial conflict in recent years.

See cultural resources effects under alternative C for more information.

Created Wetlands—Alternative B (Proposed Action)

Under this alternative: (1) we would more likely maximize support for focal resources; and (2) we would support and possibly improve the control of hydrology within refuge boundaries. This may increase the long-term probability of sustaining native communities that occurred presettlement, partly depending on watershed conditions. Because of management refinements and with more fully developed biological knowledge, we would more likely achieve greater success in conserving those resources of highest concern. For example, if we were to regularly integrate information on the detection of community thresholds, such as when salinities or nutrients exceed a normal range for an extended period of time, we may be more successful in managing for the long-term sustainability of focal resources and its associated cost. We would likely require more time collecting, synthesizing, and assessing information within a continual planning process. We may improve the conservation of many wetland-dependent resources of concern at State, regional, and national levels, such as whooping cranes, rails, northern pintails, and various shorebirds.



Rachel Laubhan/USFWS

Muskrat

Under alternative B, we would consider closing only hunting areas that are near those being used by whooping cranes. We also propose changing the locations of areas open to different hunting seasons in part to decrease conflicts. Birders and hunters both increasingly affect the economics of the area, as both out-of-state and local users spend money in the local economy because of Quivira Refuge's resources.

See cultural resources effects under alternative C for more information.

Created Wetlands—Alternative C

The greatest risk associated with this alternative is having less control over hydrology within refuge boundaries and relying increasingly on watershed conditions to achieve the refuge's purposes, goals, and objectives at a time when water quantity and quality are of increasing concern. Proposed restoration evaluation would consider larger, landscape changes and the constraints of our refuge management. The full restoration of wetland systems after human modification is never assured, and the limitations of chosen performance criteria has created uncertainty when assessing the success of past wetland restorations (Matthews and Endress 2008, Moreno-Mateos et al. 2012). Success criteria used before to measure wetland restorations include: species population response, sediment or nutrient load reduction or stabilization, the creation of a more natural-looking environment, and plant community characteristics. These could also be considered potential effects to future restoration.

With less water control, the availability and reliability of required resources for many species might be more dynamic within, and among, years. At the same time, a more careful evaluation of restoration possibilities may reveal a new biological potential for refuge lands—a shift in communities compared to what occurred presettlement or since. Still, environmental conditions may still be healthy, productive, and diverse. And these new conditions may, or may not, be more adaptable to the long-term trends associated with climate change (Erwin 2009). If less water were to be impounded and more temporally to seasonally flooded habitat replaces more permanently flooded habitat, then species associated with those habitat types would shift accordingly. For example, this change in conditions likely would favor many shorebird species and result in less use by some diving waterfowl species.

Social and economic effects would primarily affect hunting opportunities and the number of hunters because there may be fewer wetlands that attract waterfowl. There would be fewer areas to hunt, espe-

cially if our future management involves bison. It is likely that waterfowl using the refuge might be reduced in areas without water management capabilities, especially early in the fall, assuming that most wetlands would be dry until late November. Most early fall wetland habitat would be confined to the LSM, which would remain closed to hunting. If wetland resources are more limited and hold fewer waterbirds, then we would expect that wildlife observation-related activities would decrease as well. This would have a negative effect on both the social interactions and the economics of the local area.

Costs associated with the restoration and management of created wetlands under alternative C would be substantially increased in the short term, such as if infrastructure changes are required, and would likely decrease in the long term. But, much depends on the results of the evaluation of restoration potential. Time and costs associated with controlling invasive species, such as saltcedar, could possibly increase.

Effects to cultural and historic resources within created wetlands are greater under this alternative because wetland developments would be reevaluated and would likely be removed, or breached, and the wetlands would be returned to their natural communities as much as is practical. Wetland developments affecting cultural and historic resources span decades and were largely the result of the original refuge master plan. And many waterfowl hunting clubs used the refuge before its establishment. Now, we would seek to alter our infrastructure to achieve a more natural state of environmental conditions.

Freshwater Springs— Alternative A

There is limited knowledge of the functions and wildlife values of the freshwater springs area. The springs are most recognized for supporting a State-threatened Arkansas darter population, and they are a source of fresh water in an area of predominantly brackish to saline water. Fresh water can be important for wildlife not adapted to saline conditions. Also, the occurrence of environmental conditions ranging from fresh to saline may contribute to a greater diversity potential within that area of the refuge. However, recent questions exist about current conditions and management of springs. Exotic, invasive woody vegetation in the area has been increasing, and some relatively larger ponds in the area support green sunfish and possibly other predatory fish that may adversely affect Arkansas darter populations. There would be a reduction of woody

vegetation in the area of the springs and water cress and other nonnative aquatic plants would be controlled.

A beaver downed a tree in 2011, causing the enlargement of area surface water in the immediate vicinity of the spring. This may increase predator fish. There would be reduced coverage of exotic, invasive trees, such as Russian olive. This may improve the availability or quantity of water in the area of the springs. But, the existing pipe at the Boiling Springs would remain. Effects would be largely unknown, and, thus, the full habitat potential of the area may not be realized. Water quality would continue to be checked. We would evaluate the habitat to conserve fish communities, but our actions would be limited.

Tourism groups have been curious about the Boiling Springs area, but we presume that their interest has mostly been about the potential availability of hot springs for their use. But, the Boiling Springs are not hot springs, and increased visitor use would increase threats to its conservation. The area is not closed to public use, but, if use were to increase dramatically, we would consider closing it.

There are no known or anticipated economic or social effects attributed to the springs.

Freshwater Springs—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that our focus would shift to supporting native plant communities, largely through support of focal resources. Spring and Arkansas darter habitat conditions would be better protected and enhanced under this alternative. Management plans, implementation, and monitoring programs would be refined to more purposefully increase benefits to focal resources. If results of an evaluation suggest we remove the pipe or make a proper modification to the “enhanced ponds” in the area of the Boiling Springs, then we may improve the availability and sustainability of water and spring habitat conditions. Evaluations, however, may also encourage us to continue our current management.

Freshwater Springs—Alternative C

Effects would be the same as under alternative B, except that our focus would be on restoring natural ecological conditions. Results may, or may not, sup-

port focal resources besides spring and threatened and endangered species habitat, such as that of the Arkansas darter.

Meadow—Alternative A

While often considered part of upland or wetland habitats, meadow is a unique habitat type that occurs in a transitional zone between other upland and wetland communities. As such, changes in refuge surface and ground water hydrology likely have various effects on meadow, and many of these may not even be known. Obvious changes resulting from existing infrastructure, such as roads and dikes, and from the management of water mostly include shifts in vegetation composition or complete habitat conversions. For example, in areas where impoundments were built and managed to hold increased coverage and deeper water for longer periods, some meadow habitat has been replaced by cattail, Phragmites, or other tall, emergent vegetation that favors, or tolerates, those environmental conditions. At the same time, under these conditions, some upland prairie areas were converted to meadow or wetland communities. In certain areas, reduced levels in the ground water table and changes in surface runoff may have caused conversions from meadow to upland communities, such as tallgrass prairie. To more carefully consider habitat conversions that have occurred on the refuge, partly as a result of current management, past and present cover types were broadly compared on refuge lands (figures 11 and 12).

At the refuge scale, meadow provides a wide range of habitat conditions that support diverse and abundant wildlife communities. For example, saltgrass generally provides habitat that is short in height with density that ranges from sparse to dense that, collectively, are used by many waterbirds for foraging, nesting, and protective cover. Other meadow habitat, such as that occupied by sedges, rushes, and prairie cordgrass, provides relatively taller habitat used by wildlife that require, or prefer, those conditions, such as black rail or bobolink. With dynamic hydrologic conditions, meadow habitat is characteristically productive, and essential for supporting bird, invertebrate, amphibian, reptile, and small mammal communities. As such, we would have many variable effects if we were to alter conditions to favor certain species over others.

We have little control over many of the hydrologic conditions that drive changes in meadow, such as runoff from nearby private lands and reductions in ground water levels at the watershed scale. As a result, some future effects cannot be known.

We would prevent the extensive coverage of dense litter over long periods of time, but would allow rest periods for the subsequent use of habitat by wildlife following individual, or combined, flooding and drying, grazing, burning, and mechanical treatments. It is likely that measures would not be as specifically tied to species needs as would be under alternative B. The restoration of sheet flow or other past alterations would be minimal to none, thus the effects of alternative A would include existing infrastructure that limits the full biological potential of meadow in supporting native communities.

Meadow—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that the support of focal resources would be improved. Also, alternative B would likely form an improved awareness of the connectedness of different habitats and species relationships. This might be especially true with the meadow community because it is a highly transitional habitat type.

Meadow—Alternative C

A positive effect would be the restoration of natural processes and native vegetation characteristic of meadow in this region. For meadow, restoration of sheet flow and its effects on ground water levels might be especially influential to community changes. For example, if flooding depth, frequency, and duration are decreased among years in areas that are now open water or tall emergent, then these areas may be replaced by meadow. If flooding depth, frequency, and duration are increased among years, or ground water levels increase in areas that are now upland, especially in lower elevations, then these areas may be replaced by meadow. Of course, we would have little control over watershed management, which would greatly influence potential outcomes.

Effects on the meadow community would need to be considered for bison reintroduction or for patch burn grazing.

Woodland—Alternative A

Most shelterbelts, tree groves, and riparian woodland on the refuge are not dominated by native trees and are the result of tree plantings as land claims and

other projects that occurred decades ago. At the time those decisions were made, differences existed in the conditions of prairie and riparian communities, grassland bird trends, and threats to conservation. Therefore, to be more consistent with presettlement conditions, we would allow only a few, select tree groves to remain on the refuge as part of woodland.

The abundance and, possibly, the richness of wildlife associated with woodland would be reduced from current levels. However, the abundance and, possibly, the richness of wildlife associated with open prairie habitat would increase over current levels. Allowing woodland to remain on the landscape would be based on an evaluation of variables and species–habitat trade-offs to sustain native sand prairie communities and to address other conservation concerns or threats. For example, we may allow the continued existence of woodland to support colonial nesting or species of conservation concern, especially if it occurs nears the refuge boundary where wooded areas occur on private land and if benefits to prairie species that prefer open habitat were found to be little to none if the trees were removed.

We do not plan to cut trees in the Migrants Mile in the near future, other than to thin and clean the stand. Reduced woodland in the riparian corridor would generally involve saltcedar control. With increased access during drought conditions, the cut-



Soapweed Yucca

ting of exotic, invasive species such as Russian olive and saltcedar in created wetlands and riparian corridor habitats would be a priority. Control of these species would also support improved soil and water conservation. Various types of woodland habitat are available and increasing at the regional and landscape scales outside refuge boundaries. See the sand prairie complex and wildlife sections in this chapter for more information about community effects.

We would expect mixed reactions on the cutting of trees. For example, birdwatchers that are interested in spotting the most bird species in the shortest amount of time would be disappointed in the effects, while those most interested in the conservation of declining endemic grassland birds would be pleased, and hunters likely would have mixed opinions. There would be no effect to waterfowl hunters. Most who visited to the refuge in recent years, however, came to see lots of waterfowl, shorebirds, and sandhill cranes or to view the endangered whooping crane. Woodland does not help these species or the observation of these species. We would likely need to increase awareness of the “wildlife first” mission of the Refuge System, and of the roles and responsibilities of the refuge to conserve species and reduce threats on various spatial scales.

Our costs would increase in the short term as woodland is reduced and proper habitat is restored. But, subsequent costs would decrease partly because of a reduction in resources spent to control woody encroachment and invasive species. Costs related to water use and availability would improve with substantial reductions in tree cover, especially saltcedar along the riparian corridor.

The reduction of trees and shrubs would create communities that are closer to what occurred in presettlement times. To accomplish this, several tree claims and shelterbelts planted around historical residence areas would likely be removed.

Woodland—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that we would emphasize developing prescriptions that would increase benefits for focal species.

Woodland—Alternative C

Effects would be the same as under alternative A, except that we would allow few isolated trees and no

tree groves on the refuge except for those more naturally occurring native species that are associated with riparian areas or springs to reach conditions that are more like those during presettlement times.

Sand Prairie Complex— Alternative A

Tree and shrub encroachment affects the remaining tracts of sand prairie within the Great Bend Lowlands and on lands surrounding the refuge. Therefore, successfully reducing woody vegetation would promote unique and essential habitat conditions at various scales and would create communities closer to those of presettlement times.

Among the effects of woody vegetation spreading into prairie grassland, there are many important species–habitat relationships to consider, including those involving migratory birds. Declining trends of grassland bird populations are of serious conservation concern (Sauer et al. 2008), and it has been suggested that even large grassland tracts remaining in Kansas and Oklahoma that are largely part of an agricultural landscape may not support regional populations (With et al. 2008). While individual reports vary, research of woody vegetation in grassland generally finds negative effects on grassland birds (Bakker 2003; Coppedge et al. 2001, 2004; Chapman et al. 2004; Grant et al. 2004, Coppedge et al. 2008). While there are several management and environmental conditions that influence woody plant dominance, such as plant adaptations and competition, fire and grazing regimes or prescriptions, and climate (Fuhlendorf 1999, Ratajezak et al. 2011), our refuge planning considers such factors in refining strategies to accomplish related objectives.

Many endemic or obligate grassland birds avoid areas with, or near, trees; incur lower densities or the probability of occurrence and nest success where trees are present; and suffer increased predation and parasitism in treed areas. Factors related to bird use of habitat in the landscape are complex and birds’ responses to them are variable (Ribic et al. 2009). But, managing for larger tracts of open prairie seems a responsible action considering available information and the purpose of the refuge. In a recent literature review, it was shown that half of the 32 species of temperate, obligate grassland birds of North America have area sensitivity, “defined as a positive relationship between probability of occurrence of species or species density and [habitat or patch] area” (Ribic et al. 2009). Many birds included in this review occur on Quivira Refuge during the breeding season, such as northern harrier, upland sandpiper, grasshopper

sparrow, dickcissel, bobolink, and eastern and western meadowlarks. At the same time, it is important to remember the connectivity among habitats on the refuge and in the landscape. For example, Coppedge et al. (2008) showed that distance to ponds, creeks, and roads had both positive and negative effects on grassland bird abundance, which varied among species.

Other literature has shown the influence of trees in the landscape on waterbird annual life events and their use of habitat (Naugle et al. 1999). One study found substantial declines in duck nesting success when Russian olive trees were abundant at a landscape scale (Gazda et al. 2002).

Increasing coverage of shrubs in grasslands has similar effects as described above with trees, but some reports are noted that specifically discuss the effects of shrub cover on grassland birds. In the Flint Hills of Kansas, daily nest survival of grassland songbirds decreased with increasing shrub cover partly attributed to higher rates of predation, and occurrence of successful nests was associated with tallgrass and forbs but reduced shrub cover (Klug et al. 2010). In mixed grassland, probability of occurrence of 11 of 15 breeding grassland birds decreased with increases in coverage of trees, tall shrub, or brush (Grant et al. 2004). Studies in Oklahoma are some of the only reports describing bird–plum habitat relationships that may be used to evaluate trade-offs of shrub management and guide decisions (Dunkin and Guthery 2009). While there are several management and environmental conditions that influence woody plant dominance, such as plant adaptations and competition, fire and grazing regimes or prescriptions, and climate (Fuhlendorf 1999, Ratajczak et al. 2011), refuge planning considers such factors in refining strategies to accomplish related objectives.

Besides the effects to migratory birds, other plants are affected by the increased woody vegetation. Cheatgrass thrives under scattered trees, tree rows and plum shrub habitat. Areas around, and under, almost all trees have a cheatgrass understory instead of native grasses, and cattle affect those areas by resting and congregating under trees for shade. Sand plum stands with a cheatgrass understory become largely impervious to fire because of the cool-season nature of cheatgrass. In the spring, hot prescribed fires burn around plum stands. Later, when the plum buds and leafs out, plum stands become even more resistant to fire. Native grasses appear to outcompete cheatgrass once the overstory and heavy cattle effects are taken away with the removal of trees or by mowing sand plum and other tall shrubs.

The successful, long-term management of the sand prairie complex under alternative A would

result in sustaining open, native sand prairie communities dominated by short-to-medium, and medium-to-tall, warm-season grasses and reduced woody and invasive plant species coverage. Under alternative A, we would focus on supporting diverse, native communities in a more general sense relative to alternative B, and there would be various trade-offs related to plant and wildlife community composition and structure. Because we would not consider certain focal resources at a finer scale, a wider range of habitat conditions and use by wildlife might be acceptable. This may support a higher diversity and abundance of wildlife overall at the refuge scale, but the needs of focal resources of management concern (table 3) may not be entirely satisfied. At the same time, other species not now considered of highest conservation concern, such as deer, likely would benefit more from alternative A, when compared to alternative B.

With a reduction of trees and shrubs, the abundance and, possibly, the richness of wildlife associated with those habitat types would be reduced, and the abundance and, possibly, the richness of wildlife associated with open prairie habitat would increase. We would expect mixed reactions on the cutting of trees. For example, birdwatchers who are interested in spotting the most bird species in the shortest amount of time would be disappointed in the effects, while those most interested in the conservation of declining endemic grassland birds would be pleased, and hunters likely would have mixed opinions.

Changes in the water table will likely have some effects on communities, such as shifts in species composition (Castelli et al. 2000, Henszey et al. 2004, Hammersmark et al. 2009), but both changes and consequences are unknown and likely would be largely influenced by watershed management.

Sand Prairie Complex— Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that the habitat needs of focal resources would largely guide our management of plant community composition and structure on the refuge. Management prescriptions and priorities would be specific to accomplish the particular habitat needs of those species, such as providing stands of habitat of a certain size, shape, height, and density, within a specified distance to water or another habitat type. Species that are of conservation concern and have been a lesser priority of recent management would benefit, such as Bell's vireo or upland sandpiper.

Because focal resources collectively require a wide range and diversity of vegetation structure and composition, refuge habitat would support many, different wildlife with needs that are not specifically used in management decisionmaking. It is unknown if, and how, the costs of conducting management treatments would differ from alternative A, but these costs would be less than those associated with alternative C. On the other hand, more specific monitoring measures and subsequent feedback would be involved with alternatives B and C, when compared to A, to measure progress and to provide management recommendations.

The time required for monitoring programs and management planning would increase slightly.

Largely because of uncertainties related to future water availability and conditions, it is difficult to predict if alternatives B or C would create communities that are closer to what occurred in presettlement times.

Sand Prairie Complex— Alternative C

Effects would be the same as under alternatives A and B, except that, as a result of managing to restore natural functions and communities to the extent possible, community composition and structure would likely change more from alternative A than it would under alternative B.

When considering bison to replace cattle grazing as a management tool, substantial effects to communities would be expected. However, changes may be caused more by the removal of fences and the use of fire to influence the distribution and intensity of grazing rather than because of differences between these herbivores (Towne et al. 2005). After 10 years of grazing in Kansas tallgrass prairie, plant communities grazed by bison and cattle were 85 percent similar based on a comparison of parts measured (Towne et al. 2005). Mixed reactions would be expected from different interest groups if bison were reintroduced and areas were closed to the public for safety reasons.

In evaluating the use of bison, management would need to consider the following changes and associated costs: adding boundary fences that are proper for bison, removing most fencing within refuge boundaries, coordinating with the burning program, health screening and herd culling, constructing and keeping a handling facility, water tank needs, safety concerns, and the logistics related to moving bison. On the other hand, tourism may increase with opportunities

to observe bison, which would help the economies of local communities.

Our costs would likely increase in the short term to reduce invasive species coverage and for possible changes in infrastructure. More monitoring programs would be required to evaluate infrastructure before and after changes.

We would focus on restoring natural functions and native communities to the extent possible to support certain cultural and historical aspects of natural communities that occurred in presettlement times. For instance, we would evaluate the application of grazing and fire in a way that more closely mimics what occurred then.

Cropland—Alternative A

The refuge would slowly reduce cropland acres and replant with proper native vegetation as cooperators voluntarily quit farming. 186 acres have been reseeded in the past 2 years. Slowly reducing the area of cropland and restoring native plant communities would continue at a rate of about 50 acres annually, depending on cooperator contracts and climate and resources available to buy native seeds. Once reseeded the areas would be aggressively managed with mowing, fire, grazing, “interseeding” and herbicides to improve stand establishment, pending climate conditions. After establishment, restored areas may be harvested for seed for other reseeding projects in the future. Food is not a limiting factor in the landscape, and reconstruction of annual cropland to native communities would not alter the ability to achieve regional and national waterfowl population goals. It is presumed that reconstruction would improve habitat conditions for native sand prairie communities.

Cropland areas create artificially high deer densities, as deer are drawn to the winter wheat crops and waste grain in other crop types. Use of cropped fields by deer and waterfowl may get more attention from visitors, as they concentrate wildlife and many are near roads and the auto tour route but these same animals use other parts of the refuge.

Farming as a management tool would remain an option for habitat restoration or to meet conservation goals (USFWS 2011), but farming solely to supply food crops for wildlife would be gradually reduced and eventually ended.

The use of genetically modified crops to prepare seedbeds for the reestablishment of native plants is allowed. An EA was completed for this use in 2011. That method has never been used on the refuge, but would remain a future option.

The slow rate of reseeded would be because of the high cost of native grass and forb seeds and associated restoration activities, such as seedbed preparation and invasive species control. The refuge uses a cooperater to harvest native grass seeds from the refuge for use in the reseeded program to reduce costs. We harvest seed in relatively normal to wet years with 75 percent going to the cooperater and 25 percent going to the refuge.

With farming, there is a risk of invasive species establishment and spread because of equipment and the disturbance of bare ground.

Cropland—Alternative B (Proposed Action)

Effects under alternative B would be the same, except that areas would also be reseeded instead of being left to naturally go back to a native community. This action would speed the recovery in those approximately 200 acres that were cropped before to a native community but would also cost much more in time and money than actions under alternative A. “Interseeding,” burning, mowing, grazing and herbicide treatments would be used for restoration. These areas do not have the same types of wildlife use and public viewing opportunities that cropland has, so this addition would have fewer negative or positive effects (figure 14).

Cropland—Alternative C

Effects under alternative C would be the same as under alternative B, except that restoration activities would be accelerated and would consume more time and money than actions under either alternative A or alternative B, and the result would be a faster restoration of native communities. Ultimately, effects would be the same as under alternative B. Wildlife would benefit sooner under this alternative.

Migratory Birds—Alternative A

Our wetland management promotes high use by waterfowl, shorebirds, and other waterbirds; see the BSM, created wetlands, and LSM sections in this chapter for more detail. A wide diversity and abundance of migratory birds would continue to benefit from habitat management. Habitat use on the refuge would likely be reduced for heron rookeries, raptor

perching, some neotropical migrant resting and foraging, and other tree- and shrub-associated species use, while habitat use likely would be increased for endemic grassland bird migration and nesting activities. It is possible that, with reduced woody coverage, the predation of eggs, young, and adult birds would decrease.

Certain generalist species that have benefited from human modifications to the landscape would have decreased benefits on refuge lands. However, it is expected that birds that see reduced benefits on refuge lands would be supported by current habitat conditions occurring in the landscape beyond refuge boundaries. Species recovery plans and various regional and national bird conservation plans would be supported.

Migratory Birds—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that a shift in management focus would increase the potential benefits to endemic and obligate grassland species and waterbirds adapted to environments with less coverage of trees and shrubs. Tree- and shrub-dependent species would have reduced benefits.

Migratory Birds—Alternative C

Because most woodlands would be removed, wading bird rookeries would likely exist off refuge and other tree-nesting species would decline on refuge lands. However, a diversity of woodland and shrubland habitat occurs on surrounding lands outside refuge boundaries. These are conditions that are commonly found, and are increasing, at both a regional and State level.

The overall abundance of migratory birds would likely decrease with potential changes in hydrology, refuge infrastructure, and management. For example, our current ability to hold and control water would be reduced, and, consequently, our ability to make desirable habitat conditions available to species at proper times would decrease. It is also expected that conditions for migratory birds would fluctuate in wet and dry periods; more “boom and bust” conditions would prevail. If water is properly managed at a watershed level, our management would support long-term ecosystem sustainability and productivity and, therefore, continue to provide long-term benefits

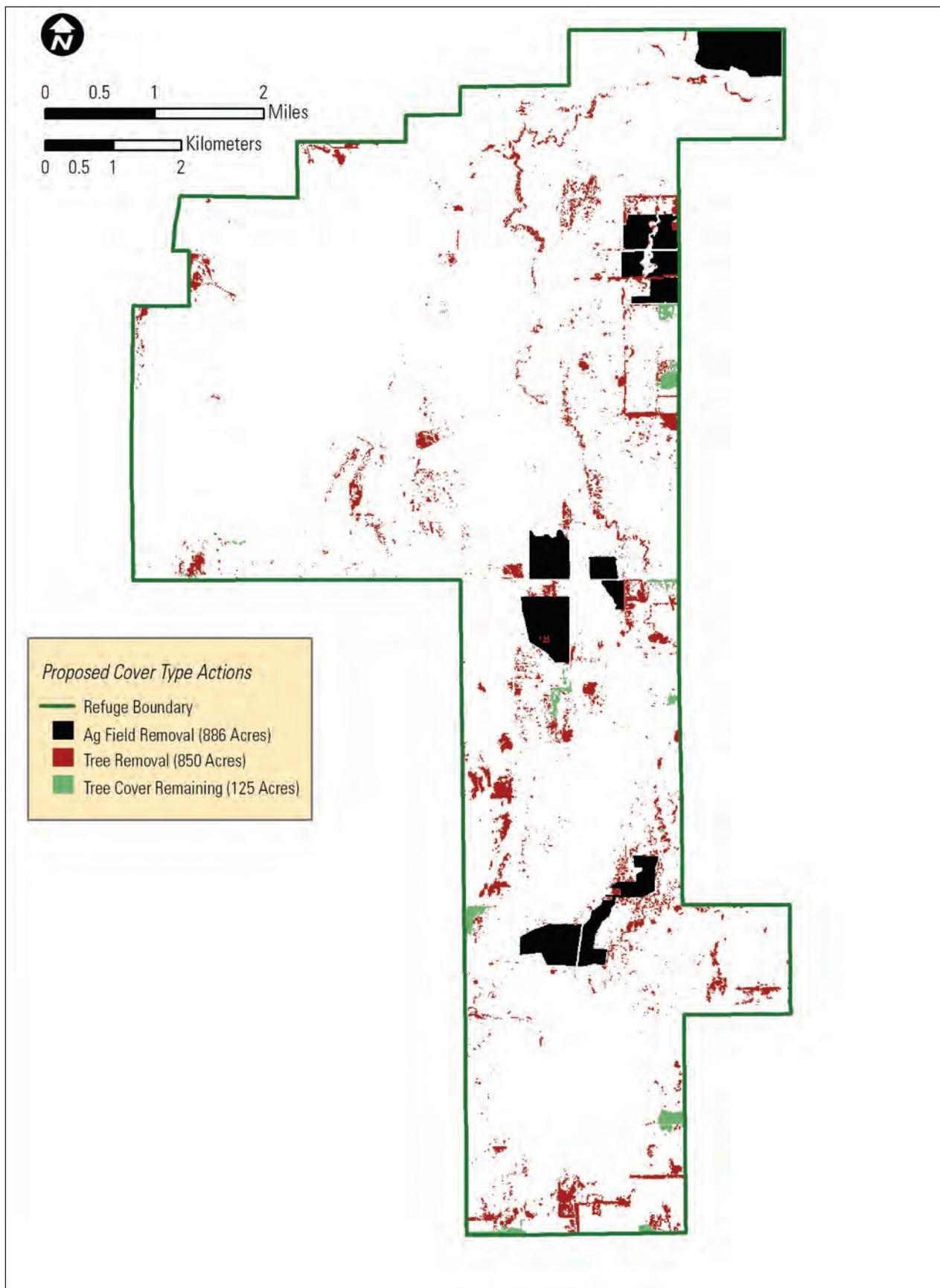


Figure 14. Cropland and tree coverage planning under alternative B (proposed action), Quivira National Wildlife Refuge, Kansas.

to migratory birds. But, we would no longer maximize wetland habitats every year.

Fish—Alternative A

Water quality would be improved as carp and other undesirable fish are reduced, mostly through the periodic drying of wetlands. These fish promote higher water turbidity, which lowers the productivity of plants that are beneficial to birds during migration and, in some cases, some native fish during the breeding season.

To reduce the likelihood of introducing foreign or unwanted diseases and pathogens to resident aquatic species, we would avoid stocking nonnative fish except at the Kids' Fishing Pond. Native fish populations would also benefit from our conserving desirable habitat. We would manage the BSM area to encourage a more natural range of high salinity and other water quality conditions, which we would expect to support plains killifish and other native fish populations that tolerate high salinity. We would continue to conserve the Boiling Springs freshwater habitat to support a healthy source population of State-threatened Arkansas darters.

Fishing opportunities on the refuge have traditionally been on the north and east sides of the LSM, and this would continue. Fishing at the Kid's Fishing Pond would remain unchanged. See the fishing section in this chapter for more detail.

The biological effects of crayfish are complex partly because of their interactions with, and the similar roles of, fish in ecological systems, including predating on each other's eggs or young, competing for food and shelter, and affecting community resources (Reynolds 2011). Both fish and crayfish would have significant effects on food web relationships that may negatively or positively influence migratory birds, depending on the balance of resources at a given point in time. The balance of resources would be constantly changing and, therefore, would be difficult to measure and track, especially when one considers that aquatic species would be frequently introduced to Quivira Refuge through Rattlesnake Creek and that many wetlands on the refuge would be managed to regularly flood and dry.

Fish—Alternative B (Proposed Action)

Effects would be the same as under alternative A, plus we would focus on species–habitat relationships

to support a productive and healthy aquatic environment, including special focus on the Arkansas darter and plains killifish. As a result, we expect that native fish populations would improve.

Native fish populations may benefit even more from management that is more acutely focused on specific species–habitat needs; from the potential reintroduction of native fish; and from the results of evaluations to create and keep more suitable habitat in targeted areas both on and off the refuge, which we would conduct with help from the public and our partners. By not allowing the use of live fish bait, we expect to further reduce the likelihood of introducing diseases and pathogens to aquatic species. By allowing the frogging of bullfrogs only, changes in fish populations and other associated links in the ecosystem, such as invertebrates and birds, are possible, though we do not expect that the level of take would have major effects.

By periodically removing carp from the system, native fish populations would improve and fishing activities would likely increase.

Fishing opportunities on the refuge have traditionally been located on the north and east sides of the LSM, and this would continue.

Fish—Alternative C

Effects would be the same as under alternative B, except that, by restoring hydrology and communities to the extent possible, we would expect an improvement in water quality, but limitations on this improvement are possible because of uncertainties in future watershed management and conditions. Improvements in water quality and restored hydrology would be expected to benefit fish populations native to prairie streams. Sport and nonnative fish populations would likely decline in many areas of the refuge.

With removal of the Kid's Fishing Pond, fish populations would decrease in that basin because regular stocking would no longer occur and the pond would have shallow water or be dry, depending on spring flows. Conditions for fish on the refuge, overall, would vary in wet and dry years. The extent and duration of deep, permanent water on the refuge from Rattlesnake Creek would likely be reduced, which would adversely affect nonnative, or sport, fish. However, some of the natural sloughs and ponds, and riffle pool sequences that leave areas periodically isolated from the creek may function better to conserve native prairie fish populations. Also, overall and in certain years, there may be improved habitat for certain life cycle events of native fish, such as for nesting or brooding. Where water control is reduced, there may

be occasional issues related to carp or undesirable fish populations. In these cases, management might largely depend on dry periods to control populations and related effects, such as water turbidity, aquatic vegetation productivity and food chain viability.

Most fishing opportunities on the refuge have traditionally been on the north and east sides of the LSM, and this would not change. Fishing at the Kid's Fishing Pond, however, would no longer occur.

Maintenance and stocking costs would decrease.

Threatened and Endangered Species and Species of Concern—Alternative A

T and E species would remain a management priority, and we would continue to support recovery plans and the conservation of critical habitat. By reducing woody vegetation, we would expect to improve habitat conditions for all federally listed T and E species and all State-listed species except, possibly, for the eastern spotted skunk. However, there have been no known observations of this skunk species on the refuge in recent decades, and Stafford County is not reported as critical habitat for it. It is possible that, with reduced woody coverage, the predation of eggs, young, and adult T and E birds would decrease.

Our water management would continue to support habitat conditions that are favorable for migrating shorebirds and waterfowl, as well as for migrating and roosting T and E species. Areas in, and around, the BSM and the LSM have received the most use by whooping cranes on the refuge in recent years. The BSM area is traditionally used by both interior least terns and snowy plover. In 2011, a drought year, several pairs of interior least terns successfully used shoreline and beach habitat where the Rattlesnake Creek enters the LSM.

See the fish section in this chapter for more information on the Arkansas darter.

Threatened and Endangered Species and Species of Concern—Alternative B (Proposed Action)

Effects would be the same as under alternative A, plus, with a shift in management focus and more quantitative checking of management effects, poten-

tial benefits for T and E species may increase. We would measure and consider factors that properly describe vegetation conditions following treatments that influence species use to figure out our success in achieving our objectives. For example, we could evaluate our success in supporting the black rail, a State Species in Need of Conservation, by following water depth and coverage of certain plant species in the meadow habitat (Kane 2011).

Threatened and Endangered Species and Species of Concern—Alternative C

Effects would be the same as under alternative A, except that our shift in management focus from species-specific habitat needs to native communities and processes would likely result in decreased benefits to certain T and E species in some years and increased benefits in other years. We expect to have limited control over some areas of the refuge, and, therefore, habitat availability would be less dependable within, and among, years. At the same time, increased benefits may result if we find that habitats would support the reintroduction of species, such as lesser or greater prairie-chicken. Provided that water is properly managed at a watershed level, and pending climate change effects, our management would support long-term ecosystem sustainability and productivity and, therefore, continue to provide long-term benefits to T and E species.

Managing the BSM in a manner that more closely mimics what occurred during presettlement times would be expected to increase nesting habitat for western snowy plover and interior least tern. Less use of the BSM by whooping crane would be expected because there likely would be more years with little to no water at the time of migration. There would likely be less flooding of traditional least tern nesting areas because the basin would have more room to store rainfall, since water would not be kept artificially high in the spring, and artificial dikes and roads that impede waterflow would be removed.

Wildlife Native to the Region—Alternative A

Our management of habitat would support wildlife native to this region of the Great Plains. In doing so, other wildlife native to the larger Great Plains would also benefit, and species diversity would be

supported at regional, landscape, and national scales. Species associated with woody habitat would be expected to decrease within refuge boundaries, while native endemic species associated with open grassland would increase. However, a diversity of woody habitat conditions occurs on surrounding lands outside refuge boundaries. These conditions are commonly found, and are increasing, both regionally and across the State. Many of the species associated with woodlands on refuge lands have benefited from human modifications to the landscape such as the American robin and black-capped chickadee. It is likely that, with reduced woody coverage, the predation of wildlife prey eggs, young, and adults would decrease on the refuge.

For more information on species-specific examples and trade-offs, see chapters 3 and 4 and the appendixes.

Wildlife Native to the Region— Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that, with our shift in management focus, potential benefits to endemic and obligate grassland species and wetland species that are adapted to environments with less coverage of trees and shrubs would increase.

Wildlife Native to the Region— Alternative C

Effects would be the same as under alternative B, except that the overall abundance of different wildlife



Barry Jones/USFWS

Coyote

would likely be mixed, depending on species and conditions. Wildlife populations would likely experience more dynamic fluctuations within, and among, years because of potential changes in hydrology, refuge infrastructure, and management. For example, our ability to hold and control water would be reduced, and, consequently, our ability to make desirable habitat conditions available to species at proper times would decrease. Provided water is properly managed at a watershed level, our management would support long-term ecosystem sustainability and productivity. Therefore, we would continue to provide long-term benefits to wildlife. If a patch burn strategy is carried out, we expect that there would be benefits to species diversity.

Wildlife Health—Alternative A

We would decrease adverse health conditions for wildlife. To the extent possible, and with the understanding that influences exist outside of our control, we would keep contaminant levels within a normal range for the ecosystem. Our surveillance of disease outbreaks would continue, and we would collect specimens and send them to a lab for testing when appropriate. With reductions in woody vegetation, we would expect positive changes in deer distribution and that contact rates would decline. Considering the current high population of deer, this may reduce the potential effects of chronic wasting disease; see chapter 4 for more details.

Wildlife Health—Alternative B (Proposed Action)

Effects would be the same as under alternative A, plus we would emphasize water sampling to improve the early detection of potentially adverse conditions for wildlife health and, possibly, prevent substantial wildlife die-offs. Regular water and, possibly, soil sampling in and near streams and tributaries, ditches, and oil wells on the refuge would track trends in contaminant levels. Changes in hunting regulations would be expected to improve wildlife health conditions, specifically for the high-density deer population.

Trapping could help control disease and nuisance animals, which would benefit wildlife. There would be a small economic benefit for trappers. And we would expect most trappers to live in the local area.

Wildlife Health—Alternative C

Effects would be the same as under alternative A, plus a broader suite of environmental conditions would be checked to further improve benefits to wildlife health. However, because there is the potential that we would have less control over water management, a decrease in our ability to manage disease and health concerns would be expected. At the same time, our management for ecosystem sustainability would be expected to increase resilience to adverse conditions, excluding human-caused disasters, such as an oil spill. Trapping effects would be the same as under alternative B.

Inventory, Monitoring, and Research—Alternative A

We conduct monitoring programs for surface waterflows, water levels, and water quality, but improved methods to collect this data are also being developed. We would evaluate the possibilities and constraints of observing ground water and soil factors. Effects include our receiving better information about these factors within the refuge boundaries and, perhaps, being able to favorably influence conditions.

There would be a relatively general focus on supporting diverse, native communities. For example, because we would not focus on specific focal resource needs, as under alternative B, a potentially wider range of habitat conditions and wildlife use would be acceptable. At a minimum, we would need to evaluate for native and nonnative trends, the diversity of refuge communities, and for T and E species conditions and activities. It would be expected that required monitoring programs would involve relatively broad-scale measures and perhaps less intensive sampling than under the other alternatives.

We would continue to inform a variety of interest groups on our findings. Limitations would exist relative to the types and extent of information that we would be able to collect or provide.

Our objectives and protocols and our historical methods and outcomes would be reviewed for relevancy and cost. Information learned from our activities would be properly used to gain more support for our refuge management and for resources of concern. We would continue to share information for varied interests, including local economies, educational institutions, and conservation programs and groups.

Inventory, Monitoring, and Research—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that monitoring measures related to species-habitat needs would be more specific. For example, our management focus and associated treatment prescriptions would need to evaluate species-habitat need factors such as providing stands of habitat of a certain size, shape, height, and density, within a specified distance to water and or to another habitat type. Species that are of conservation concern and have been a lesser priority of recent management, such as Bell's vireo or upland sandpiper, would likely benefit as a result of this finer level of monitoring. Because focal species, collectively, require a wide range and diversity of vegetation structure and composition, refuge habitat would continue to support many different wildlife species not considered focal species. It would be expected that more specific monitoring measures and subsequent feedback would be involved to measure our progress and to provide proper management recommendations.

Inventory, Monitoring, and Research—Alternative C

Activities related to soils and hydrology would be more extensive.

Activities related to biological factors would also be more extensive. For example, there would be more habitat and wildlife population monitoring programs used to decide if hunting and trapping would be allowed for a certain time. It would be expected that activities both before and after inventory, monitoring programs and research would be needed to evaluate the accomplishments of restoration activities.

Our management and monitoring programs would be more costly than they would be under the other alternatives. While the potential consequences to natural resources would be of primary concern, costs related to our management strategies and monitoring programs must be factored into decisionmaking, especially considering the uncertainties and constraints associated with Federal money and the varied interests of conservation groups.

5.5 Visitor Services Effects

This section discusses the effects of alternatives pertaining to visitor services.

Hunting—Alternative A

The following affect hunting activities under alternative A.

Effects Associated with an Unnaturally High and Increasing Population of Deer

White-tailed deer would likely increase until artificial controls, such as hunting, or natural controls, such as disease, change this trend. In the meantime, we presumed that there would be a growing risk of exceeding habitat carrying capacity and experiencing a decline in deer health and habitat conditions. The threat of chronic wasting disease would be of concern, as incidences occur closer to the refuge each year and because some local areas are managed to increase deer populations for the economic benefits of recreational hunting.

With an increasing deer population public viewing opportunities would be maintained or increased because deer that are not afraid of humans are easier to observe from vehicles. The refuge has many trophy bucks that one can view and photograph easily. But, the presence of many deer within, and near, the refuge could also create traffic safety issues. Having many trophy deer would also encourage poaching, which would be a law enforcement issue. Also, if disease did become an issue, public viewing of unhealthy deer would be expected to have mostly negative effects.

Because the refuge would continue to be closed to deer hunting, it would also remain closed to the retrieval of deer that are shot off the refuge. Some hunters have concerns that it is a waste of game to not be able to retrieve deer. Retrieving deer is not allowed, according to the CFR, primarily because much hunting occurs next to the refuge because it is closed and because there have been frequent and repeated requests in the past to retrieve big game animals that have crossed into the refuge after having been shot. Hunting blinds also exist extremely close to the refuge boundary in many areas.

While browse lines are evident, we have limited knowledge on the effects of deer on native vegetation and habitat conditions. Native forbs and, possibly,

shrubs may be negatively affected by high deer populations.

Effects Associated with Whooping Crane Protection

Whooping cranes have spent more time on the refuge over the past few years in the fall, and, with climate change, they may spend even more time here in the future. This trend may improve the observation of this endangered species, but it may also limit the time that the refuge is open and available for hunting. All areas of the refuge are closed to hunting when whooping cranes are present, even in cases where only one bird is using a small area of the LSM for a month and never going near the upland hunting areas where hunters are only pursuing upland gamebirds.

Whooping cranes tend to be predictable in their daily movements once they arrive on the refuge, and they have traditional use areas on and off the refuge. Whooping cranes may actually be at higher risk when they fly off the refuge daily in the early morning and over hunters looking for sandhill cranes, than when they are on the refuge where sandhill crane hunting is not allowed. No whooping cranes have ever been known to have been shot by hunters on the refuge.

We suspect that many hunters would continue to be frustrated with our closures, particularly those related to whooping cranes.

Hunting—Alternative B (Proposed Action)

White-tailed deer hunting would be allowed on most of the refuge. The hunt plan would be fully developed after this CCP is completed, but would likely initially involve an archery-only or a youth-archery-muzzleloader-only season, with limited entry by draws for all hunt seasons. All possibilities for hunting deer would be explored, and safety for visitors would also be considered. Based on consultations with State experts, information used to justify a desired target population is limited partly because the potential range carrying capacity of the area is unknown and likely to be constantly changing because of factors such as land management at multiple scales. Initially, we would want to understand if selected harvest strategies would successfully result in a reduced deer population. Also, deer hunting on the refuge would create many more opportunities for

public hunting in a state of which less than 3 percent is publicly owned.

The viewing opportunities of trophy deer and deer with little-to-no fear of humans would likely decline, as deer would become more wary and difficult to observe and photograph closely.

There would be more potential interaction between hunters and nonhunters because more areas would be open for hunting, there would be longer hunting seasons, and there would be more chances for wildlife observers to see hunters in the field. Youth and muzzleloader hunting could increase the range of firearms used on the refuge and would increase the chances for safety issues with hunters and nonhunters. Youth and muzzleloader seasons would allow for more harvest, more opportunities for various hunters, and more opportunities to decrease deer densities to healthy levels. They would also allow us to meet goals for increased youth hunting.

It is unknown how refuge deer hunting would affect the number of hunting blinds immediately surrounding the refuge boundary, but it is possible that there would be increased requests from hunters to enter the refuge to retrieve deer, resulting in many calls after hours and on weekends when there may be no employees working. This may lead to frustration that the refuge doesn't provide 24-hour access to employees and to more costs for calling employees in to work whenever a hunter needs to retrieve a deer.

Turkey hunting would be allowed. Prairie-chicken hunting would be allowed if the refuge population increased and warranted hunting or harvesting for health purposes. Furbearer hunting would also be allowed, but weapons would be restricted to archery or firearms because of safety concerns. Many deer hunters also hunt furbearers. This offers more hunting opportunities for such popular furbearers as raccoons and bobcat when populations support it and according to State regulations.

We would only close areas of the refuge to waterfowl hunting when whooping cranes are in, or near, hunting units. Upland game hunting would not be closed when whooping cranes are present, unless we find that hunter presence would disturb whooping cranes. Under all hunting scenarios with any species and unit, the refuge would close specific units to hunting and other public uses if whooping cranes are using that area. Sandhill crane hunting would remain closed at all times on the refuge. We would need to spend more time on law enforcement, signage, and communicating specific closure areas. Reducing hunting threats to whooping cranes would be accomplished through increased public awareness of cranes via kiosks, brochures, signs, and public programs.

Waterfowl hunting areas would be realigned. The area of salt flats and North Lake would be closed to hunting because that is near one of the primary

whooping crane use areas. In turn, we would open a similar-sized area of created wetlands in the middle of the refuge to waterfowl hunting that whooping cranes have not used in the past. This would result in closing one of the most popular waterfowl hunting areas, but it would also lessen the chances that an area would be closed because of the presence of whooping cranes and would provide more protection for them.

With changes in water management, those areas that we propose closing to waterfowl hunting would generally be dry in most years during the first month of waterfowl season because they would be allowed to fluctuate more naturally with hydrology of the BSM. The created wetlands would be a more reliable source of flooded habitat in most years, would remain open the entire season in most years, and, with active management, would provide higher-quality, moist-soil habitat that would attract more waterfowl. More parking areas and roads would need to be opened to provide access to these created wetlands.

There would be added costs for changing the hunt areas, signage, parking lots, brochures and more law enforcement. More costs would also occur if specific hunt areas have to be signed open and closed, but there would less likely be closures after the hunting area is redrawn.

Hunting—Alternative C

With respect to hunting, protection of resources would be the overriding principle. Hunting for migratory birds would remain the same as under alternative A, except that we would add sandhill crane hunting. The entire refuge would continue to be closed to migratory bird hunting when whooping cranes are present to give the greatest protection to the endangered species when they are using designated critical habitat at Quivira Refuge. Because sandhill crane hunting would be allowed, our refuge staff would increase awareness of cranes through kiosks, signage, and public programs. All other hunting, including upland game hunting, would continue and would only be closed in specific units if whooping cranes are present in those units, because of potential disturbance, not because of risk of shooting, as we presume that deer, turkey, quail and pheasant hunters would not shoot at waterfowl or cranes. This would allow more upland bird hunting with little-to-no risk to whooping cranes. Deer, turkey, prairie-chicken, and furbearer hunting would be opened and managed as under alternative B.

Added costs because of larger hunting areas, signage, law enforcement, more species and seasons, more permits and activities to administer, and wild-

life observation changes would be same as under alternative B.

Hunting would follow ecological restoration. Waterfowl and other migratory bird hunting would be expected to decrease, as we may not control water in some of the created wetlands and natural hydrology flows there would produce changing, less-consistent water conditions in the fall. Deer and turkey populations would be expected to decline because there would be fewer trees, less shrub habitat, and no cropland habitat on the refuge. Upland bird populations would be expected to decrease or remain the same as more prairie habitat is restored and fewer trees and shrubs exist and cropland is restored to native communities. Prairie-chickens would be expected to increase because more quality prairie would be available on the refuge.

Whooping crane use may increase with the increase in open meadow and prairie habitat without trees, croplands, and, possibly, with reduced artificial infrastructure to break up the landscape. Whooping crane use would likely vary because some wet years would produce widespread shallow sheet flow across meadows and the possible removal, or notching, of internal roads and canals might create water habitat that is less deep. The LSM, now a popular and consistent crane roosting area, would likely have less water during the fall in most years. Therefore, whooping cranes may use other areas, such as wide-open meadows, more often during migration.

If bison are restored to Quivira Refuge, hunting opportunities may have to be altered to prevent their interacting with hunters in the field. Refuge policy does not allow for the hunting of captive herds of ungulates on refuges. This includes bison.

Fishing—Alternative A

Fishing on all waters, according to State-established seasons and regulations, would continue to provide recreation opportunities that are compatible with our refuge management. Accessible fishing piers are already in place on the LSM and Kid's Fishing Pond, which are the two most popular fishing locations on the refuge. Fishing on most of the refuge would be of low quality because of carp infestations that reduce the productivity of invertebrates and creates high turbidity. Most who come to the refuge to fish are local, and they return often. There is little here to draw visitors from outside the local area here to fish, except during the annual Kid's Fishing Day, when from 70 to 100 people take part. Still, most come from within an hour's drive for this event. Many other locations hold a Kid's Fishing Day event

on that same day because it is a State free-fishing day designed to encourage youth to fish.

Our refuge staff would continue to stock the Kid's Fishing Pond, either by purchasing local fish or by donations of fish from the State hatchery. The stocking of other waters has not occurred in the recent past but would be considered appropriate and possible under this alternative if the KDWPT is interested and has fish available. Many of the other waters on the refuge undergo periodic drying because we manage them for migratory birds. This would reduce, or end, the possibility of establishing other fishing areas that could be kept except, possibly, at Darrynane Lake.

Fishing for crayfish would not be allowed. This would be consistent with our decision to not allow the collection of minnow or bait. Enforcing the bait collecting restriction, however, would be difficult if crayfish fishing were allowed.

Prohibiting the use of live bait on the refuge would support the prevention of invasive species, pathogen, or disease introduction or spread.

Fishing—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that we would only allow fish stocking at the Kid's Fishing Pond.

No fish bait collecting would make more food fish available for wildlife. This is the preferred food source for nesting interior least terns that would be expected to continue nesting on the LSM.

Frogging for bullfrogs, only, would be allowed because it is considered fishing in Kansas and bullfrogs are plentiful on the refuge and a harvest could reasonably be sustained. Frogging regulations would be the same as fishing regulations for Kid's Fishing Pond.

Fishing—Alternative C

Effects would be the same as under alternative B, except that we would conduct more monitoring programs on fish, reptile and amphibian populations to make sure that these remain sustainable. Our staff would also conduct more aggressive control on nonnative fish, reptiles, amphibians, and aquatic nuisance organisms to restore and keep the ecological integrity of the system.

Drawdowns to control carp would be used as needed, as would the chemical control use of rote-

none. Costs to manage the fishery would increase with a biologist and technicians conducting biological surveys and creel surveys, with more management activities, and with the use of chemicals. Our staff would reintroduce native fish into the system after carp and other invasive species have been controlled.

Depending on the activity, permits may have to be issued for some fishing, such as for turtling, or frogging. The quality of fishing would improve because of carp control and subsequent restocking, but costs would be much higher. The Kid's Fishing pond would be removed.

Wildlife Observation and Photography—Alternative A

We would allow and encourage wildlife observation and photography throughout the entire refuge except in seasonally closed areas, which are used by nesting bald eagles, and tern nesting salt flats. Other areas may have to be closed because of changing conditions, such as when whooping crane roost areas are close to roads, the area around the photography blind on the LSM, and the Wildlife Drive.

Horseback riding could spread invasive species on access roads that are closed to public vehicles, but use would be low and not be expected to have an effect

Wildlife Observation and Photography—Alternative B (Proposed Action)

Effects would be the same as under alternative A.

Wildlife Observation and Photography—Alternative C

Effects would be the same as under alternative A, except that more closures would be carried out during the nesting season. Public entry would be restricted to a few selected roads. We would close the Wildlife Drive during nesting season every year to reduce potential disturbances to western snowy plovers, interior least terns, killdeer, and other birds. We would evaluate the potential environmental effects that the Wildlife Drive has on hydrology and



USFWS

The Kid's Fishing Pond is a popular spot during the annual Kid's Fishing Day.

consider removing it and human use of area during next 15 years.

If evaluation supports bison reintroduction, then this would have mixed effects. Areas would be closed to the public for safety reasons, but the presence of bison might become an attraction.

Environmental Education and Interpretation—Alternative A

Increased and improved environmental education programs at both Quivira Refuge and the GPNC would engage the public and help connect more visitors to nature thereby aiding in understanding and appreciating the natural resources found on the refuge, in Kansas, and across the Great Plains.

Updating displays in the Koch Habitat Hall (GPNC) would increase visitation to the facility because the citizens of Wichita and visitors around the State would be interested in seeing the new exhibits.

Through the GPNC, our partnership with the City of Wichita Department of Park and Recreation and the KDWPPT would continue.

Environmental Education and Interpretation—Alternative B (Proposed Action)

Environmental education programs would be enhanced through improvements to facilities at both Quivira and the GPNC. There would also be an increase in appreciation of refuge resources for those who engage in virtual geocaching.

Moving the environmental education classroom building at the refuge to a site near the headquarters would improve our ability to provide environmental education programs and would further the development of a comprehensive program. See the facilities and infrastructure section in this chapter for more detail.

Increased and improved environmental education programs at both Quivira Refuge and the GPNC would engage the public and help connect more visitors to nature thereby aiding in understanding and appreciating the natural resources found on the refuge, in Kansas, and across the Great Plains.

Updating displays in the Koch Habitat Hall (GPNC) would increase visitation to the facility because the citizens of Wichita and visitors around the State would be interested in seeing the new exhibits.

Environmental Education and Interpretation—Alternative C

Effects would be the same as under alternative B, plus all aspects of public use, including facilities, roads, access, and permitted activities would be scrutinized. Because some roads and facilities may be targeted for elimination, the scope and logistics of both environmental education and interpretation programs may be limited. We would emphasize focal resources and how we manage for them in these programs.

Other Uses—Alternative A

There would be little effect from these activities because few people engage in them, and few people request prohibited activities.

Other Uses—Alternative B (proposed action)

Effects would be the same as under alternative A, except that commercial photography would expand opportunities for photographers and enhance the public's appreciation of wildlife.

Other Uses—Alternative C

Effects would be the same as under alternative B.

5.6 Public Outreach Effects

This section discusses the effects of alternatives pertaining to public outreach.

Alternative A

Major goals would be to foster an appreciation of wildlife and the outdoors, as well as to instill a sense of stewardship of lands like Quivira Refuge among the public. Continuing to work with Friends of Quivira would promote public awareness and outreach of the refuge.

Oversee the development, maintenance, and staff of our information booth at the annual Kansas State Fair to promote both Quivira Refuge and the GPNC.

Recruit, train, and use volunteers from local communities to help with management and public use goals at Quivira Refuge and the GPNC. The GPNC has an active volunteer program and large population to draw from in the Wichita area. About 2,800 hours of volunteer time is donated annually, with much of the time spent in outreach and education.

Alternative B (Proposed Action)

Effects would be the same as under alternative A, plus public understanding and awareness of refuge resources would be heightened through the installation of a tower camera at the bald eagle and BSM areas. One negative aspect of this change would be that viewers would not have to leave their homes to see the refuge, which conflicts with our various initiatives, such as Let's Go Outside, and Connecting People with Nature. But this method may also interest people in the refuge and encourage them to come out and see it in person.

The mounted, moveable camera would not be expected to negatively affect wildlife or the habitat around it, though there would be short-term effects during installation. There would be more costs for its installation and operation. Donations may be requested to offset costs.

Alternative C

Effects would be the same as under alternative B.

This section discusses the effects of alternatives pertaining to archeological and historic sites.

Alternative A

Properly obtaining permits and clearances before beginning work would reduce the effects from substantial dirt or surface alteration on the refuge.

Consultation with our regional archeologist during the planning phase of proposed projects to decide on the need for an archeological site clearance from the Kansas State Historic Preservation Office would help make sure that any cultural resources found would be adequately protected.

Alternative B (Proposed Action)

Effects would be the same as under alternative A, plus increased interpretation of cultural resources through exhibits in the visitor center, interpretive signage on tour roads and pullouts, and more, would increase the knowledge and awareness of Native American use of the site before the establishment of the refuge.

Alternative C

Effects would be the same as under alternative B.

This section discusses the effects of alternatives pertaining to visitor and employee safety and resource protection.

Visitor and Employee Safety— Alternative A

By making safety a high priority, refuge and GPNC employees, visitors, and contractors would enjoy a safe working and visiting environment. The refuge and GPNC would continue to make improvements to the safety program to meet the needs of a changing world, thus ensuring everyone's safety to the best of our ability.



Rachel Laubhan/USFWS

Egrets and Ibis

Visitor and Employee Safety— Alternative B (Proposed Action)

Effects would be the same as under alternative A.

Visitor and Employee Safety— Alternative C

Effects would be the same as under alternative A unless bison are reintroduced, at which time dangers would be heightened. We would train staff to work with, and around, bison. Job hazard analyses would need to be written to increase awareness and knowledge of bison. As a result, there would be more costs for employee training and safety needs.

Resource Protection— Alternative A

Because refuge law enforcement officers would enforce hunting, fishing, and all other regulations in accordance with CFRs, State laws, and refuge-specific regulations, the resources of the refuge would be protected as much as possible. The cultural resources of the refuge would also be protected as cultural clearance would be approved before restoration projects or other habitat disturbances would be conducted. Habitat and wildlife would be protected

because refuge law enforcement officers would check and enforce unlawful oil and gas operations on and off the refuge. Endangered and threatened species would continue to be protected because managers and law enforcement officers would make management decisions that protect species or their critical nesting habitats.

Resource Protection—Alternative B (Proposed Action)

Effects would be the same as under alternative A, except that many more species would be permitted to be taken by trapping, fishing, and hunting on the refuge, including deer, turkey, prairie-chicken, bullfrogs, and furbearers. With each added species there would be many changes to the amount of regulations that require enforcement, and there would be a dramatic increase in visitor use, which, in turn, would require more law enforcement.

The hunting areas on the refuge would be modified, and species-specific hunting boundaries would be needed to allow big game, upland game, and waterfowl to be hunted at the same time as other uses. The refuge would only close areas where whooping cranes are present, which would require the added enforcement of temporary closures and signing. The increased workload because of multiple uses, the increased visitor use, and the new boundary distribution would require us to hire more law enforcement staff. One full-time refuge officer and two dual-function officers would be needed for adequate enforcement.

During the initial stages of carrying out alternative B, law enforcement officers would have to work many weekends and more overtime. Without more law enforcement, T and E species and resource protection could be harmed. With more law enforcement, refuge resources and infrastructure would be better protected and there could be an economic gain to the community with the new employment opportunities.

Resource Protection— Alternative C

Effects would be the same as under alternative B, except that the refuge would allow the hunting of sandhill crane when whooping cranes are not present. Because sandhill cranes look like whooping cranes, we would need to add staff time to more closely watch whooping crane locations to prevent an accidental shooting. There would be increased efforts to educate about whooping cranes through more signage, kiosk displays, and handout information. Waterfowl and sandhill crane hunting would not occur when whooping cranes are present, therefore staff time would also be required to close and enforce regulations on the closed areas.

The refuge may reintroduce a large bison herd that would increase the need for enforcement to prevent accidental or illegal take. Unlike cattle grazing, a bison herd would be present throughout the year, increasing the potential for hunter and bison interaction and injury. This safety concern would require staff and law enforcement to closely watch visitor use to prevent safety issues. Boundary fences would be required to be patrolled on regular basis to prevent bison from escaping the refuge and providing damage or injury to our adjacent landowners and to the public.

5.9 Administration Effects

This section discusses the effects of alternatives pertaining to administration activities.

Staff and Budget—Alternative A

Money would be adequate to keep our permanent staff and facilities. Current refuge programs such as habitat management, visitor services, fire, and main-

tenance would proceed with little change, increases or enhancement.

A list of permanent and temporary staff, as well as recommended staff increases, can be found in Section 4.9 Administration and in table 17.

Quivira Refuge would continue to provide office space for a regional refuge zone biologist and a Partners private lands biologist. The refuge would also continue to use the YCC program, and Youth in the Great Outdoors to hire youth for conducting natural resource projects. We would continue to raise money through grants and initiatives to supplement staff and to pay for projects.

Staff and Budget—Alternative B (Proposed Action)

Would allow us to fully carry out and achieve the stated goals and objectives for alternative B.

Staff and Budget—Alternative C

Effects would be the same as under alternative A, plus, to carry out more monitoring programs for populations and habitats, two permanent, full-time biological positions would be needed. And one added permanent, full-time employee would be needed to work specifically on controlling invasive species to accomplish full ecological restoration.

Facilities and Infrastructure— Alternative A

Under our current deferred maintenance list, the maintenance shop is scheduled for rehabilitation, which would include more space and would remove the in-ground hydraulic vehicle hoist. The shop bay is too short to allow some of the heavy equipment we use to be moved inside for maintenance and repair. The cost of the rehab is projected at \$490,000.

Vehicle and equipment storage would be inadequate, as all vehicles must be kept inside and protected from packrats that can quickly move into vehicles parked outside to chew electrical wires and build nests. Biological controls, such as barn owl nest boxes, have been erected around all facilities to control these small mammals, but expensive repairs are still occasionally needed for vehicles and equipment that cannot be kept inside..

More employees that are not specific to Quivira Refuge have been stationed at the refuge, including a zone biologist and a private lands biologist. For them, we would need more vehicle and equipment storage. It is possible that other program employees would be stationed at Quivira Refuge because of its central location, so more storage area would be needed.

Adding onto the GPNC would allow staff of the partner agencies to conduct more meetings and present increased educational programs onsite. The addition would include increased office space for expanding staff needs. Adding another storage facility at the GPNC would extend the life of agency equipment (such as vehicles, boats and trailers) and keep it from being vandalized.

Facilities and Infrastructure— Alternative B (Proposed Action)

Effects would be the same as under alternative A, plus another cold storage building would allow vehicles and equipment to be better protected. Moving the environmental education classroom and bunkhouse from their current location to the headquarters administrative site would centralize buildings, improve visitor service, reduce staff travel, and improve water quality for these facilities.

Trapping could help control nuisance animals, which would benefit our refuge operations in preserving infrastructure. There would be a small economic benefit for trappers. And we would expect most trappers to live in the local area.

More space at the GPNC would accommodate an expanded and enhanced environmental education program. With additional space, we could serve more school programs, and allow our programming efforts to increase and improve. We would be able to entertain the idea of hosting traveling exhibits that would increase visitation to the facility.

Facilities and Infrastructure— Alternative C

Effects would be the same as under alternative B for buildings at Quivira Refuge and the GPNC, but much of the other infrastructure at the refuge would

be reduced or removed to complete the ecological restoration and visitor services would be adversely affected.

We would evaluate, and likely reduce, trails, parking lots, roads, dikes, canals, water control structures, and fences at Quivira Refuge. Larger blocks of land would be fenced, if bison were to be reintroduced, to allow them to move on their own and graze as much as possible in a natural setting. Unnecessary roads would be removed and canals would only be used to spread waterflow over the refuge in sheet flow to mimic natural flooding and drying. More spillways would be constructed to spread sheet flow out of Rattlesnake Creek and across meadows and wetlands.

5.10 Socioeconomic Effects

What follows is an analysis of the economic effects associated with each alternative.

Effects from the Refuge Revenue Sharing Act

The Service makes revenue sharing payments to the counties for the land that is under administration. Under provisions of the refuge Revenue Sharing Act (RRS), local counties receive an annual payment for lands that have been bought by full fee-title acquisition by the Service. Payments are based on the greater of 75 cents per acre or 0.75 percent of the fair market value. The exact amount of the annual payment depends on Congressional appropriations, which in recent years have tended to be substantially less than the amount required to fully fund the authorized level of payments. In fiscal year 2011, RRS payments were appropriated at only 21.6 percent of the approved value. The three counties that contain the refuge each received a payment; Stafford County received \$69,600, Rice County received \$2,580, and Reno County received \$2,115. Table 18 shows the effects of the \$74,295 received by the local area in RRS payments. The RRS payments generate an estimated total effect of \$22,200 in labor income and \$30,200 in value added to the local 5-county area.

Table 18. Annual effects of Refuge Revenue Sharing Act payments under alternatives A, B and C on the area around Quivira National Wildlife Refuge, Kansas.

	<i>Employment number of full and part time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Direct effects	0	\$17.7	\$22.5
Secondary effects	0	\$4.4	\$7.6
Total effect	0	\$22.2	\$30.2

Effects of Refuge Staff Salary Spending within the Local Economy

Quivira Refuge employees reside and spend their salaries on daily living expenses in the local area, thereby generating effects within the local economy. Household consumption expenditures consist of payments by individuals or households to industries for goods and services used for personal consumption. The IMPLAN modeling system contains household income consumption spending profiles that account for average household spending patterns by income level. These profiles also capture average annual savings and allow for leakage of household spending to outside the region. The IMPLAN household spending pattern for households earning \$50–75 thousand dollars per year was used to reflect the average salary of full-time permanent employees at the refuge.

The current approved refuge staff consists of 17 employees: 12 permanent staff, 3 temporary staff, and the two regional staff; the salary associated with the vacant positions has not been included in the analysis (table 17). The two regional staff positions are not paid for by the refuge, but they are stationed at the refuge and, as such, their salary has been included in this analysis. Refuge staff is anticipated to remain the same under alternative B and to increase to 22 employees under alternative C with the addition of two wildlife biologists, a range technician in the invasive program, and two bison work staff.

Refuge staff estimate that current annual salaries total approximately \$819,000 with an additional \$81,050 to cover the staff funded at the regional level, for a total of \$900,050, under alternative A. Staff needs would remain the same under alternative B

and increase to \$1.275 million under alternative C. The economic effects associated with spending of salaries in the local 5-county area by refuge employees are summarized in table 19. These effects only include the secondary effects of nonrefuge jobs created as refuge employees spend their salaries in the local five-county area. For alternative A, it is estimated that salary spending by Quivira Refuge staff would generate secondary effects of 5 jobs, \$168,600 in labor income, and \$301,700 in value added in the local economy. For alternative B, the effect of salary spending would remain the same as alternative A, as additional staff are not required. For alternative C, salary spending would generate secondary effects of 7 jobs, \$238,900 in labor income, and \$427,400 in value added.

Table 19. Annual effects of salary spending in the area around Quivira National Wildlife Refuge, Kansas.

	<i>Employment number of full and part time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Alternatives A and B			
Direct effects	0	\$0.0	\$0.0
Secondary effects	5	\$168.6	\$301.7
Total effect	5	\$168.6	\$301.7
Alternative C			
Direct effects	0	\$0.0	\$0.0
Secondary effects	7	\$238.9	\$427.4
Total effect	7	\$238.9	\$427.4

Effects of Refuge Purchases of Goods and Services within the Local Economy

A wide variety of supplies and services are bought for refuge operations and maintenance activities. Refuge purchases made in the local five-county area contribute to the local economic effects associated with the Quivira Refuge. The refuge now spends an average of \$270,000 per year on nonsalary expenditures. Major local expenditures include: sup-

plies related to habitat and grounds improvements, supplies related to the maintenance and repair of structures, and office supplies and utilities. Table 20 provides a breakdown of current nonsalary expenditures by expenditure category. To figure out the local economic effects of nonsalary expenditures, only expenditures made within the local five-county area are included in the analysis.

Table 20. Breakdown of Current Purchases of Goods and Services in the area around Quivira National Wildlife Refuge, Kansas.

<i>Expense category</i>	<i>Average annual percent of nonsalary expenditures</i>	<i>Percent spent in local five-county area</i>
Equipment maintenance and repair	10	85
Vehicle maintenance and repair	6	85
Habitat and grounds improvements and treatments (not including acquired lands restoration)	48	90
Travel	7	10
Construction of new structures	1	75
Maintenance and repair of structures	12	75
All other expenses (such as overhead, office supplies and utilities)	16	80

Average annual nonsalary expenditures are anticipated to be \$272,972 for alternative A, the same for alternative B, and \$397,973 for alternative C. Table 21 shows the economic effects associated with nonsalary related expenditures in local communities near the refuge. For alternative A, nonsalary related purchases would generate an estimated total economic effect of 5 jobs, \$183,300 in labor income, and \$199,900 in value added. The same effect would be generated under alternative B. For alternative C, nonsalary related purchases would generate an estimated total economic effect of 7 jobs, \$267,200 in labor income, and \$291,400 in value added.

Table 21. Annual effects of purchases of goods and services in the area around Quivira National Wildlife Refuge, Kansas.

	<i>Employment number of full- and part-time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Alternatives A and B			
Direct effects	4	\$150.9	\$143.1
Secondary effects	1	\$32.4	\$56.8
Total effect	5	\$183.3	\$199.9
Alternative C			
Direct effects	6	\$220.0	\$208.6
Secondary effects	1	\$47.2	\$82.8
Total effect	7	\$267.2	\$291.4

Effects of Visitor Expenditures

Spending associated with recreational visits to national wildlife refuges generates significant economic activity. The Service report *Banking on Nature: The Economic Benefits of National Wildlife Refuge Visitation to Local Communities*, estimated the effect of national wildlife refuges on their local economies (Carver and Caudill, 2007). According to the report, more than 34.8 million visits were made to national wildlife refuges in fiscal year 2006 that generated \$1.7 billion of sales in regional economies. Accounting for both the direct and secondary effects, spending by national wildlife visitors generated nearly 27,000 jobs and more than \$542.8 million in employment income (Carver and Caudill, 2007). Approximately 82 percent of total expenditures were from nonconsumptive activities, 12 percent from fishing, and 6 percent from hunting (Carver and Caudill, 2007).

This section focuses on the local economic effects associated with Quivira National Wildlife Refuge visitation. Quivira Refuge offers a wide variety of recreation opportunities including wildlife observation and photography, interpretation, environmental

education, hunting, and fishing. Now, only waterfowl and upland bird hunting are allowed on the refuge, and opportunities would increase with deer, turkey, and furbearer hunting under alternatives B and C. With its key location in the middle of the central flyway, the refuge attracts hundreds of migratory birds each year and as a result, draws bird watchers and photographers from across the county. Wildlife observation is the primary visitor activity that occurs on the refuge.

Annual visitation estimates for the refuge are based on several refuge statistic sources including visitors entering the visitor center and office and the general observation of refuge staff. Annual visitation estimates are on a per-visit basis. Table 22 summarizes estimated visitation by type of visitor activity for alternatives A, B, and C. Under alternative B, the primary focus is the restoration of native communities that help focal resources, or focal species, and their respective habitats. This restoration is expected to enhance migratory bird and upland game hunting opportunities. Additionally, under alternative B, the public would have the opportunity to engage in big game, turkey, and furbearer hunting on the refuge. Conservation is also the primary focus of alternative C, with an emphasis on promoting the sustainability of native communities, including the introduction of bison onto the range, and lowering maintenance costs. Habitat would be allowed to fluctuate more under dry and wet cycles and water amounts and movement would be altered to mimic

natural patterns. These conservation actions are expected to decrease migratory bird hunting and fishing opportunities and enhance upland game hunting opportunities. As with alternative B, a small amount of big game hunting would be allowed on the refuge.

Spending associated with recreational visits generates significant economic activity in the five-county area. A visitor usually buys a wide range of goods and services while visiting an area. Major expenditure categories include lodging, restaurants, supplies, groceries, and recreational equipment rental. To figure out the local economic effects of visitor spending, only spending by persons living outside of the local five-county area are included in the analysis. The rationale for excluding local visitor spending is twofold. First, money flowing into the local five-county area from visitors living outside the local area (hereafter referred to as nonlocal visitors) is considered new money injected into the local economy. Second, if residents of the local five-county area visit the refuge more or less because of the management changes, they will correspondingly change the spending of their money elsewhere in the local area, resulting in no net change to the local economy. These are standard assumptions made in most regional economic analyses at the local level. Refuge staff figured out the percentage of nonlocal refuge visitors. Table 22 shows the estimated percent of nonlocal refuge visits and visitor days under each alternative.



USFWS

The Great Plains Nature Center in Wichita, Kansas, looks out onto the wildlife habitats of Chisholm Creek Park.

Table 22. Estimated annual visitation activity at Quivira National Wildlife Refuge, Kansas, by alternative.

	<i>Total number of visits</i>	<i>Number of nonlocal visits</i>	<i>Average hours spent on refuge</i>	<i>Number of nonlocal visitor days*</i>
Alternative A				
Fishing	1,000	100	4	50
Big game hunting	0	0	8	0
Waterfowl and migratory bird hunting	1,225	460	6	345
Upland game hunting	500	250	6	188
Nonconsumptive uses	12,000	10,200	4	5,100
Total Visitation	14,725	11,010		5,683
Alternative B				
Fishing	1,000	100	4	50
Big game hunting	5	4	8	4
Waterfowl and migratory bird hunting	1,286	483	6	362
Upland game hunting	525	263	6	197
Nonconsumptive uses	12,000	10,200	4	5,100
Total Visitation	14,816	11,050		5,713
Alternative C				
Fishing	1,050	105	4	53
Big game hunting	5	4	8	4
Waterfowl and migratory bird hunting	1,286	483	6	362
Upland game hunting	525	263	6	197
Nonconsumptive uses	12,000	10,200	4	5,100
Total Visitation	14,866	11,055		5,716

* One visitor day = 8 hours.

Besides the Quivira Refuge, refuge staff also manage and maintain the Great Plains Nature Center (GPNC), located outside of Wichita, Kansas. Visitors to the GPNC have the opportunity to tour the education center, observe wildlife in the park, fish in two ponds located at the center or attend one of the educational programs. In 2011, 145,700 visitors came through the center. Visitors were generally local residents and averaged approximately 30 minutes at the GPNC. These visits occurred in Sedgwick County, outside of the five-county project area, and thus the effect of these visits is not included in this report.

To estimate visitor expenditures, we use average daily visitor spending profiles from the Banking on Nature report (Carver and Caudill, 2007) that were derived from the 2006 National Survey of Fishing, Hunting, and Wildlife Associated Recreation (USFWS, 2008). The National Survey reports trip related spending of State residents and nonresidents for wildlife-associated recreational activities. For each recreation activity, spending is reported in the categories of lodging, food and drink, transportation, and other expenses. Carver and Caudill (2007) calcu-

lated the average per-person-per-visitor day expenditures by recreation activity for each region of the Service. We used the spending profiles for nonresidents for Region 6—which includes Kansas, and updated the 2006 spending profiles to 2012 dollars using the Consumer Price Index Inflation Calculator. Average daily spending profiles for nonresident visitors to Region 6 for fishing (\$128.53 per day), waterfowl and other migratory bird hunting (\$77.59 per day), upland game hunting (\$179.99 per day), and big game hunting (\$218.44 per day) were used to estimate nonlocal visitor spending for refuge fishing and hunting related activities. The average daily nonresident spending profile for nonconsumptive wildlife recreation (observing, feeding, or photographing fish and wildlife) was used for nonconsumptive wildlife viewing activities (\$161.16 per day).

Visitor spending profiles are estimated on an average per day (8 hours) basis. Because some visitors only spend short amounts of time visiting a refuge, counting each refuge visit as a full visitor day would overestimate the economic effect of Quivira Refuge visitation. In order to properly account for

the amount of spending, the annual number of nonlocal refuge visits were converted to visitor days. Refuge staff estimate that nonlocal anglers spend approximately 4 hours (1/2 a visitor day) on the refuge, while waterfowl and upland game hunters spend approximately 6 hours (3/4 a visitor day). Nonlocal visitors that view wildlife on nature trails or take part in other wildlife observation activities typically spend 4 hours (1/2 a visitor day). Table 11 shows the number of nonlocal visitor days by recreation activity for each alternative. Total spending by nonlocal refuge visitors was determined by multiplying the average nonlocal visitor daily spending by the number of nonlocal visitor days at the refuge.

Table 23 summarizes the total economic effects, in thousands of dollars, associated with current nonlocal visitation by alternative. Under alternative A, nonlocal Quivira Refuge visitors would spend nearly \$888,878 in the local economy annually. This spending would directly account for an estimated 8 jobs, \$205,800 in labor income, and \$339,200 in value added in the local economy. The secondary or multiplier effects would generate an additional 2 jobs, \$87,600 in labor income, and \$144,600 in value added. Accounting for both the direct and secondary effects, spending by nonlocal visitors for alternative A would generate total economic effects of 10 jobs, \$293,400 in labor income, and \$483,800 in value added.

Table 23. Annual effects of nonlocal visitor spending by alternative in the area around Quivira National Wildlife Refuge, Kansas.

	<i>Employment number of full- and part-time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Alternative A			
Direct effects	8	\$205.8	\$339.2
Secondary effects	2	\$87.6	\$144.6
Total effect	10	\$293.4	\$483.8
Alternative B			
Direct effects	8	\$206.7	\$340.7
Secondary effects	2	\$87.9	\$145.2
Total effect	10	\$294.6	\$485.8
Alternative C			
Direct effects	8	\$206.8	\$340.8

Table 23. Annual effects of nonlocal visitor spending by alternative in the area around Quivira National Wildlife Refuge, Kansas.

	<i>Employment number of full- and part-time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Secondary effects	2	\$87.9	\$145.2
Total effect	10	\$294.7	\$486.0

As shown in table 22, Quivira Refuge nonlocal visitation for all activities is anticipated to increase by 31 visitor days under alternative B as compared to alternative A. Under alternative B, nonlocal Quivira Refuge visitors would spend \$892,778 in the local area annually. Accounting for both the direct and secondary effects, spending by nonlocal visitors for alternative B would generate an estimated total economic effect of 10 jobs, \$294,600 in labor income, and \$485,800 in value added.

Quivira Refuge nonlocal visitation across all activities is anticipated to increase by 33 visitor days under alternative C as compared to alternative A (table 22). Under alternative C, nonlocal refuge visitors would spend \$893,099 in the local area annually. Accounting for both the direct and secondary effects, spending by nonlocal visitors for alternative C would generate an estimated total economic effect of 10 jobs, \$294,700 in labor income, and \$486,000 in value added.

Summary of Economic Effects for Alternative A

Table 24 summarizes the direct and total economic effects in the five-county area of refuge management activities for alternative A. Under alternative A, Quivira Refuge management activities directly related to refuge operations generate an estimated 12 jobs, \$374,400 in labor income, and \$504,800 in value added in the local economy. Including direct, indirect, and induced effects, refuge activities generate a total economic effect of 20 jobs, \$667,500 in labor income, and \$1.015 million in value added. In 2009, total labor income in the five-county area was estimated at \$2.572 billion and total employment was estimated at 66,660 jobs (IMPLAN 2009 data). Thus, total economic effects associated with Quivira Refuge operations under alternative A represent 0.026 percent of total income and 0.030 percent of total employment in the overall five-county

area economy. Total economic effects of refuge operations play a much larger role in the communities near the refuge where most of the refuge-related expenditures and public use-related economic activity occurs.

Table 24. Economic effects of alternative A.

	<i>Employment number of full- and part-time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Refuge Administration*			
Direct effects	4	\$168.7	\$165.6
Total effects	10	\$374.1	\$531.7
Public use activities			
Direct effects	8	\$205.8	\$339.2
Total effects	10	\$293.4	\$483.8
Aggregate effects			
Direct effects	12	\$374.4	\$504.8
Total effects	20	\$667.5	\$1,015.5

* Refuge administration effects include effects associated with RRS payments made to counties, staff salary expenditures made in the local five-county area, and refuge nonsalary expenditures made in the local five-county area.

Summary of Economic Effects for Alternative B

Table 25 summarizes the direct and total economic effects in the 5-county area of refuge management activities for alternative B. Under alternative B, Quivira Refuge management activities directly related to refuge operations would generate an estimated 12 jobs, \$375,400 in labor income, and \$506,300 in value added in the local economy. Including direct, indirect, and induced effects, all refuge activities would generate a total economic effect of 20 jobs, \$668,700 in labor income, and \$1.018 million in value added.

Table 25. Economic effects of alternative B.

	<i>Employment number of full- and part-time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Refuge Administration*			
Direct effects	4	\$168.7	\$165.6
Total effects	10	\$374.1	\$531.7
Public use activities			
Direct effects	8	\$206.7	\$340.7
Total effects	10	\$294.6	\$485.8



Library of Congress

Wheat harvesting in Kansas around 1900. Agriculture has long been important to the economy near Quivira Refuge.

Table 25. Economic effects of alternative B.

	<i>Employment number of full- and part- time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Aggregate effects			
Direct effects	12	\$375.4	\$506.3
Total effects	20	\$668.7	\$1,017.5
* Refuge administration effects include effects associated with RRS payments made to counties, staff salary expenditures made in the local five-county area, and refuge nonsalary expenditures made in the local five-county area.			

Table 26 summarizes the change in economic effects associated with Quivira Refuge operations under alternative B as compared to alternative A. Because of small expected increases in refuge visitation and administration, alternative B would generate \$1,300 more in labor income, and \$2,000 more in value added as compared to alternative A.

Table 26. Change in economic effect from alternative A to alternative B.

	<i>Employment number of full- and part-time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Refuge Administration*			
Direct effects	no change	no change	no change
Total effects	no change	no change	no change
Public use activities			
Direct effects	no change	(+) \$0.9	(+) \$1.5
Total effects	no change	(+) \$1.3	(+) \$2.0
Aggregate effects			
Direct effects	no change	(+) \$0.9	(+) \$1.5
Total effects	no change	(+) \$1.3	(+) \$2.0

* Refuge administration effects include effects associated with RRS payments made to counties, staff salary expenditures made in the local five-county area, and refuge nonsalary expenditures made in the local five-county area.

Summary of Economic Effects for Alternative C

Table 27 summarizes the direct and total economic effects in the five-county area of refuge management activities for alternative C. Under alternative C, Quivira Refuge management activities directly related to refuge operations would generate an estimated 14 jobs, \$444,600 in labor income, and \$571,900 in value added in the local economy. Including direct, indirect, and induced effects, all refuge activities would generate a total economic effect of 24 jobs, \$823,000 in labor income, and \$1.235 million in value added.

Table 27. Economic effect of alternative C.

	<i>Employment number of full- and part-time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Refuge Administration*			
Direct effects	6	\$237.8	\$231.2
Total effects	14	\$528.3	\$748.9
Public use activities			
Direct effects	8	\$206.8	\$340.8
Total effects	10	\$294.7	\$486.0
Aggregate effects			
Direct effects	14	\$444.6	\$571.9
Total effects	24	\$823.0	\$1,234.9

* Refuge administration effects include effects associated with RRS payments made to counties, staff salary expenditures made in the local five-county area, and refuge nonsalary expenditures made in the local five-county area.

Table 28 summarizes the change in economic effects associated with Quivira Refuge operations under alternative C as compared to alternative A. Because of increases in refuge visitation and administration, alternative C would generate 4 more jobs, \$155,600 more in labor income, and \$219,400 more in value added as compared to alternative A.

Table 28. Change in economic effect from alternative A to alternative C.

	<i>Employment number of full and part time jobs</i>	<i>Labor income in \$thousand 2012</i>	<i>Value added in \$thousand 2012</i>
Refuge Administration*			
Direct effects	(+) 2	(+) \$69.1	(+) \$65.5
Total effects	(+) 4	(+) \$154.2	(+) \$217.2
Public use activities			
Direct effects	no change	(+) \$1.0	(+) \$1.6
Total effects	no change	(+) \$1.4	(+) \$2.2
Aggregate effects			
Direct effects	(+) 2	(+) \$70.1	(+) \$67.1
Total effects	(+) 4	(+) \$155.6	(+) \$219.4

* Refuge administration effects include effects associated with RRS payments made to counties, staff salary expenditures made in the local five-county area, and refuge nonsalary expenditures made in the local five-county area.

5.11 Cumulative Impacts

Cumulative impacts include the incremental effects of the actions for an alternative when added to past, present, and future actions. Cumulative impacts can be the result of effects that appear minor when

looked at individually, but that can become substantial when accumulated over time. The Council on Environmental Quality regulations that carry out NEPA require mitigation measures when the environmental analysis process detects possible significant effects on habitat, wildlife, or the human environment, including cumulative impacts.

None of the activities proposed for this CCP would be expected to produce substantial levels of cumulative environmental impacts that would require mitigation measures. Nevertheless, the final CCP would contain the following measures to preclude significant environmental effects from occurring:

- Federally listed species would be protected from intended or unintended effects by having the activities that cause those effects banned where these species occur.
- All proposed activities would be regulated to lessen their effects on wildlife, fish, and plant species, especially during sensitive reproductive cycles.
- Monitoring protocols would be established to decide on goal achievement levels and to find effects to resources that had been unforeseen as well as to help apply adaptive resource management to make sure that wildlife and habitat resources and the human environment are preserved.
- We could revise and amend this CCP after 5 years of implementation to apply adaptive resource management to correct unforeseen effects that occurred during the first years of the plan.

Chapter 6—Implementation of the Proposed Action



© 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.

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 keeping 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 (Refuge System 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).”

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.

6.2 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 north-east of the BSM where it joins with Salt Creek on the refuge (figure 15). 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 cubic feet per second (cfs), and average streamflow for the 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

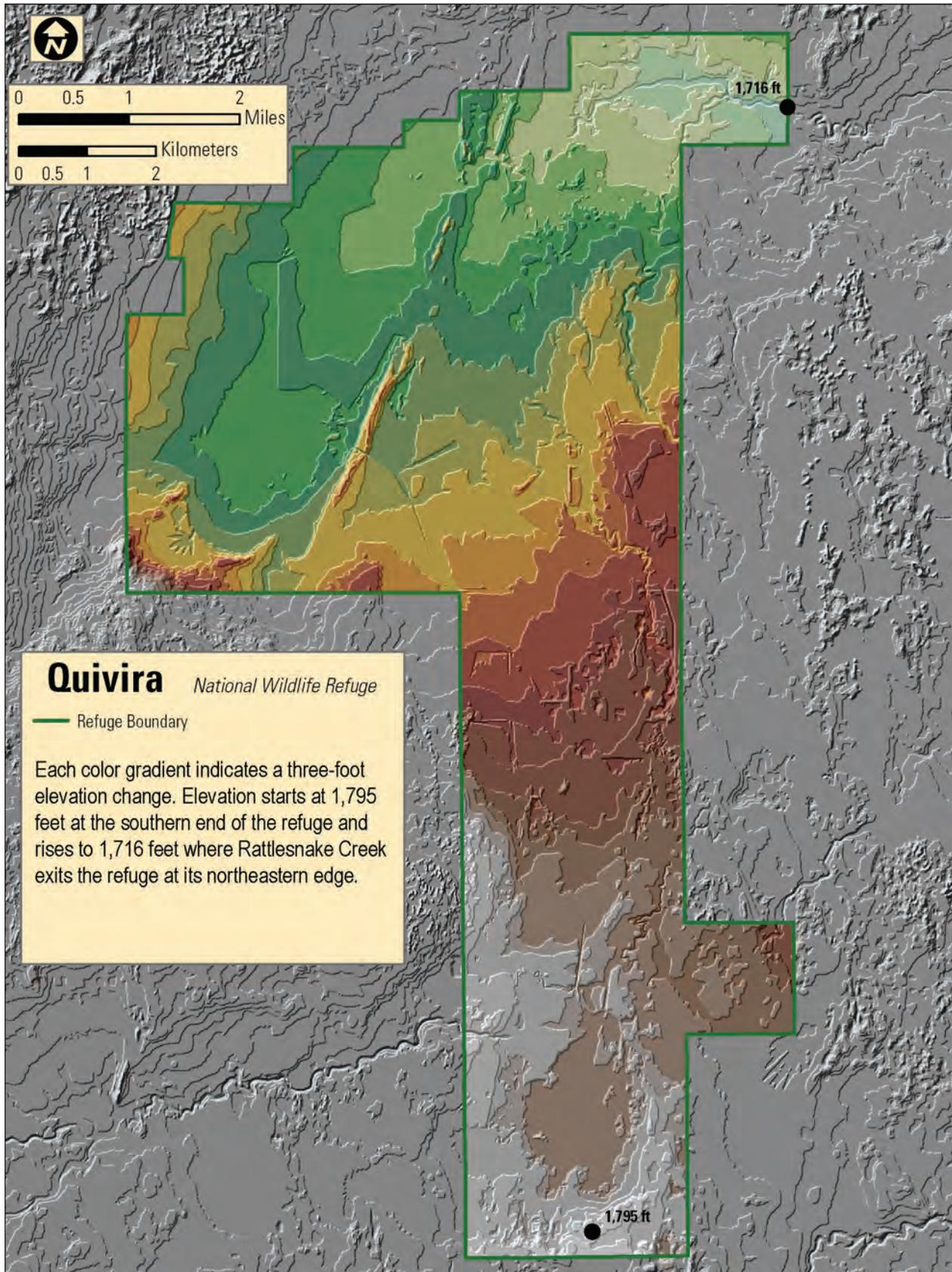


Figure 15. Elevation at Quivira National Wildlife Refuge, Kansas.

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 name 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 7). 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

- 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 find pertinent research and monitoring programs to name 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 find 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, Playa Lakes Joint Venture, 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 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

- Continue to include Partners staff in our regular refuge staff meetings.

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.

We mean this objective to 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 F, 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 proper, 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 proper 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, like a stripper, and harvest local seed.

Rationale

We looked at refuge lands and the current surrounding landscape to find 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 (see native community objectives below) 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.
- Conduct informal surveillance of select wildlife species, such as waterfowl, shorebirds, and deer, during the next 15 years



A twilight view from Old Township Road on Quivira Refuge

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 would 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.

6.3 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.

The primary purpose of the Refuge System is to conserve wildlife, which requires us 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 population 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 found that the following would be consistently applied 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 proper 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 find a suite of focal species to help us quantify the range of structural and successional habitat conditions that we would 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 find 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 incorpora-

tion 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 3). 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 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 find 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 16).

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 non-breeding period, except for dietary information and waterbird foraging depths. Therefore, the quantitative information compiled to develop objectives is limited because, as focal species table 3 shows, Qui-

vira 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 proper habitat on the refuge.

Given these limitations, we find using habitat-based objectives for a given native plant community to represent a continuum of conditions along a successional gradient for long-term sustainability to be a proper interpretation of the data. From our perspective, this more aptly represents the dynamic nature of systems and ends any attempt to keep 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 name 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 would provide refuge-specific information useful for understanding treatment effects and species-habitat

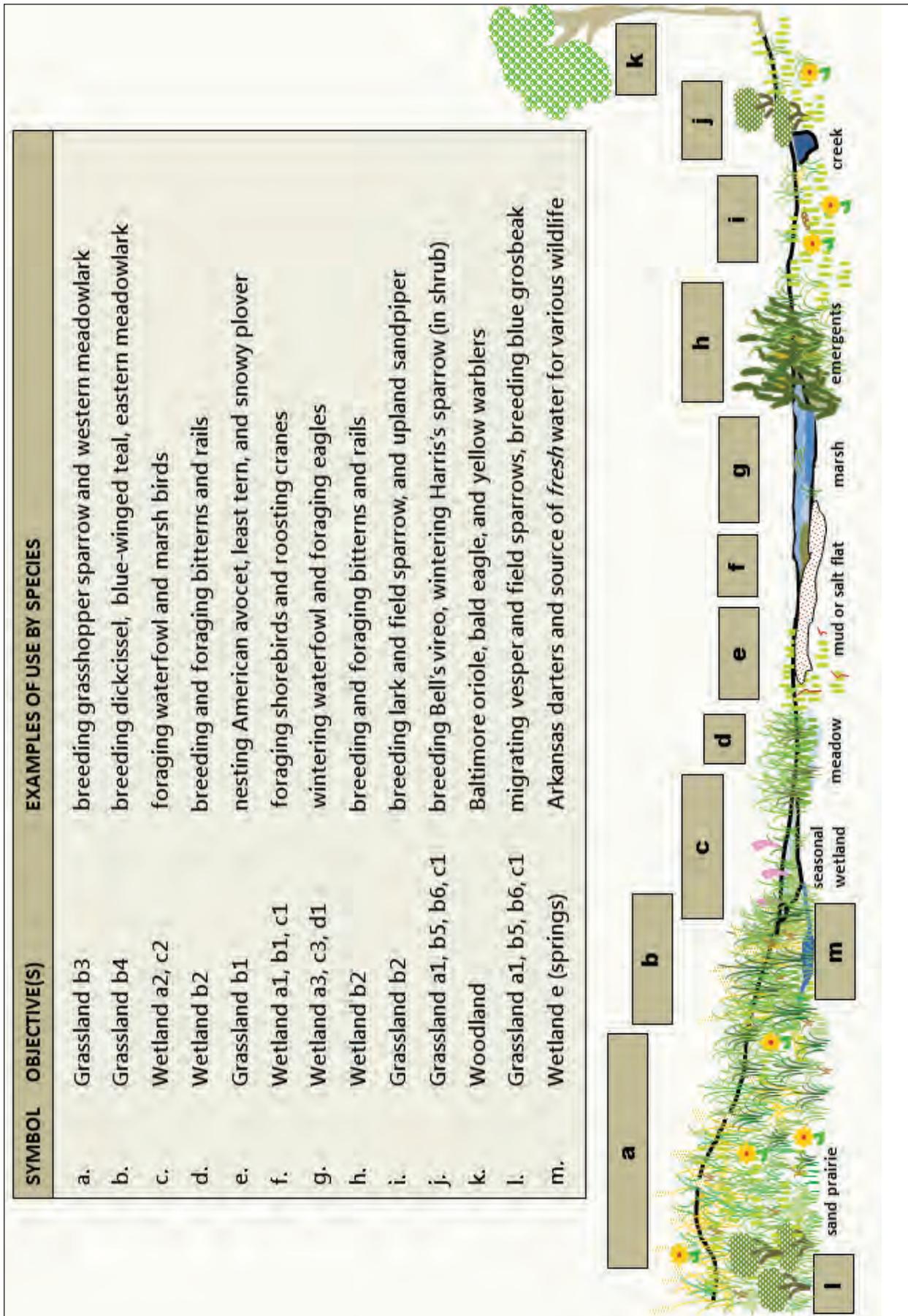


Figure 16. Native Ecological Community Conservation Objectives for Quivira National Wildlife Refuge, Kansas, Illustrated in a Community Profile Schematic.

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 proper 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 minimum, 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 29); tolerance level of exotic or invasive plant species is equal to, or less than, 5 percent.

2. Reliably provide, at minimum, 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 29); tolerance level of exotic or invasive plant species is equal to or less than 1 percent and perennial robust emergent vegetation, such as cattail, is equal to, or less than, 25 percent.

3. Reliably provide, at minimum, 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 29); tolerance level of exotic or invasive plant species is equal to, or less than, 5 percent.

B. Apply from May through July—breeding season:

1. Reliably provide a minimum of 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 terns, and resident focal species (table 29);



USFWS

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

tolerance level of exotic or invasive plant species is equal to, or less than, 5 percent.

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 29); tolerance level of exotic or invasive species is equal to, or less than, 5 percent.

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

1. Reliably provide, at minimum, 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 29); tolerance level of exotic or invasive species is equal to, or less than, 1 percent.
2. Reliably provide, at minimum, 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 29); tolerance level of exotic or invasive plant species is equal to, or less than, 1 percent and perennial robust emergent vegetation, such as cattail, is equal to, or less than, 25 percent;
3. Reliably provide, at minimum, 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 29); tolerance level of exotic or invasive plant species is equal to, or less than, 5 percent.

D. From November through February—winter—reliably provide, at minimum, 70 percent of the 5,086 estimated potential acres, with a minimum block size



Rachel Laubhan/USFWS

Damselflies on a wetland with submerged aquatic vegetation.

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 29); tolerance level of exotic or invasive plant species is equal to, or less than, 5 percent.

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

Areas that can be managed to provide designated habitat are provided in table 29. 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, lidar and vegetation data, and our staff experience and knowledge of management potential; and on management philosophy described under the proposed alternative. 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 would not keep static hydroperiods within, and among, years.

Table 29. Estimated greatest potential distribution of wetland habitat conditions (acres by unit and objective) for the proposed alternative for Quivira National Wildlife Refuge, Kansas.

Wetland	Acres	<i>Mid-February through May spring migration</i>			<i>May through July summer breeding</i>		<i>August–November fall migration</i>			<i>November– February winter</i>
		A1	A2	A3	B1	B2	C1	C2	C3	D
		Acres bare flats <25% vegetation, flood <6 inches	Acres >75% annual or meadow, flood <15 inches	Acres <25% emerging >20% sub- merged aquatic veg- etation, 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 29. Estimated greatest potential distribution of wetland habitat conditions (acres by unit and objective) for the proposed alternative for Quivira National Wildlife Refuge, Kansas.

Wetland	Acres	<i>Mid-February through May spring migration</i>			<i>May through July summer breeding</i>		<i>August–November fall migration</i>			<i>November– February winter</i>
		A1	A2	A3	B1	B2	C1	C2	C3	D
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.



USFWS

Northern shoveler in a wetland with midheight, sparse vegetation.

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 would provide foraging habitat for waterbirds.
- 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.
- Keep 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 proper times and depths. In addition, wildlife values of a given wetland change within, and among, years, and attempts to manage for static con-

ditions 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 fresh-water springs, which supports a population of the State-threatened Arkansas darter. We want to keep 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, addi-

tion 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 discharge 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 interspersed 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 would occur within, and among, years. In most years, surface water would be allowed to evaporate in late summer and ground water discharge

would 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 would have water during the spring, and then slowly begin drying in late spring through the summer. Use of Rattlesnake Creek water would 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 proper salinity gradients through water management, including limiting fresh 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.



Rachel Laubhan/USFWS

Big Salt Marsh

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 wetland units on Quivira Refuge can also be managed as temporary or semipermanent wetlands to provide supplemental 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



Created Wetland

USFWS

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 non-native 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.

Freshwater Springs Strategies

- Collaborate with experts on evaluating habitat improvements to make sure that the Arkansas darter population persists, including the removal of existing infrastructure north of the springs.
- Develop a 15-year management plan.



Rachel Laubham/USFWS

Seasonal Prairie Wetland

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 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

- Find and map the location of these basins.
- Protect the integrity of basin morphology, such as their shape, structure and pattern.
- Avoid mechanical disturbances that would 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 E).

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 would 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 (Ratajezak 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 proper 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 a minimum of 500 acres of estimated habitat predominantly native—short, bare-sparse—to help associated focal species, such as breeding killdeer, American avocet, interior least tern, western snowy plover, upland sandpiper, and ground-foraging passerines; defined as composition of

less than 5 percent grass or fine-stemmed emergent, less than 5 percent forb, and 0 percent shrub; mean greatest height less than 6 inches; visual obstruction, or height density, of less than 4 inches; litter depth 0 centimeters; the estimated acres do not overlap with similar habitat made available under wetland objective B1 above.

2. Provide a minimum of 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; defined as composition of 40–50 percent grass or fine-stemmed emergent, 10–20 percent forb, and 10–20 percent shrub; mean greatest height 6–20 inches; visual obstruction, or height density, of less than 4 inches; litter depth 0.2–1.2 inches.
3. Provide a minimum of 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; defined as composition of 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 a minimum of 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; defined as composition of 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 estimated for this objective do not include acres 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 greater than 10 sparse stands of shrub—mostly plum—interspersed within larger grassland blocks and riparian corridor to support associated focal species, such as lark and field sparrows; defined as: 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 greater than 10 dense stands of shrub—mostly plum—habitat interspersed within larger grassland blocks and riparian corridor to support shrub-dependent focal species, such as Bell's vireo; defined as 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 30). 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.

Table 30. Dominant nonwetland habitat types at Quivira National Wildlife Refuge, Kansas.

<i>Habitat type</i>	<i>Dominant vegetation</i>	<i>Estimated acres</i>
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
	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

Strategies

- Use a wide range of disturbance types, lev-

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



Kildeer in short, sparse grassland.

USFWS



Little bluestem in intermediate grassland.

USFWS



Switchgrass in tall, dense grassland.

USFWS

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



Barry Jones/USFWS

Sandhills

3.28 yards tall by 24.71 acres (3 meters tall by 10 hectares) compared to habitat with less than 10 percent woody interspersed or less than 50 percent woody interspersed (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 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: Woodland

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

Strategies

- Based on current conditions, maintain woodlands in areas identified in appendix E.

- Keep select trees or small groves that are located in areas along roads or next to other undesirable 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 would 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 species largely associated with nonnative woodlands. Prioritize time and money resources for other species–habitat communities over woodland, especially shelterbelts and nonnative types.
- Manage woodland areas to reduce seed or propagation sources or to maintain fence lines and other infrastructure, such as with the removal of 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 inter-

persed 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 17). 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 would still have opportunities to view woodland-associated birds on refuge lands in easily accessible areas. It seems that bird species richness would be maintained.



USFWS

Shrubland



USFWS

Woodland

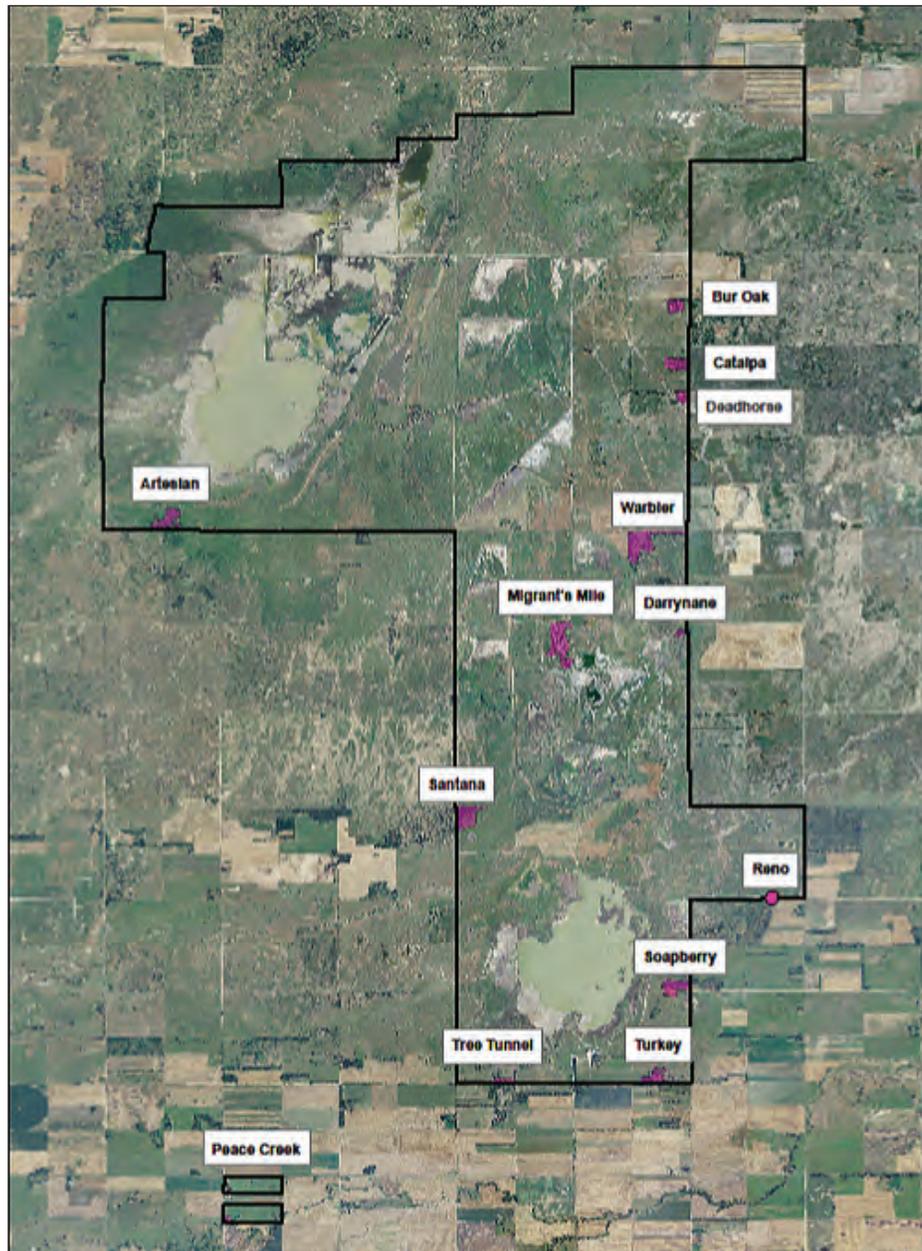


Figure 17. Location of woodland groves at Quivira National Wildlife Refuge, Kansas, in 2012.

6.4 Visitor Services Goal

Visitors enjoy quality wildlife-dependent recreation opportunities.

Following are objectives for a variety of visitor activities.

Hunting Objective 1

Within 5 years realign waterfowl and upland game hunt areas to continue to protect whooping cranes and provide approximately 1000 acres of additional, consistent safe zones for whooping cranes in the flats area north of the BSM.

Strategies

- Allow hunting on no more acres than what is allowable and approved now, which is about 8,000 acres of the refuge's 22,135 acres.
- Close hunting areas favored by whooping cranes.
- Update boundary signs to reflect new hunt areas.
- Do not allow sandhill crane hunting.
- Keep, improve, and increase access to hunting information through kiosks, interpretive displays, handout literature, and other means, such as social media and the refuge Web site.
- Increase law enforcement.
- Develop new parking areas.
- Alter waterfowl and upland game hunting area boundaries.
- Update hunting maps.

Rationale

The refuge must manage the hunt program in a manner that protects whooping cranes from harm and disturbance. Managing hunting areas for when

whooping cranes are present may require the closure, and active management, of a specific unit.

The primary reason for separate hunting unit boundaries for waterfowl and upland game is because only up to 40 percent of the area can be opened for waterfowl hunting on refuges created under the Migratory Bird Hunting and Conservation Stamp Act of 1934 (Federal Duck Stamp Act). There is no limit to areas of the refuge that can be legally opened for upland, small game, furbearer and big game hunting, but hunting areas are decided by the refuge manager based on safety concerns; the need to separate consumptive and nonconsumptive users, when necessary; and disturbance to wildlife, which may necessitate the closure of some areas.

Waterfowl hunting would be altered to remove hunting from the Marsh Road Meadow, Park Smith Meadow and South Deadhorse units, all, of which, have marginal waterfowl use and few wetlands; and more created wetland units would be opened up to hunting. These units (figure 18) would include Unit 2, which includes the managed marsh units 24, 25, and 26, and Unit 4, which includes the managed marsh units 40, 48, 49, 50, 61, 62, 63 and 37 (Dead Horse Slough). The waterfowl area would total 7,606 acres, or 34 percent of the refuge. The current hunt area, by comparison, totals 8,062 acres, or 36 percent of the refuge.

Waterfowl hunting regulations would follow State and Federal regulations. Snow goose hunting during the spring Conservation Hunt season is not allowed on Quivira Refuge.

Upland and small game hunting would be similar to the waterfowl hunting area boundaries (figure 19) but would also include the South Deadhorse Unit, Park Smith Meadow, and Unit 27, which are all primarily upland habitats with no managed wetland units except for a small part of Unit 37 (Dead Horse Slough). The total area open for upland and small game hunting would be 9,289 acres.

Hunting Objective 2

Within 5 years realign hunt areas to reduce the average annual number of days the refuge is closed to hunting because of the presence of whooping cranes from 30 to 15 days per year.

Strategies

- Open new areas that were closed before but not regularly used by whooping cranes.

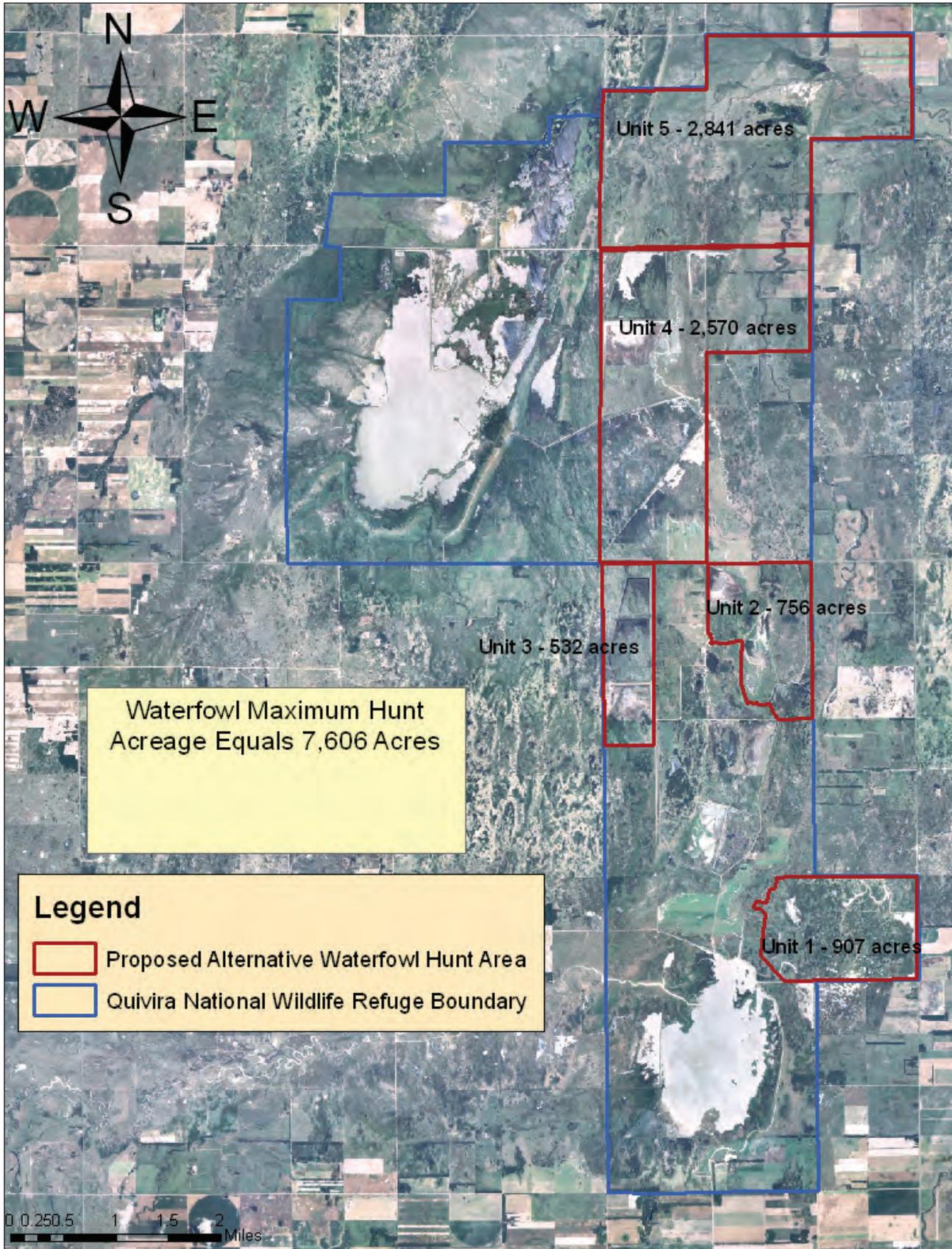


Figure 18. Proposed waterfowl hunt area, Quivira National Wildlife Refuge, Kansas.

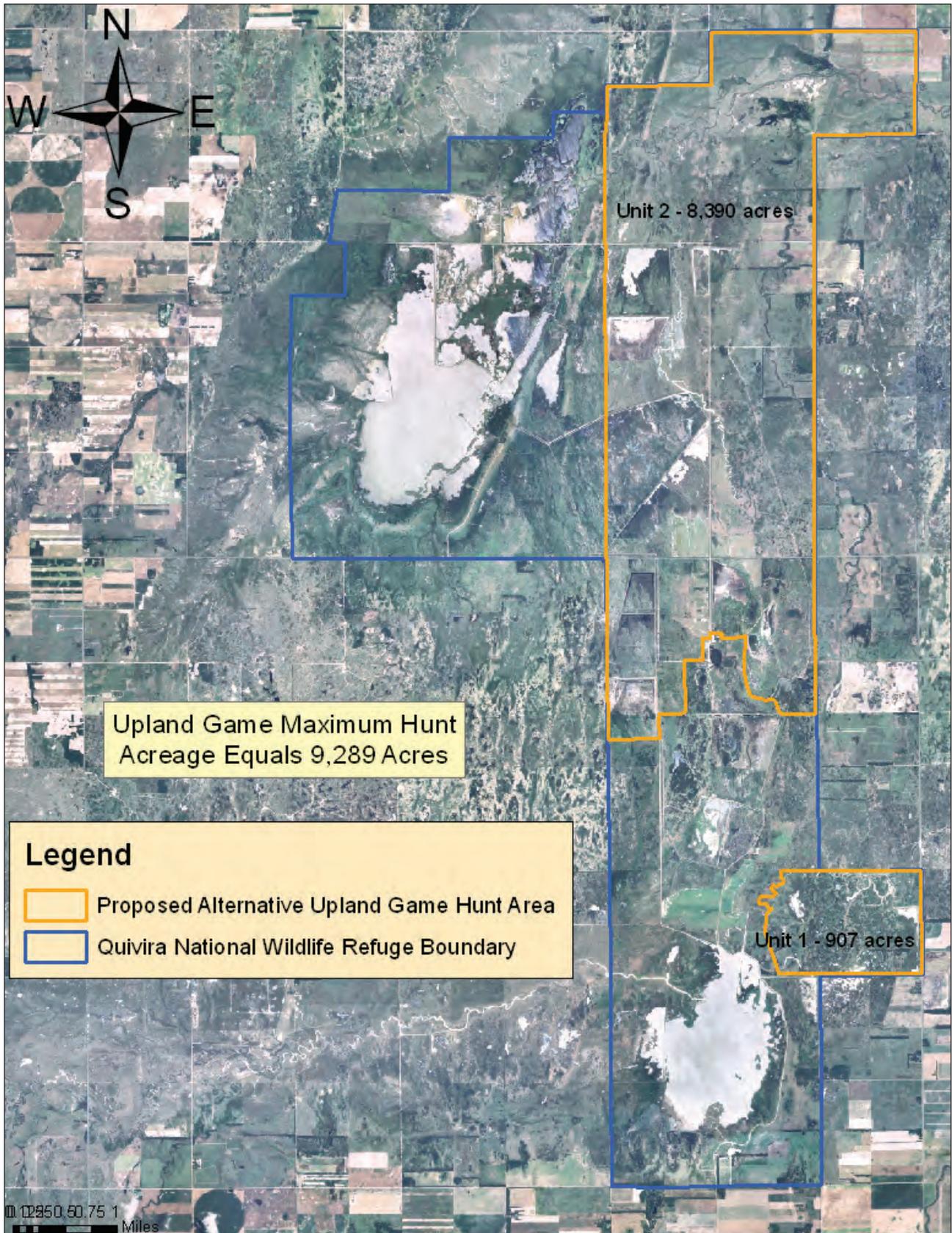


Figure 19. Proposed upland game hunt area, Quivira National Wildlife Refuge, Kansas.

- Update boundary signs to reflect new hunt areas.
- Provide an accessible waterfowl hunting blind, by reservation, in quality wetland habitat.
- Keep, improve, and increase access to hunting information through kiosks, interpretive displays, handout literature, and other means, such as social media and the refuge Web site.
- Increase law enforcement.
- Develop new parking areas.
- Alter waterfowl and upland game hunting area boundaries.
- Update hunting maps.

Rationale

This approach would better accommodate hunter needs while protecting whooping crane use areas. This approach would also reduce staff time spent closing hunt areas when whooping cranes are present. Now the refuge is closed about 30 days per year because of whooping crane presence, which is a frustration to hunters, especially those that travel from out of state to hunt at Quivira.

Hunting Objective 3

Within 10 years develop a hunt plan to broaden and increase hunting opportunities on the refuge including deer, turkey, and furbearers.

Strategies

- Update the CFR to be consistent with the approved hunt plan.
- Work with State of Kansas to determine areas open for hunting and limits based on deer herd health and population targets.
- Deer hunting would be allowed by special refuge permit only, with hunting potentially occurring during youth, muzzleloader, firearms, special hunts, and archery seasons.

- Turkey hunting would be allowed by State permit and according to State regulations. Close specific units when whooping cranes are present.
- Furbearer hunting would be allowed if refuge populations allow or for health purposes. Open areas would be the same as for big game hunting, in accordance with State regulations.
- Keep, improve, and increase access to hunting information through kiosks, interpretive displays, handout literature, and other means, such as social media and the refuge Web site.

Rationale

Deer, turkey, and furbearer hunting would be allowed on most areas of the refuge, totaling 15,239 acres (figure 20) except (1) the south end of the LSM around the headquarters and the public use facilities at the Kids' Fishing Pond, the tower, and the trail; (2) the area around the Migrants Mile hiking trail and refuge storage facilities, the environmental education classroom, and the bunkhouse; and (3) the BSM area, which contains the Wildlife Drive, the most popular nonconsumptive public use area, and a major roosting area for migratory birds. Deer hunting quotas would be figured out, and managed in consultation with the KDWPT for holders of special refuge permits. Turkey hunting would be allowed without special refuge permits.

Creating separate hunting areas for different species would increase the need to provide more hunting information, signage, and law enforcement because the program would be more complex, but it would increase opportunity for the hunting of other species with little-to-no disturbance to migratory birds

Fishing Objective 1

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

Strategies

- Allow fishing, in accordance with State regulations, year round on all waters on the refuge.

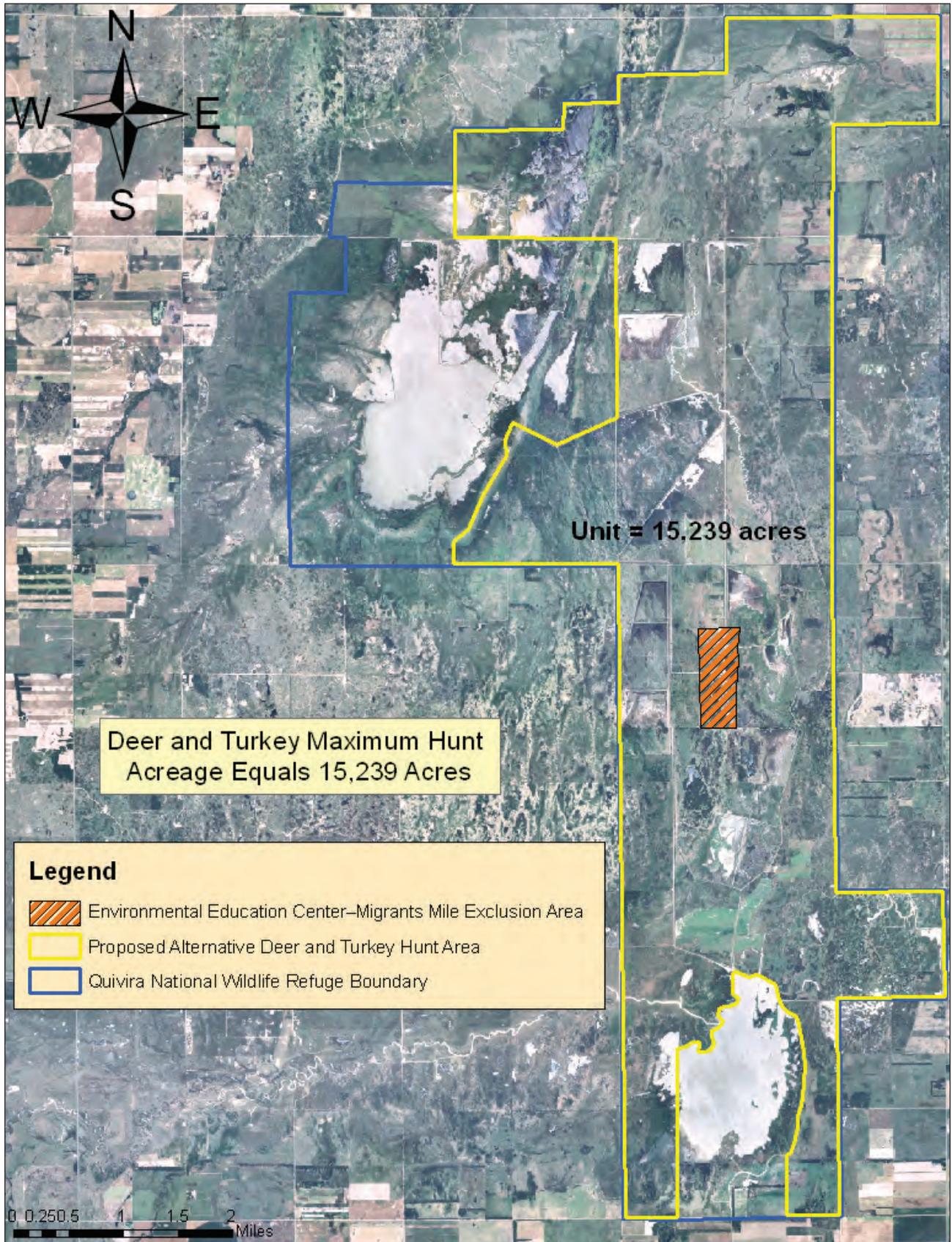


Figure 20. Proposed deer and turkey hunt area, Quivira National Wildlife Refuge, Kansas.

- 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 special fishing events for kids to encourage and support a new generation of anglers.

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

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 regulations, for kids 14 and under (and adults accompanying such children). Adults would 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 keep 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 dogs under their owners' control, but leashed during the nesting season of April 1 to August 15.

Wildlife Observation and Photography Objective 2

Over the next 10 years, promote and expand the opportunity of use at 12 existing 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 parking and access at each of the sites
- 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.

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.

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 the timeliness of communications and educational resources.
- Use social media to increase contact and exposure to the refuge.

Environmental Education and Interpretation Objective 3

At the Great Plains Nature Center, interagency staff will annually conduct an average of 1,700 annual onsite and offsite programs that focus on “at risk” youth and other underserved audiences.

Strategies

- Evaluate staff needs and increase Service staff, as applicable, to support programming efforts.
- Increase communication and networking efforts with USD 259 (Wichita) and area

school administrators to advertise and market GPNC program opportunities (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 KDWPRT.
- Use funding opportunities from the Urban Presence Initiative to support educational programming at the GPNC.



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

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 consultant to evaluate 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, 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 signage 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 signage 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 would not be allowed to disturb wildlife and would not be allowed when areas are closed for safety reasons.

Strategies

- Allow dog training by individuals, not commercial vendors, outside of the nesting season of April 1st to August 15th and without live training aids.
- 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 would not be allowed to disturb wildlife during certain times of the year, and would not be allowed when areas are closed for safety reasons.

6.5 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 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 birdwatching opportunities and rare species occurrences and the draw these have on bringing visitors to the area.



USFWS

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

- 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.

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 wild-life 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 five 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 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 one- or multiday events.
- 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 created 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.

6.6 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 signage 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 (Refuge System 2011). Cultural services are one of many ecosystem services, or benefits, that one can get from nature (Refuge System 2011).

6.7 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

Make sure that visitor safety and the safety of our employees at Quivira Refuge and the GPNC. Strive to keep the refuge as 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 signage, 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.
- Keep 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 proper 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 proper 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 name 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.
- Change hunting areas and establish new regulations to protect whooping cranes.

- Use law enforcement and education to protect cultural resources in accordance with Federal, State, and tribal laws, policies and guidelines.
- Keep a minimum of 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 (Refuge System 2011), Recommendation 16, charges us to: Conduct a new, independent analysis of refuge law enforcement to measure progress and to name needed improvements.

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.

Staff and Budget 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.

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 YCC 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.



The Great Plains Nature Center

Staff and Budget 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.

Strategies

- Find needed positions and projects in the RONS database and update as requested. The top refuge priority identified in RONS 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 (Refuge System 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 (Refuge System 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 and Infrastructure Objective 1

At the refuge and GPNC, within 5 years review and update our refuge deferred maintenance projects

list and document deficiencies, and submit a ranked project list for potential money every year.

Strategies

- Keep and enhance the water delivery infrastructure necessary to achieve our wetland goals and objectives for the refuge.
- Keep the roads and parking lots required to support public use opportunities consistent with our goals and objectives for the refuge.
- Keep the fencing, wells, and other infrastructure necessary to run a grazing program that helps us achieve our goals and objectives for the refuge.
- Keep 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.
- Keep 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 the infrastructure at the GPNC, including the Koch Habitat Hall, Coleman Auditorium, offices, classrooms, and a storage garage, to support our multi-agency cooperative partnership with the City of Wichita Department of Park and Recreation and KDWPT.

Rationale

Visitor services infrastructure for both the refuge and GPNC need routine annual and long-term maintenance to keep these resources 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 water control structures need to be replaced because of advanced age. 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, but this building 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 and Infrastructure 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 and Infrastructure 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 and Infrastructure 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.



USFWS

Migrants Mile Trail

- 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.

6.9 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 31 lists the stepdown plans needed, their status, and their next revision dates.

Table 31. Stepdown management plans for Quivira National Wildlife Refuge, Kansas.

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

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.

ATV—All-terrain vehicle.

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; fire-fighting; 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 PIF 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, USFWS)—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.

USFWS—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.

Appendix A

Key Legislation and Policy

This appendix briefly describes the guidance for the National Wildlife Refuge System and other policies and key legislation that guide the management of the Quivira National Wildlife Refuge.

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

(National Wildlife Refuge System Improvement Act of 1997)

Goals

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

Guiding Principles

There are four guiding principles for management and general public use of the Refuge System established by Executive Order 12996 (1996):

- *Public Use*—The Refuge System provides important opportunities for compatible wildlife-dependent recreational activities involving hunting, fishing, wildlife observation, photography, environmental education, and interpretation.
- *Habitat*—Fish and wildlife will not prosper without quality habitat and without fish and wildlife, traditional uses of refuges cannot be sustained. The Refuge System will continue to conserve and enhance the quality and diversity of fish and wildlife habitat within refuges.
- *Partnerships*—America’s sportsmen and women were the first partners who insisted on protecting valuable wildlife habitat within wildlife refuges. Conservation partnerships with other Federal agencies, State agencies, tribes, organizations, industry, and the general public can make significant contributions to the growth and management of the Refuge System.
- *Public Involvement*—The public should be given a full and open opportunity to participate in decisions regarding acquisition and

management of our national wildlife refuges.



Management actions on national wildlife refuges are circumscribed by many mandates including laws and Executive orders.

American Indian Religious Freedom Act (1978)—Directs agencies to consult with native traditional religious leaders to figure out proper policy changes necessary to protect and preserve Native American religious cultural rights and practices.

Americans with Disabilities Act (1992)—Prohibits discrimination in public accommodations and services.

Antiquities Act (1906)—Authorizes the scientific investigation of antiquities on Federal land and provides penalties for unauthorized removal of objects taken or collected without a permit.

Archaeological and Historic Preservation Act (1974)—Directs the preservation of historic and archaeological data in Federal construction projects.

Archaeological Resources Protection Act (1979), as amended—Protects materials of archaeological interest from unauthorized removal or destruction and requires Federal managers to develop plans and schedules to locate archaeological resources.

Architectural Barriers Act (1968)—Requires federally owned, leased, or financed buildings and facilities to be accessible to persons with disabilities.

Clean Water Act (1977)—Requires consultation with the U.S. Army Corps of Engineers (404 permits) for major wetland modifications.

Dingell–Johnson Act (1950)—Authorized the Secretary of the Department of the Interior to provide financial help for State fish restoration and management plans and projects. Financed by excise taxes paid by manufacturers of rods, reels, and other fishing tackle. Known as the Federal Aid in Sport Fish Restoration Act.

Endangered Species Act (1973)—Requires all Federal agencies to carry out programs for the conservation of endangered and threatened species.

Executive Order No. 7168 (1935)—Establishes Arrowwood Migratory Waterfowl Refuge “as a refuge and breeding ground for migratory birds and other wild life... to effectuate further the purposes of the Migratory Bird Conservation Act...”

Executive Order 11988 (1977)—Requires Federal agencies to provide leadership and take action to reduce the risk of flood loss, decrease the effect of floods on human safety, and preserve the natural and beneficial values served by the floodplains.

Executive Order 12996, Management and General Public Use of the National Wildlife Refuge System (1996)—Defines the mission, purpose, and priority public uses of the National Wildlife Refuge System. It also presents four principles to guide management of the Refuge System.

Executive Order 13007, Indian Sacred Sites (1996)—Directs Federal land management agencies to accommodate access to and ceremonial uses of American Indian sacred sites by American Indian religious practitioners, avoid adversely affecting the physical integrity of such sacred sites, and where proper, keep the confidentiality of sacred sites.

Federal Noxious Weed Act (1990)—Requires the use of integrated management systems to control or contain undesirable plant species and an interdisciplinary approach with the cooperation of other Federal and State agencies.

Federal Records Act (1950)—Requires the preservation of evidence of the Government’s organization, functions, policies, decisions, operations, and activities, as well as basic historical and other information.

Fish and Wildlife Coordination Act (1958)—Allows the U.S. Fish and Wildlife Service to enter into agreements with private landowners for wildlife management purposes.

Migratory Bird Conservation Act (1929)—Establishes procedures for acquisition by purchase, rental, or gifts of areas approved by the Migratory Bird Conservation Commission.

Migratory Bird Hunting and Conservation Stamp Act (1934)—Authorizes the opening of part of a refuge to waterfowl hunting.

Migratory Bird Treaty Act (1918)—Designates the protection of migratory birds as a Federal responsibility; and enables the setting of seasons and other

regulations, including the closing of areas, Federal or non-Federal, to the hunting of migratory birds.

National Environmental Policy Act (1969)—Requires all agencies, including the Service, to examine the environmental impacts of their actions, incorporate environmental information, and use public participation in the planning and implementation of all actions. Federal agencies must integrate this Act with other planning requirements, and prepare proper documents to facilitate better environmental decisionmaking. [From the Code of Federal Regulations (CFR), 40 CFR 1500]

National Historic Preservation Act (1966), as amended—Establishes as policy that the Federal Government is to provide leadership in the preservation of the Nation's prehistoric and historic resources.

National Wildlife Refuge System Administration Act (1966)—Defines the National Wildlife Refuge System and authorizes the Secretary of the Department of the Interior to allow any use of a refuge, provided such use is compatible with the major purposes for which the refuge was established.

National Wildlife Refuge System Improvement Act of 1997—Sets the mission and administrative policy for all refuges in the National Wildlife Refuge System; mandates comprehensive conservation planning for all units of the Refuge System.

Native American Graves Protection and Repatriation Act (1990)—Requires Federal agencies and museums to inventory, find ownership of, and repatriate cultural items under their control or possession.

Refuge Recreation Act (1962)—Allows the use of refuges for recreation when such uses are compatible with the refuge's primary purposes and when sufficient money is available to manage the uses.

Rehabilitation Act (1973)—Requires programmatic accessibility and physical accessibility for all facilities and programs paid for by the Federal Government to make sure that any person can take part in any program.

Rivers and Harbors Act (1899)—Section 10 of this Act requires the authorization of U.S. Army Corps of Engineers before any work in, on, over, or under navigable waters of the United States.

Volunteer and Community Partnership Enhancement Act (1998)—Encourages the use of volunteers to help in the management of refuges within the Refuge System; facilitates partnerships between the Refuge

System and non-Federal entities to promote public awareness of the resources of the Refuge System and public participation in the conservation of the resources; and encourages donations and other contributions.

Appendix B

List of Preparers and Contributors

This CCP and EA is the result of extensive, collaborative, and enthusiastic efforts by the members of our planning team, listed below.

<i>Team member</i>	<i>Position</i>	<i>Work unit</i>
Mike Artmann	Wildlife biologist	USFWS, Region 6, Lakewood, CO
Lorrie Beck	Park ranger	USFWS, GPNC, Wichita, KS
Barbara Boyle	Refuge supervisor	USFWS, Region 6, Lakewood, CO
Rebecca Brave	Native American Graves Protection and Repatriation Act assistant	Osage Nation, Historic Preservation Office, Pawhuska, OK
Mark Ely	GIS specialist	USFWS, Region 6, Lakewood, CO
Kimberly Farr	Biological technician	USFWS, Quivira Refuge
Toni Griffin	Refuge planner	USFWS, Region 6, Lakewood, CO
Karl Grover	Field supervisor	KDWPT, Cheyenne Bottoms Wildlife Area, Great Bend, KS
Andrea A. Hunter	Tribal historic preservation officer	Osage Nation, Historic Preservation Office, Pawhuska, OK
Barry Jones	Park ranger	USFWS, Quivira Refuge
Steve Karel	Former deputy refuge manager	USFWS, Quivira Refuge
Joe Kocher	Maintenance worker	USFWS, Quivira Refuge
Christine LaRue	Administrative officer	USFWS, Quivira Refuge
Murray Laubhan	Zone biologist	USFWS, Quivira Refuge
Rachel Laubhan	Wildlife biologist	USFWS, Quivira Refuge
Dave McCauley	Range technician	USFWS, Quivira Refuge
Mike Mitchener	Wildlife section chief	KDWPT, Pratt Operations Office, Pratt, KS
James Munkres	Archeologist I	Osage Nation, Historic Preservation Office, Pawhuska, OK
Mike Oldham	Project leader	USFWS, Quivira Refuge
Mike Rader	Wildlife education coordinator	KDWPT, Pratt Operations Office, Pratt, KS
Andy Schaal	Range technician	USFWS, Quivira Refuge
Dan Severson	Former project leader	USFWS, Quivira Refuge
Brad Stumph	Natural resource specialist	Osage Nation, Department of Environmental and Natural Resources, Pawhuska, OK
Bill Waln	Fire management specialist	USFWS, Quivira Refuge
Brent Waters	Maintenance worker	USFWS, Quivira Refuge

Many organizations, agencies, and individuals provided help with the preparation of this CCP and EA. We acknowledge the efforts of the following individuals and groups. The diversity, talent, and knowledge contributed dramatically improved the vision and completeness of this document.

U.S. Geological Survey, Policy Analysis and Science Assistance Branch (socioeconomic impact studies)

Matt Hogan (Assistant Regional Director, Refuge System, USFWS, Region 6)

Sheri Fetherman (chief, Division of Education and Visitor Services, USFWS, Region 6)

Mickey Heitmeyer (wetlands ecologist, contractor)

Wayne King (biologist, Refuge System, USFWS, Region 6)

Mitch Werner (writer–editor, Division of Refuge Planning, USFWS, Region 6)

David Lucas (chief, Division of Refuge Planning, USFWS, Region 6)

Meg Van Ness (regional archaeologist, USFWS, Region 6)

Appendix C

Public Involvement

C.1 Public Involvement

We started public scoping Quivira Refuge in a notice of intent published in the Federal Register on February 24, 2010. The notice of intent announced our intent to prepare a CCP and EA document for the refuge and to obtain suggestions and information on the scope of issues to be considered in the planning process. Written comments were accepted through March 26, 2010.

On February 2010 a planning update was sent to each individual, organization, and government representative on the CCP mailing list, see below. The planning update provided information on the history of the Refuge System and on the CCP process, along with an invitation to, and schedule of, upcoming open houses.

Open houses were announced to local newspapers, radio, and television stations. Flyers were posted, and announcements were made via email and at the meetings of local organizations.

Three public open houses were held from March 8–10, 2010, in the local communities of Stafford, Great Bend, and Wichita, Kansas. At the meetings informational posters, maps, and handouts, along with a PowerPoint presentation provided a history of the Refuge System, an orientation of the planning area, and an overview of the CCP and NEPA processes. The draft vision statement developed for the refuge was also presented at the meetings. Our staff was available to answer questions on a variety of topics about refuge management and the CCP process. Attendees were encouraged to ask questions and offer comments. The turnout was moderate, with 5–15 people attending each meeting.

More than 80 comments were received orally and in writing during the scoping process. We received letters from three organizations—the National Wild Turkey Federation, Defenders of Wildlife, and the Great Bend Convention and Visitors Bureau—and from 12 individuals. Input obtained from public meetings, letters, emails, and comment forms was considered in developing this draft CCP and EA. These comments identified biological, social, and economic concerns about our refuge management. Our planning team's response to public comments will be completed before the final approval of this CCP.

C.2 Public Mailing List

What follows is the mailing list for Quivira Refuge CCP and EA.

Federal Officials

U.S. Senator Pat Roberts, Washington, DC
U.S. Senator Jerry Moran, Washington, DC
U.S. Congresswoman Lynn Jenkins, Topeka, KS
U.S. Congresswoman Lynn Jenkins, Washington, DC
U.S. Congressman Tim Huelskamp, Hutchinson, KS
U.S. Congressman Tim Huelskamp, Washington, DC
U.S. Congressman Kevin Yoder, Overland Park, KS
U.S. Congressman Kevin Yoder, Washington, DC
U.S. Congressman Mike Pompeo, Wichita, KS
U.S. Congressman Mike Pompeo, Washington, DC

Federal Agencies

USFWS—Atlanta, GA, Anchorage, AK, Sacramento, CA, Arlington, VA, Shepherdstown, WV, Portland, OR, Hadley, MA, Albuquerque, NM, Washington, DC, Fort Snelling, MN
USGS—Fort Collins, CO
National Park Service—Denver, CO, Omaha, NE
NRCS—Saint John, KS

Tribal Officials

Osage Nation Tribal Council, Pawhuska, OK

State Officials

Governor Sam Brownback, Topeka, KS
Representative Mitch Holmes, Saint John, KS
Representative Michael O’Neal, Hutchinson, KS
Representative Janice Pauls, Hutchinson, KS
Representative Joe Seiwert, Pretty Prairie, KS
Senator Terry Bruce, Hutchinson, KS
Senator Jay Emler, Lindsborg, KS
Senator Ruth Teichman, Stafford, KS

State Agencies

Kansas Department of Wildlife, Parks and Tourism—Great Bend, KS, Pratt, KS, Topeka, KS

Local Government

Big Bend Groundwater Management District 5—Haviland, KS, Macksville, KS
City Manager, Sterling, KS
Clerk Bell Township, Rice County, Raymond, KS
Clerk Stafford County, Saint John, KS
Commissioner Reno County, District 2, Hutchinson, KS
Commissioner Rice County, District 2, Sterling, KS
Commissioner Stafford County, District 2, Macksville, KS
Commissioner Stafford County, District 3, Saint John, KS
Mayor, Great Bend, KS
Mayor, Hudson, KS
Mayor, Saint John, KS
Mayor, Stafford, KS
Treasurer Bell Township, Rice County, Raymond, KS
Trustee, Putnam Township, Stafford County, Ellinwood, KS

Local Businesses

Alden State Bank, Sterling, KS
ANR Pipeline Co., Alden, KS
Cole Body Shop, Great Bend, KS
Hoisington Main Street Inc., Hoisington, KS
Jayhawk Pipeline, McPherson, KS
White Eagle Resources Corporation, Louisville, KS

Organizations

American Bird Conservancy, The Plains, VA
Audubon Society, Washington, DC
Defenders of Wildlife, Washington, DC
Ducks Unlimited, Memphis, TN
Friends of Great Plains Nature Center, Wichita, KS
Friends of Quivira—Hudson, KS, Larned, KS, Saint John, KS, Stafford, KS, Sterling, KS
Great Bend Convention and Visitors Bureau, Great Bend, KS
Izaak Walton League, Gaithersburg, MD
Kansas Herpetological Society, Wakarusa, KS
Kansas Ornithological Society, Prairie Village, KS
National Trappers Association, New Martinsville, WV
National Wildlife Federation, Reston, VA
National Wildlife Refuge Association, Washington, DC
Quail Unlimited, Wichita, KS
Sierra Club, San Francisco, CA
Sierra Club Southwind Group, Wichita, KS
Smokey Hills Audubon Society, Salina, KS
Stafford County Ducks Unlimited, Saint John, KS
The Nature Conservancy, Ellinwood, KS
The U.S. Humane Society, Washington, DC
The Wilderness Society, Washington, DC
Wichita Audubon Society, Wichita, KS

Universities and Schools

Colorado State University, Fort Collins, CO

Media

Great Bend Tribune, Great Bend, KS
Hays Daily News, Hays, KS
Saint John News, Saint John, KS
Wichita Eagle, Wichita, KS

Individuals

55 private individuals

Appendix D

Draft Compatibility Determinations

[REDACTED]

Quivira National Wildlife Refuge.

[REDACTED]

May 3, 1955.

[REDACTED]

Migratory Bird Conservation Act (16 U.S.C. § 715d)
Fish and Wildlife Act of 1956 (16 U.S.C. § 742f(a)4)
Fish and Wildlife Act of 1956 (16 U.S.C. § 742f(b)1)

[REDACTED]

The establishing and acquisition authorities set out the purposes for the refuge, as described below:

- For use as an inviolate sanctuary, or for any other management purpose, for migratory birds.
- For the development, advancement, management, conservation, and protection of fish and wildlife resources.
- For the benefit of the United States Fish and Wildlife Service, in performing its activities and services.

[REDACTED]

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

[REDACTED]

The following uses are evaluated for compatibility within the Quivira National Wildlife Refuge:

- hunting
- fishing
- wildlife observation and photography, including bicycling, horseback riding, and commercial birding tours via special use permit
- environmental education and interpretation
- cooperative farming, haying, and grazing
- commercial filming, audio recording, and still photography
- research and monitoring
- dog training
- firewood cutting

Hunting

The refuge's hunting program would be driven by its compatibility with wildlife population objectives. Besides the site-specific regulations mentioned below, the State hunting regulations would apply to the lands we own. Hunters may only possess and use our approved, nontoxic shot loads on our owned lands, and vehicle travel and parking is restricted to public roads, pullouts, and parking areas. The refuge Web site and public use brochures would provide guidance on site-specific regulations. The general hunting regulations are available from the KDWPT.

This draft CCP proposes the hunting uses described below. Also, we would increase regulatory hunting signage, such as more "closed to hunting area" and "nontoxic shot required" signs, and interpretive materials, like an updated, and more comprehensive refuge hunting leaflet or tearsheet, in an effort to reduce unintentional hunting violations on the refuge.

Hunting of migratory gamebirds, including three dove species, duck, goose, snipe, Virginia and sora rail, and coot would continue in designated areas of the refuge on approximately 7,606 acres. Sandhill crane hunting would be prohibited. Hunting of upland game, including pheasant, bobwhite quail, and prairie-chicken, would be allowed in designated areas of the refuge on approximately 9,289 acres of upland and wetland habitat. Big game hunting would be allowed for white-tailed deer and turkey on up to 15,239 acres. Small game hunting would include rabbits and squirrels only. Furbearer trapping by special use permit would be allowed on the same area as big game hunting.

A universally accessible hunting blind is located in Unit 30 and may be reserved through the refuge office.

Availability of Resources

Existing programs, such as current refuge directional signs and brochures, could be updated with available resources. Maintenance of access roads, parking, hunting and information kiosks, and public use signs, is closely tied to our Asset Maintenance Management System. The refuge's base budget would pay for the update and printing of existing and new brochures.

More law enforcement staff time and resources would be required to manage substantial changes to the hunting program. Additions would be (1) to start a deer and turkey hunting program; (2) to change hunt area boundaries and parking areas including signage and hunt brochures; and (3) to check compliance with this new public use and manage whooping

crane unit closures as necessary. Existing law enforcement staff is sufficient to manage the new programs.

Anticipated Effects of Use

The hunting program would continue to provide ample quality hunting opportunities without materially detracting from the mission of the Refuge System and the goals or establishing purposes of refuge lands. Public use brochures and the refuge Web site would be kept up to date and made readily available to hunters. Hunter success and satisfaction would be checked with random contacts with hunters in the field and at refuge headquarters.

Hunting is considered by many to be a legitimate, traditional, recreational use of renewable natural resources. The Administration Act, the Improvement Act, other laws, and our policy allow hunting on a national wildlife refuge when it is compatible with the purposes for which the refuge was established and acquired. National wildlife refuges exist primarily to safeguard wildlife populations through habitat preservation.

The word "refuge" includes the idea of providing a haven of safety for wildlife, and, as such, hunting might seem to be inconsistent with the National Wildlife Refuge System. However, habitat that normally supports healthy wildlife populations produces harvestable surpluses that are a renewable resource. As practiced on Quivira Refuge, hunting does not pose a threat to the wildlife populations and, in some instances, is actually necessary for sound wildlife management.

By its nature, hunting creates a disturbance to wildlife and directly affects the individual animals being hunted. However, it is well recognized that this activity has given many people a deeper appreciation of wildlife and a better understanding of the importance of conserving their habitat, which has ultimately contributed to the Refuge System mission.

Furthermore, despite the potential effects of hunting, a goal of the refuge is to provide opportunities for quality wildlife-dependent recreation. The hunting program would be designed and watched closely for safety and quality. A substantial change in the hunting program would be to only close parts of the refuge to hunting when whooping cranes are present on the refuge, instead of closing the entire refuge. This poses a slightly increased risk to whooping cranes. However, sandhill crane hunting, which could lead to the misidentification of the two bird species during a hunt, is not allowed on the refuge, and whooping cranes are actually at higher risk of being accidental shot during hunting season off refuge when they go out to feed where sandhill crane hunting is allowed.

Although hunting directly affects the hunted species and may indirectly disturb other species, limits on harvest and access for recreational hunting would make sure that populations do not fall to unsustainable levels. Closed areas on the refuge provide sanctuary to migratory birds during the hunting season. In some cases, hunting can be used as a management tool to control elevated populations that are having a negative effect on wildlife habitat.

Added effects from hunting activity include conflicts with individuals participating in wildlife-dependent public uses such as wildlife observation and photography. This could decrease visitors' satisfaction during the hunting season if all users are restricted to the same parts of the refuge.

Determination

Recreational hunting would be a compatible use on the Quivira Refuge in accordance with State regulations.

Stipulations Necessary to Make Sure that There is Compatibility

Visitors participating in recreational hunting would follow our public use regulations, including site-specific regulations, and the State's hunting regulations.

- Hunters would continue to use approved nontoxic shot for migratory and upland gamebird hunting and turkey hunting on the lands we own.
- Vehicles would be restricted to county and public roads and parking areas on the refuge.
- Signage, brochures, and our Web site would be used to provide hunters information on where, and how, to hunt on the refuge to make sure that we have their compliance with public use regulations.

Justification

Hunting is identified as a priority public use in the Improvement Act of 1997 and would help meet Refuge System goals with only minimal conflicts. Recreational hunting can instill, in citizens of all ages, a greater appreciation for wildlife and its habitat. This appreciation may extend to the Refuge System and other conservation agencies.

In *Conserving the Future*, Recommendation 17 states: "The Service will work closely with State fish and wildlife agencies to conduct a review of its current hunting and fishing opportunities, especially opportunities offered for youth and people with disabilities. Based on this review, the Service and states will work cooperatively to prepare a strategy for increasing quality hunting and fishing opportunities on national wildlife refuges." (Refuge System 2011)

Based on the anticipated biological effects described above and in the EA, we have found that recreational hunting on the refuge would not interfere with our habitat goals and objectives or purposes for which the refuge was established. Limiting access and checking the use could help limit any adverse effects.

Mandatory 15-year Reevaluation Date: 2028

Fishing

Fishing is defined as wildlife-dependent recreation under the Improvement Act. As one of the six priority recreational activities noted therein, fishing provides a traditional recreational activity on the refuge with no definable adverse effects to biological resources.

National wildlife refuges may be opened to sportfishing only after a determination is made that this activity is compatible with the purposes for which the refuge was established. In addition, the sportfishing program must be consistent with principles of sound fishery management and otherwise be in the public interest.

This draft CCP and EA includes continued recreational fishing and allows for a new program for frogging. Fishing would continue on the following units of the refuge in accordance with State regulations:

Availability of Resources

The fishing program could be administered using current resources.

Anticipated Effects of Use

Fishing and other human activities cause disturbance to wildlife and the trampling of vegetation along the bank of rivers and streams. Littering can also become a problem.

Determination

Fishing would be a compatible use on Quivira Refuge in accordance with State regulations.

Stipulations Necessary to Make Sure that There is Compatibility

- Visitors participating in recreational fishing would follow our public use regulations and State fishing regulations and limits.
- No bait collecting and no live fish bait use except for night crawlers would be allowed.
- Vehicles would be restricted to county and public roads and parking areas on the refuge.
- The use of motorized boats would be prohibited.
- Boats, fishing equipment, and all other personal property must be removed at the end of each day.
- Fish stocking would only occur in the Kid's Fishing Pond as necessary.

Justification

Fishing is listed as a priority public use in the Improvement Act. Based on the biological effects addressed above and in the environmental assessment, we have found that recreational fishing would not interfere with the habitat goals and objectives of the refuge or with the purposes for which the refuge was established.

Mandatory 15-year Reevaluation Date: 2028

Wildlife Observation and Photography

As two of the six priority recreational uses identified in the National Wildlife Refuge System Improvement Act of 1997, wildlife observation and photography provide recreational activities on the

refuge with no definable adverse effects to biological resources.

Wildlife observation and photography opportunities would continue to be provided on the refuge, and would be supported by providing observation towers and blinds, keeping an up-to-date bird species list for the refuge, and allowing the opportunity to use portable viewing and photography blinds through the issuance of special use permits. Facilities exist to support these activities by bringing people closer to wildlife.

The auto tour and Wildlife Drive will provide year-round opportunities for wildlife viewing and photography via auto, foot, dog walking, bicycling, and horseback. Hazardous road conditions, such as the flooding of emergency spillways on the route may occasionally require closures for safety. The Wildlife Drive area may also occasionally close because of whooping crane use to avoid disturbance.

All roads and trails are open for foot traffic year round, from sunrise to sunset, unless short-term closures are enacted to prevent wildlife disturbance or maintenance. All refuge lands are open to foot traffic except for periodic closures during the nesting season. Two areas are routinely closed during nesting season on the salt flats for interior least tern nesting and in the South Big Salt Marsh unit around the bald eagle nest site. The observation tower road and photo blind on the LSM have been occasionally closed because of whooping crane use near the blind and tower. Other areas may be closed in the future depending on changes in wildlife use.

Facilities providing more opportunities for wildlife observation and photography include the LSM photo and observation blind and observation tower, the trail between the observation tower and the Kid's Fishing Pond, and the Migrants Mile hiking trail and photo and observation blind. Spotting scopes are available at the LSM observation tower and on the Wildlife Drive. A binocular loan program is also available for checkout at refuge headquarters.

More observation opportunities would be available through the proposed tower-mounted, remote camera at the BSM and bald eagle nest site. The movable tower camera would be installed near the bald eagle nest. It would allow Internet viewing of the nesting activity and would also provide viewing of wildlife on the BSM year round.

Commercial birding would be allowed with a special use permit obtained at the refuge headquarters.

Availability of Resources

The only money required for a new facility would go toward buying and installing an Internet-connected tower camera at the BSM. Money would be acquired from various sources, such as the Friends of

Quivira, outside donations, local utilities, grants, and refuge sources. Other refuge money for visitor facilities are received as visitor facility enhancement projects through our Asset Maintenance Management System and through Visitor Facility Enhancement grants. Existing programs, such as current directional signs and brochures, can be updated with available resources.

More staff time would be required to manage the tower camera and for maintenance.

Anticipated Effects of the Use

Effects associated with the wildlife observation and photography uses of the refuge resources. These uses are ongoing, and potential disturbances are being managed with temporary closures without issue. Law enforcement is available to enforce closures, and the Internet and temporary signage at headquarters and closed areas announce closures.

Sanctuary would be provided for migrating waterfowl and other waterbirds during the waterfowl hunting season at Quivira Refuge. Changes to the waterfowl hunt boundary would reduce any conflicts between hunters and nonhunters in the Marsh Road and Wildlife Drive area, as those areas become nonhunting sanctuary, but they may increase in other parts of the auto tour route when hunting is allowed in units next to the tour route. Much of the area already sees hunting activity on the Hunter Access Road, but units 26, 49, 62, and 63 have been closed to hunting.

Determination

Wildlife observation and photography would be compatible uses on Quivira Refuge.

Stipulations Necessary to Make Sure that There is Compatibility

- Visitors participating in wildlife observation and photography would follow all public use regulations.
- Seasonal closures to protect sensitive wildlife areas and reduce disturbance to fish and wildlife would be kept.
- Commercial photography would require a special use permit.
- Non-Service vehicles would be restricted to county and public access roads on the refuge.
- ATV or UTV use on the refuge would be compatible with State and county regulations on county roads. ATV or UTV use by the public is prohibited off public roads, unless allowed under a special use permit.
- Viewing areas would be designed to decrease disturbance effects to wildlife and all refuge resources while providing a good opportunity to view wildlife in their natural environments. Visitors using the refuge's permanent blinds or their own portable observation and photography blinds would be provided with information on their proper use and on the etiquette of these structures to decrease disturbance to wildlife and their natural environments and to other refuge visitors.
- Horseback riding and biking would be prohibited on hiking trails, off roads, or in closed areas.
- Dogs must be under owner's control, but leashed during the nesting season of April 1 to August 15.

Justification

Wildlife observation and photography are identified as priority public uses in the Improvement Act and would help meet Refuge System goals with only minimal conflict. Wildlife observation and photography can instill, in citizens of all ages, a greater appreciation for wildlife and its habitat. This appreciation may extend to the Refuge System and other conservation agencies.

Based on anticipated biological effects described above and in the EA, we have found that wildlife observation and photography on the refuge would not interfere with our habitat goals and objectives or with the purposes for which the refuge was established. Limiting access and watching use closely could help limit any adverse effects.

***Mandatory 15-year Reevaluation Date:
2028***

Environmental Education and Interpretation

As two of the six priority recreational uses identified in the Improvement Act, environmental education and interpretive activities on the refuge and offsite programming and events at schools, fairs, and expo centers provide activities with no definable adverse effects to biological resources.

- Interpretive panels and auto tour brochures provide information about habitat, wildlife, management actions, and activities. Interpretation is passive in nature, from self-guided opportunities to interpretive panels, brochures, Web sites, and tearsheets. We would continue to offer binocular and Let's Go Outside! backpack loan programs at the refuge and at the GPNC. We would continue to use social media, and update it weekly, to increase contact with, and exposure to, the refuge.
- We would continue to provide interpretive programs at Quivira Refuge and the GPNC on a variety of refuge management and wildlife-oriented subjects, both by request and as scheduled activities, and we would increase programs as staff and time allow.
- We would continually evaluate our interpretive media, such as brochures, signs, and displays, for relevancy, effectiveness, and timeliness, and we would update them as needed, provided we have the money to do it.

This CCP proposes to continue environmental education and interpretation and add the following to improve these programs:

- Replace the refuge environmental education classroom with a new one near the headquarters. The location already has several facilities nearby that would be used in conjunction with the classroom, including trails, an observation tower, a pavilion, restrooms, wetlands, sand prairie uplands, meadows and other habitats.
- We would expand the opportunities for environmental education and interpretation to foster appreciation and understanding of the National Wildlife Refuge System and the resources of Quivira Refuge. More interpre-

tive panels would be developed for the refuge, and accessible observation sites would be developed on the refuge. The mammal, reptile and amphibian lists would be updated for the refuge, and a brochure would be developed.

- We would interpret the cultural history of the Quivira Refuge area, including tribal uses, and early settlement.
- Refuge staff would continue to take part in offsite special events and activities to bring the refuge message to many people, including at-risk youth. Participation in these events would occur as staff and time allow.
- Environmental education programs would be provided to teach curriculum-based programs for all grade levels that meet State educational standards.
- We would encourage the use of both Quivira Refuge and GPNC facilities by educational organizations as outdoor classrooms.
- We would continue to support the GPNC through its partnership with the City of Wichita Department of Park and Recreation and the KDWPT. We would use educational kits and discovery boxes, and continue to promote current and future national initiatives, such as America's Great Outdoors and Let's Go Outside!
- Participation by teachers and students in the Junior Federal Duck Stamp program will continue to increase through more outreach and marketing efforts. Artwork will be displayed 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.
- We would encourage virtual geocaching to enhance the appreciation of refuge resources.

Availability of Resources

Payment for environmental education and interpretation activities, directional signs, and brochures would come from annual operations and maintenance money. Other sources, such as grants, regional project proposals, challenge cost-share agreements, deferred maintenance and others would also be sought and used as they became available.

Requests to pay for new facilities would be submitted as visitor facility enhancement projects through our Asset Maintenance Management System.

Anticipated Effects of the Use

The use of the refuge for onsite activities by groups of teachers and students for environmental education or interpretation may minimally affect the immediate and surrounding areas in the short term. Effects may include the trampling of vegetation and temporary disturbance to nearby wildlife species.

Refuge brochures, interpretive panels, and other educational materials would continue to be updated as needed to meet our needs. Features such as the auto tour route and accessible observation sites would continue to provide access to the refuge.

A new, relocated environmental education classroom would have a small effect on lands near the Kid's Fishing Pond, but this would be offset by a reduction of the footprint area where the existing environmental education classroom is located. All facilities at the current location except for the public restrooms and area of the parking lot would be removed, including the bunkhouse and trailer pads, which would be relocated at the headquarters administrative site, and the area would be restored to upland habitat.

We would continue to promote a greater public understanding and appreciation of refuge resources, programs, and issues through interpretive, outreach, and environmental educational programs. Working with our Friends groups and other local groups, we would continue to provide environmental education and interpretation both on and off the lands we own. Presentations, both on and off our lands, would be provided to refuge visitors, school groups, and organizations, allowing us to reach a broader audience. Onsite presentations would be managed to decrease disturbance to wildlife, habitat, and cultural resources. Environmental education and interpretation activities taking place at the GPNC and offsite by GPNC staff would not affect wildlife or habitat in the urban setting.

Determination

Environmental education and interpretation would be a compatible use on Quivira Refuge.

Stipulations Necessary to Make Sure that There is Compatibility

- Visitors participating in environmental education and interpretation programs would follow all of our regulations. Onsite activities would be held where minimal effect to wildlife and habitats would occur.
- We would review new environmental education and interpretation activities to make sure that these activities meet program objectives and are compatible.

Justification

Environmental education and interpretation are identified as priority public uses in the Improvement Act and would help meet Refuge System goals with only minimal conflicts. Environmental education and interpretation would be used to encourage an understanding in citizens of all ages to act responsibly to protect wildlife and their habitats. These are tools used in building a land ethic, developing support of the refuge, and decreasing wildlife violations.

Environmental education is an important tool for the refuge to provide visitors with an awareness of its purposes, values, and specific issues such as wetland ecology, water quality, effects of nonnative species, and migratory bird management. This tool would also provide visitors and students a greater understanding of the mission of the Refuge System and its importance to the American people.

Based on anticipated biological effects described above and in the EA, we have found that environmental education and interpretation on the refuge would not interfere with our habitat goals and objectives or with the purposes for which the refuge was established. Limiting access during certain times of the year and checking the uses would limit any adverse effects.

Mandatory 15-year Reevaluation Date: 2028

Cooperative Farming, Haying, and Grazing

We would continue to use cooperative farming and prescriptive livestock grazing and haying as management tools on the refuge. These tools would be used to meet habitat objectives, control vegetative litter, promote native plant production and diversity, control the spread of invasive plant species, and help convert disturbed grasslands back to native plant species.

The refuge uses cooperative farming and haying as tools to manage habitats, including the control of invasive plant species, grassland reconstruction and wet meadow management. We would enter into an agreement with a local landowner to (1) help restore cropland and poor quality habitat to quality native grassland or wetland habitat for wildlife or (2) cut grasslands to promote native seed harvest the following growing season and to rejuvenate vegetation growth. A farming cooperator would be issued a cooperative farming agreement or special use permit by the refuge manager and would be allowed to till seed, harvest small grain, control invasive plants, or harvest hay on the lands we own. The choice is reserved to use genetically modified crops only for the reconstruction of native prairie plants to create more weed-free seedbeds and has been approved through an environmental assessment. The agreement generally would be issued for a 1- to 4-year management prescription.

Cooperative farming of our lands is usually done on a share basis where we and the cooperator each receive a share of the crop. We would keep our share as standing cover for wildlife forage or in exchange for more work from the cooperator, such as seed harvesting, invasive plant control, grass seeding, or for supplies such as herbicides and fence materials for habitat protection and improvement on the management unit. Any fees or cash received by us would be deposited into the Refuge Revenue Sharing Account.

This draft CCP proposes to continue using cooperative farming and haying to manage habitats. Farming will gradually be phased out as those lands are planted back into native species. Furthermore, this draft CCP establishes goals and objectives for specific habitat types where cooperative farming and haying may be used. In addition, we have identified focal wildlife species, such as eastern meadowlark and dickcissel, and their habitat needs. This has resulted in objectives that would guide management to achieve the habitat needs of these species. The refuge would improve monitoring and research programs for vegetation and wildlife to assess habitat

and wildlife population responses to cooperative farming and haying.

The refuge uses prescriptive livestock grazing as a tool to manage a variety of uplands and wetlands. Grazing by livestock has been a preferred management tool because the effect on habitat is controllable and measurable. Livestock grazing has been used in a variety of ways including high intensity and short duration, rest rotation, and complete rest. Grazing may occur throughout the year our management needs dictate. Where applicable, a rotation schedule using multiple grazing units is used to manage intensity.

Fencing and controlling livestock is the responsibility of the cooperating rancher. We provide instruction and guidance in the special use permit for the placement of fences, water tanks, and livestock supplements to make sure that sensitive habitats and refuge assets are protected. A temporary electric fence is used where there is not an existing fence. Current forage conditions, habitat objectives, and available water would determine stocking rates in each grazing unit.

This draft CCP proposes to continue using prescriptive livestock grazing to meet habitat objectives. Furthermore, the draft CCP establishes goals and objectives for specific habitat types where prescriptive livestock grazing may be used. In addition, the Service has identified focal wildlife species and their habitat needs, which has resulted in objectives that would guide the prescriptive grazing program to achieve the habitat needs of these species while helping many others. The refuge would improve the monitoring and research programs for vegetation to assess habitat responses to prescriptive livestock grazing. Different grazing rates and management strategies would be investigated to decide on the best methods for meeting habitat goals and objectives.

Availability of Resources

Existing resources would be sufficient to administer the farming, haying, and grazing programs at current levels. These programs would continue to be conducted through special use permits or cooperative farming agreements, which decrease the need for staff time and our assets to complete the work. A refuge biologist would be needed to plan and oversee monitoring and research programs to assess the effects and effectiveness of these management programs. One or two temporary biological technicians likely will be necessary to help with on-the-ground monitoring programs.

Rehabilitation of existing stock water wells and the drilling of more wells in strategic locations would increase the effectiveness of the grazing program by spreading out grazing use and reducing the effects

caused by livestock watering in wetlands and canals and by cooperators hauling water to grazing cells on a daily basis.

Anticipated Effects of the Use

The cooperative farming and haying program and prescriptive livestock grazing program would be used to meet habitat goals and objectives identified in the draft CCP. These programs are intended to support and enhance habitat conditions for the benefit of a wide variety of migratory birds and other wildlife that use the refuge. Minimal negative effects are expected through the use of these tools. Control of invasive plant species through these programs would be a long-term benefit.

Some wildlife disturbance would occur during operation of noisy farming equipment and some animals may be temporarily displaced. Wildlife would receive the short-term benefit of standing crops or stubble for food and shelter and the long-term benefit of having cropland or other poor-quality habitat converted to native prairie plants. In addition, the restoration of cropland to grassland cover would prevent soil erosion, improve water quality, and reduce the need for chemical use.

Some trampling of areas by livestock may occur around watering areas, mineral licks or trees and wood lots. Cattle congregating under the shade of trees would increase invasive cheatgrass establishment. If fences are not kept up, it may be difficult to meet habitat objectives. It is anticipated that grazing would be in a mosaic pattern, with some areas being more intensively grazed than others in certain years. Grazing, like fire, is known to increase the nutrient cycling of nitrogen and phosphorous (Hauer and Spencer 1998, McEachern et al. 2000). Hoof action may improve conditions to allow native plant seeds to become established. However, cattle grazing would also increase the risk of invasive plants getting established. Grazing in the spring could have adverse effects on grassland bird nests because of trampling and the loss of vegetation. In addition, the presence of livestock would be disturbing to some wildlife species and some visitors. The long-term benefits of this habitat management tool should outweigh the short-term negative effects.

Determination

Cooperative farming, haying, and grazing as habitat management tools would be compatible uses on the Quivira Refuge.

Stipulations Necessary to Make Sure that There is Compatibility

For consistency with management objectives, we would require general, and specific conditions, for each farming, haying, or grazing permit.

Only areas that have a prior crop history would be included in the farming and haying program. To decrease effects to nesting birds and other wildlife, the refuge manager would decide on, and incorporate, any needed timing constraints on the permitted activity into the cooperative farming agreement or special use permit. For example, haying would not be permitted on our lands until after August 1 to avoid destroying bird nests on the management unit unless the refuge manager deems it necessary to hay earlier to control invasive plants or restore grasslands.

The cooperative farming agreement or special use permit would specify the type of crop to be planted. Farming permittees would be required to use our approved chemicals that are less detrimental to wildlife and the environment.

Control and confinement of livestock are the responsibility of the permittee, but we would decide where fences, water tanks, and livestock supplements would be placed within the management unit. Temporary electric fence would be used to keep livestock within grazing cells as well as to protect sensitive habitat areas and refuge assets such as water control structures or public use areas. Cooperators would be required to remove fences at the end of the permit.

Grazing fees would be based on the current-year USDA Statistics Board publication for Grazing Fee Rates for Cattle by Selected States and Regions, as provided annually by the regional office, or would be established by bid. Standard deductions for labor associated with the grazing permit would be included on the special use permit.

The refuge would carry out a vegetation monitoring program to assess if habitat needs of focal species are being met. A minimum of one temporary biological technician would be necessary to check and document these activities. A biologist would be necessary to plan and oversee the monitoring program and to assess the effects of these management programs.

Justification

Some habitat management needs to occur to keep and enhance habitat for migratory birds and other wildlife. When properly managed and checked, prescriptive farming and haying are options that can be used to improve wildlife cover and to restore disturbed habitats to desirable grassland cover. Prescriptive livestock grazing can rejuvenate native grasses and help control the spread of some invasive

plant species. Each of these tools can be controlled, and the results would be watched closely, as with vegetation monitoring programs, so that adjustments can be made to meet habitat goals and objectives.

Using local cooperators to accomplish the work is a cost-effective method to accomplish the habitat objectives. The long-term benefits of habitat restoration and management far outweigh the short-term effects caused by cooperative farming, haying, and grazing.

Mandatory 10-year Reevaluation Date: 2023

Commercial Filming, Audio Recording, and Still Photography

Commercial filming is the digital, or film, recording of a visual image or of a sound—and commercial still photography is the capture of a still image on film or in a digital format—by a person, business, or other entity for a market audience such as for a documentary, television, feature film, advertisement, or similar project. It does not include news coverage or visitor use.

Quivira Refuge provides tremendous opportunities for commercial filming and still photography of migratory birds and other wildlife. Each year, the refuge staff receives requests to conduct commercial filming or photography on our lands. Our staff would continue to evaluate each request on an individual basis, and, if the use is allowed, the requesting individual or group would be issued a special use permit. The permit would designate what areas may be accessed and what activities are, and are not, allowed, to decrease the possibility of damage to cultural or natural resources or to limit interference with other visitors.

Permittees would be able to access all areas of the refuge that are open to the public and must abide by all public use regulations. In rare cases, and through the special use permit process, we may allow access to areas closed to the public.

Availability of Resources

The commercial filming, audio recording, and still photography uses could be administered with current resources. Administrative costs for review of applications, issuance of special use permits, and staff time to conduct compliance checks may be offset

by a fee system designated for the agencies within the DOI.

Anticipated Effects of Use

Wildlife filmmakers and photographers tend to create the greatest disturbance of all wildlife observers (Dobb 1998, Klein 1993, Morton 1995). While observers frequently stop to view wildlife, photographers are more likely to approach the animals (Klein 1993). Even a slow approach by photographers tends to cause behavioral consequences with wildlife (Klein 1993). Photographers often remain close to wildlife for extended periods of time in an attempt to habituate the subject to their presence (Dobb 1998). Furthermore, photographers with low-power lenses tend to get much closer to their subjects (Morton 1995). This usually results in increased disturbance to wildlife, as well as habitat, including the trampling of plants. Handling of animals and disturbing cultural artifacts or vegetation, such as cutting plants and removing flowers, is prohibited on our lands.

The issuance of special use permits with strict guidelines and close checking by our refuge staff for compliance could help decrease or avoid these effects. Permittees who do not follow the stipulations of their special use permits could have their permits revoked, and further applications for filming or photographing on refuge lands would be denied.

Determination

Commercial filming, audio recording, and still photography would be compatible uses on Quivira Refuge.

Stipulations Necessary to Make Sure that There is Compatibility

Commercial filming or still photography must (1) show a means to extend public appreciation and understanding of wildlife or natural habitats; (2) enhance education, appreciation, and understanding of the Refuge System; or (3) facilitate the outreach and education goals of the refuge. Failure to show any of these criteria would result in a special use permit being denied.

All commercial filming would require a special use permit that would (1) name conditions that protect the refuge's values, purposes, resources, and public health and safety and (2) prevent unreasonable disruption of the public's use and enjoyment of the refuge. Such conditions may be, but are not limited to, specifying road conditions when access would not be allowed, establishing time limitations, and finding routes of access. These conditions would be identified

to prevent excessive disturbance to wildlife, damage to habitat or refuge infrastructure, or conflicts with other visitor services or management activities.

The special use permit would stipulate that imagery produced on refuge lands would be made available for use in environmental education and interpretation, outreach, internal documents, or other suitable uses. In addition, any commercial products must include credits to the Quivira National Wildlife Refuge, the National Wildlife Refuge System, and the U.S. Fish and Wildlife Service.

Still photography requires a special use permit, with specific conditions as outlined above, if one or more of the following would occur:

- It takes place at locations where, or when, members of the public are not allowed.
- It uses models, sets, or props that are not part of the location's natural or cultural resources or administrative facilities.
- We would incur more administrative costs to check the activity.
- We would need to provide management and oversight to avoid the impairment of the resources and values of the site, limit resource damage, or to decrease health and safety risks to the visiting public.
- The photographer intends to intentionally manipulate vegetation to create a shot, such as cutting vegetation to create a blind.

To decrease the effect on our lands and resources, our refuge staff would make sure that all commercial filmmakers and commercial still photographers, regardless of whether or not a special use permit is issued, comply with policies, rules, and regulations. Our staff would check and assess the activities of all filmmakers, audio recorders, and still photographers.

Justification

Commercial filming, audio recording, and still photography are economic uses that must contribute to the achievement of the refuge purposes, the mission of the Refuge System, or the mission of the USFWS. Providing opportunities for these uses should result in increased public awareness of the refuge's ecological importance as well as in advancing the public's knowledge and support for the Refuge System and the Service. The stipulations outlined above and conditions imposed in the special use permits issued to commercial filmmakers, audio record-

ers, and still photographers would make sure that these wildlife-dependent activities occur with minimal adverse effects to resources or visitors.

Mandatory 10-year reevaluation date: 2023

Research and Monitoring

The Quivira Refuge receives 5 to 10 requests each year to conduct scientific research or monitoring programs on our lands. Priority is given to studies that contribute to the enhancement, protection, preservation, and management of the refuge's native plant, fish, and wildlife populations and their habitats. Applicants who are not employees of ours must submit a proposal that outlines the following:

- objectives of the study
- justification for the study
- detailed method and schedule
- potential effects on wildlife and habitat including short- and long-term disturbance, injury, or mortality
- description of measures the researcher would take to reduce disturbances or effects
- staff required and their qualifications and experience
- status of necessary permits, such as scientific collection permits and endangered species permits
- costs to the Service, including staff time requested, if any
- anticipated progress reports and end products, such as reports or publications

Our refuge staff or others would review research proposals case by case and issue special use permits if approved. Criteria for evaluation would include, but would not be limited to, the following:

- Research that would contribute to specific refuge management issues would be given higher priority over other requests.

- Research that would conflict with other ongoing research, monitoring programs, or management programs would not be approved.
- Research that would cause undue disturbance or would be intrusive would likely not be approved. The degree and type of disturbance would be carefully weighed when evaluating a research request.
- Proposals would be evaluated to decide if any effort was made to decrease disturbance through study design, including adjusting the location, timing, number of permittees, study methods, and the number of study sites.
- The length of the project would be considered, and agreed on, before approval.
- Research proposals involving threatened and endangered species would require concurrence and Section 7 Endangered Species Act review before approval.

Availability of Resources

Current resources would be adequate to administer research and monitoring programs on a limited basis. A refuge biologist would be necessary to administer large and long-term projects, which generally require more indepth evaluation of applications, management of permits, and oversight of research projects. The biologist would name research and monitoring needs and work with our other staff, universities, and scientists to develop studies that would help the refuge and address the goals and objectives in this draft CCP.

Anticipated Effects of Use

Some degree of disturbance would be expected with all research activities because researchers may use our roads or enter areas that are closed to the public. In addition, some research may require the collection of samples or the handling of wildlife. However, research studies would be expected to minimally affect wildlife and habitats because special use permits would include conditions on their effects.

Determination

Research and monitoring would be compatible uses on Quivira Refuge.

Stipulations Necessary to Make Sure that There is Compatibility

Extremely sensitive wildlife habitats and species would be sufficiently protected from disturbance by limiting research activities in these areas. All refuge rules and regulations would be followed unless otherwise exempted by our refuge management. Projects would be reviewed annually.

Our refuge staff would use the above criteria for evaluating and determining whether to approve a proposed study. If research methods were found to have potential effects on habitat or wildlife, it must be shown that the research is necessary for the conservation management of resources on the refuge. Measures to decrease potential effects would need to be developed and included as part of the study design; these measures would be conditions on the special use permit.

Our refuge staff would watch research activities for compliance with conditions of the special use permit. At any time, staff may accompany the researchers to look for potential effects. They may find that research that was approved for special use permits before is terminated because of observed effects. Our refuge manager would also have the ability to cancel a special use permit if the researcher was out of compliance or for wildlife and habitat protection.

Justification

Potential effects of research activities on refuge resources would be decreased through restrictions included as part of the study design, and research activities would be checked by our refuge staff. Results of research projects would contribute to the understanding, enhancement, protection, preservation, and management of the refuge's wildlife populations and their habitats.

Mandatory 10-year reevaluation date: 2023

Dog Training

Dog training during the nonnesting season by noncommercial dog owners is an existing use at Quivira Refuge. The use of dogs for hunting is encouraged. Depending on future demand and conflicts, dog training on the refuge may require a special use permit.

Availability of Resources

Sufficient staff exists to issue the required permits, and oversee this periodic use. Facilities and staff are now available to provide access, support roads, parking lots, and secondary access roads.

Anticipated Effects of Use

There would be minimal disturbance to wildlife as a result of the activity, and effects would be temporary.

Public Review and Comment

This compatibility determination is presented for public review and comment as part of the 30-day public comment period for the draft comprehensive conservation plan and environmental assessment for the Quivira National Wildlife Refuge.

Determination

Dog training would be a compatible use on the Quivira National Wildlife Refuge.

Stipulations Necessary to Make Sure that There is Compatibility

- Depending on future demand and conflicts, dog training on the refuge may require a special use permit.
- Immediately before training activity, trainers must check in with refuge staff at the headquarters for permitted opportunities to decrease disturbances to wildlife and other public uses and to maximize trainer safety.
- Training would be allowed when most bird breeding activities do not occur: September 1–March 1.
- Training would only be allowed in wetland areas along public use roads and where disturbance to wildlife can be decreased. For instance, we would encourage the use of wetland areas that do not provide foraging or resting habitat for waterbirds at that time.
- Training would not be allowed in the Kids' Fishing Pond area.

- Training would use areas in a way that avoids or decreases unwanted, direct interactions with visitors, such as with those who are allergic or uncomfortable with dogs. Training would also use areas in a way that decreases potential conflict with visitor use activities that may be occurring in the area before training activities begin.
- Only artificial props, such as canvas or plastic dummies, may be used in training.

Justification

This activity encourages people to get outside and promotes quality and responsible hunting and the appreciation of natural resources. There is little other public land available, particularly during the non-nesting season when hunting is allowed. Use of private land with water for training dogs is difficult to find, as most is either cropland or rangeland. Most adjacent land is private farm ground that is not available to the public for this activity. The use is proposed only for individuals doing noncommercial dog training. Commercial dog training would not be allowed because of the overwhelming demand and its potential for too many dogs, trainers and vehicles on the refuge. Dog training may occur with minimal, temporary disturbance, and no permanent effect to the refuge is anticipated. The use will not materially detract from the National Wildlife Refuge System mission or purposes of the refuge.

Mandatory 10-year Reevaluation Date: 2023

Firewood Cutting

Firewood cutting would be a new use at Quivira Refuge. Firewood cutting would be an economic use of the refuge's natural resources. The use would facilitate and aid with habitat management and grassland restoration through the removal of undesirable invasive woody vegetation. The public would be permitted to cut and collect firewood on the refuge. The timber could either be removed as cut wood or as whole trees. The public would acquire a permit and a map with designated areas on the refuge to cut firewood. Unlimited permits would be available with a \$25 annual fee. The public would be allowed to remove only trees that have been marked for removal, that had been chemically treated earlier by refuge staff, or that are dead timber. All cutting

would be required to be at ground level. Access would be limited to areas along roads and trails to prevent habitat destruction and wildlife disturbance.

The use would occur potentially on all wooded upland and partially wooded upland acres of the refuge, totaling approximately 15,000 acres. Specific areas would be chosen by the refuge manager to not interfere with habitat management or threatened and endangered species, and areas on the refuge would not be open to firewood cutting when threatened or endangered species are present. Affected wildlife could include deer, small mammals, raptors such as bald and golden eagles and various hawks, upland gamebirds, quail and pheasants, and other upland migratory birds. Migratory waterfowl using the wetlands and marshes of the refuge might also be affected.

Firewood cutting would be permitted from August 1 to April 30 to prevent effects to migrating bird nesting. Firewood cutting would be permitted seven days a week from sunrise to sunset. Areas would be designated by the refuge manager and subject to closure at any time. Firewood cutting would not be permitted during periods of fire danger reaching red flag warnings as issued by the National Weather Service.

The public would be required to obtain a special use permit. Power chainsaws, handsaws, or axes would be the only means permitted to cut trees and firewood. All permittees would be required to have spark arrestors on power chainsaws and have a shovel or fire extinguisher available to aid with extinguishing fire. The public would be permitted to pull trailers or vehicles on established roads, trails, and designated areas with refuge manager approval with exact locations stated on permit and map. All firewood and equipment would be removed daily.

The use would facilitate and aid with habitat management and grassland restoration by removing undesirable invasive woody vegetation. Removal of invasive tree species would prevent further seed distribution, reduce fuel load, restore native prairie, clean up fallen and cut tree piles, and provide an economic benefit to the public. Most adjacent land is private farm ground that is not available to the public.

Availability of Resources

- Resources involved in the administration and management of the use: minimal administrative costs for the issuance of permits and maps.

- Special equipment, facilities, or improvements necessary to support the use: none.
- Maintenance costs: held to a minimum. Expected costs include installing signs when necessary to inform the public on temporary closures.
- Monitoring costs: held to a minimum. Expected costs include 1–2 hours per week by the refuge manager to monitor the woodcutting progress and potential wildlife disturbance. Monitoring would be done while conducting routine management monitoring. Refuge Law Enforcement officer could spend three to four hours per week monitoring illegal activity or noncompliance with the special use permits. This activity would be done while conducting routine refuge law enforcement.
- Offsetting revenues: an annual fee of \$25 would be assessed for a special use permit to cover administrative costs and maps.

Anticipated Effects of Use

- Short-term effects: the use would support the refuge mission by restoring grassland acres, increasing the nesting habitat of migratory grassland species, reducing invasive tree species, reducing hazardous fuel, and reducing labor hours and equipment use for mechanical tree removal resulting in cost savings for the Service. Through the management of the activity, negative direct or indirect effects would be reduced. The disturbance activity would not be any greater than what would be conducted by refuge staff conducting the same activity. Short term activity may increase as the public learns about the availability of firewood.
- Long-term effects: the use would be applied primarily in the short term, 3–10 years, until invasive tree populations have been eradicated or are at manageable levels. The duration and frequency of firewood cutting would be reduced over time and may be phased out completely. Long-term beneficial effects would include increasing the nesting habitat for migratory grassland species, controlling invasive tree species, and increasing native plant diversity.

- Cumulative effects: the use would provide beneficial effects by increasing nesting habitat of migratory grassland species, eradicating invasive tree species, and increasing native plant diversity. The combustion of the wood would be required to allow for restoration of the native plant communities on the Refuge. The activity of burning the wood can either be performed by the Refuge or by the public. The benefit of allowing the public to cut and use the firewood would help reduce the amount of petroleum products required to heat their homes.

Determination

Firewood cutting would be a compatible use on Quivira Refuge.

Stipulations Necessary to Make Sure that There is Compatibility

Refuge staff would mark trees or spray trees in designated areas before firewood cutting. The refuge manager would monitor the use and close areas during red flag fire danger, when threatened or endangered species are present, or when it would interfere with management activities such as grazing or prescribed fire. Woodcutting equipment would be limited to power chainsaws with spark arrestors, axes, and hand saws. Heavy equipment and tractors owned by the public would not be permitted to aid with firewood cutting. Monitoring the activity would be performed by refuge staff on a regular basis. Law enforcement staff would visit sites regularly during routine patrols to monitor that activities are conducted within special use permit guidelines and refuge regulations.

Justification

Firewood cutting would help us reach and meet the overall goal of managing habitat for migratory birds. It would aid refuge staff and provide a cost savings to the Government by reducing labor, equipment, and fuel costs to remove trees. It would help reduce hazardous fuel and fuel load to help prevent or manage wildfires. By managing locations, firewood cutting would not interfere with other wildlife-dependent uses. Temporary disturbance of the

wooded areas may cause minimal disturbance to wildlife in the area but would be necessary to increase quality habitat for migratory birds and other refuge species. It would help promote diverse grass stands, may increase water reserves on the refuge through tree reduction, and provide enhanced nesting habitat for upland birds.

**Mandatory 10-year reevaluation date:
2023**

D.7 Signatures

Submitted by:

Michael Oldham, Project Leader
Quivira National Wildlife Refuge
Stafford, Kansas

Date

Reviewed by:

Barbara Boyle, Refuge Supervisor
U.S. Fish and Wildlife Service, Region 6
National Wildlife Refuge System
Lakewood, Colorado

Date

Approved by:

Matt Hogan, Assistant Regional Director
U.S. Fish and Wildlife Service, Region 6
National Wildlife Refuge System
Lakewood, Colorado

Date

Appendix E

Grassland Fragmentation Assessment

To figure out the optimal distribution and area of grasslands on Quivira National Wildlife Refuge, a quantitative analysis comparing the benefits of current versus potential future grassland area and distribution was conducted on refuge lands and private lands within 2 miles of the refuge boundary using GIS. The analysis was based on the spatial needs of area-sensitive grassland birds reported in the literature and the digital NVCS map of the refuge. Species considered in the analysis are known to occur on the refuge and included upland sandpiper, grasshopper sparrow, bobolink, western meadowlark, and dickcissel (Helzer and Jelinski 1999). It is assumed that meeting the area needs of these species also would result in sufficient area to support other grassland-dependent birds. Further, similar landscape factors such as connectedness (tree cover), road density, and isolation, have been shown to affect certain wetland birds as well (Whited et al. 2000). To assess current benefits, three separate maps were created from the 2008 NVCS data: (1) a coverage of suitable breeding habitats that included all NVCS associations dominated by upland and facultative upland grasses, including areas that now support plum that could be removed by management; (2) neutral habitats that do not provide suitable habitat but are not avoided, which included areas dominated by saltgrass and sedge meadows; and (3) hostile habitats that species avoid, which included trees, roads, croplands, buildings, wetlands greater than 437.45 yards (400 meters) wide, and tall dense plum stands that are expected to persist on the refuge. Roads and trees were buffered by 54.68 yards (50 meters) to account for edge effects (nest parasitism and predation) that negatively affect breeding success (Johnson and Temple 1990, Winter et al. 2000, Herkert et al. 2003). The 54.68-yard (50-meter) buffer may actually be conservative as edge and patch effects vary temporally, spatially, and among species (Bakker et al. 2002; Winter et al. 2006a, 2006b) and some research suggest greater buffer distances (Bollinger and Gavin 2004). The maps of suitable and neutral habitats were combined and intersected with the hostile habitat map to find the area and perimeter-to-area ratio of individual grassland tracts (patches, for example). These metrics were compared to those reported for area-sensitive species to determine the suitability of individual patches.

To determine potential future benefits, the same analysis was conducted with the exception that the planning team identified hostile habitats that could be realistically restored to increase the area of suitable grassland habitat. Treed areas and cropland were the only habitats that met this criterion. County roads and existing buildings could not be removed because of legal and budgetary constraints, respectively, and wetlands greater than 437.45 yards (400 meters) wide and tall dense plum stands could not be removed because they provide important habitats for other species and could not be restored to grasslands. A 54.68-yard (50-meter) buffer was placed around those features that could not be removed or restored, and all trees and agricultural fields that did not occur within the buffer area were removed from the map of hostile habitats. Trees within the buffer were kept because removal would not increase the area of grassland habitat. In addition, treed areas on the perimeter of the refuge were evaluated relative to adjacent habitats on private lands. Treed areas on the refuge that extended onto private land were kept because removal would not substantially increase area of grassland tracts; all other perimeter woody vegetation was removed. A map of historical vegetation that was developed based on ecological site descriptions and historical botanical information (Heitmeyer et al. 2012) was used to assign new habitat types to treed areas and croplands that were slated for removal. These habitat types were then reclassified as either suitable or neutral before the analysis.

The results of the current habitat analysis show the refuge has 41 patches of suitable or neutral habitat that encompass 9,770 acres (44 percent) of grassland. Of these, 11 patches are of sufficient size and have suitable perimeter-to-area ratios necessary to support the area-sensitive species based on measures used in the analysis. However, the composition of most suitable patches are dominated (less than 50 percent) by neutral habitat, suggesting that suitable breeding habitat may be limited within these patches. For example, some patches considered to be of suitable size were dominated by saltgrass, which does not provide the plant height or litter depth necessary for nesting species in the analysis.

In comparison, the analysis of potential future habitats shows appropriate management could dra-

matically improve grassland habitats for area-sensitive grassland species and, therefore, other grassland-dependent birds. Restoration of designated treed areas (about 850 acres) and agricultural fields (about 866 acres) to historical habitat types would result in 12 grassland patches, 9 of which would be more than 500 acres and 6 more than 1,000 acres with lower perimeter-to-area ratios (less edge) that exceed the needs for the species considered in the analysis. Furthermore, 5 of the 6 patches that are greater than 1,000 acres would have more than 50 percent of the habitat area suitable for breeding grassland birds.

E.1 Current Conditions: 54.68-Yard Analysis

Black areas in figure 22 are hostile to grassland birds, as defined by: area within 54.68 yards (50 meters) of all tress, agricultural fields, primary roads, wetlands greater than 437.45 yards (400 meters) across, and plum stands not expected to change because of various management constraints. Total acres are 9,770, or about 44 percent of the refuge.

Current suitable habitat for grassland birds includes: grasslands, including meadows and sandhills, and plum. Total acres are 5,633, or about 25 percent of the refuge.

Current nonsuitable habitat for grassland birds includes tall emergents, saltgrass, water, salt flats and bare areas, secondary roads, and prairie dog towns. Total acres are 6,739, or about 30 percent of the refuge.

Black areas in figure 22 are hostile to grassland birds, as defined by: area within 54.68 yards (50 meters) around remaining trees, primary roads, wetlands greater than 437.45 yards (400 meters) across, and plum stands not expected to change because of various management constraints. Total acres are 4,138, or about 18.6 percent of the refuge.

Future, suitable, habitat for grassland birds by removing trees and restoring agricultural fields totals 9,780 acres, or about 40 percent of the refuge.

Current nonsuitable habitat for grassland birds includes: tall emergents, saltgrass, water salt flats and bare areas, secondary roads, and prairie dog towns. Total acres are 8,222, or about 37 percent of the refuge.

E.3 Current Conditions: 54.68-Yard Analysis of Patches Greater Than 1 Acre

Current patches of nonhostile habitats were created by dissolving features labeled as suitable or nonsuitable. Forty one patches greater than one acre are shown on figure 23. Perimeter-to-area ratios were computed for each patch. White space is area hostile to grassland birds.

E.4 Future Conditions: 54.68-Yard Analysis of Patches Greater Than 1 Acre

Future patches of nonhostile habitats were created by dissolving features labeled as suitable or nonsuitable. Patches were expanded from current conditions by restoring agricultural fields and removing most, but not all, trees. The result is twelve patches greater than one acre. Perimeter-to-area ratios were computed for each patch. White space is remaining area hostile to grassland birds.

E.5 Summary

If we choose to remove 850 acres of trees and restore 886 acres of agricultural fields to native habitats at Quivira Refuge over the next 15 years, the resulting gain in suitable grassland bird habitat would be approximately 4,163 acres—3,845 acres of grassland and 318 acres of plum. We propose to leave 125 acres of trees in 13 patches ranging in size from less than 1 acre to 21 acres.

Even after restoration activities, approximately 19 percent of the refuge would remain hostile to grassland birds, primarily because of the Big Salt Marsh, the Little Salt Marsh, and the presence of primary roads, which would not change.

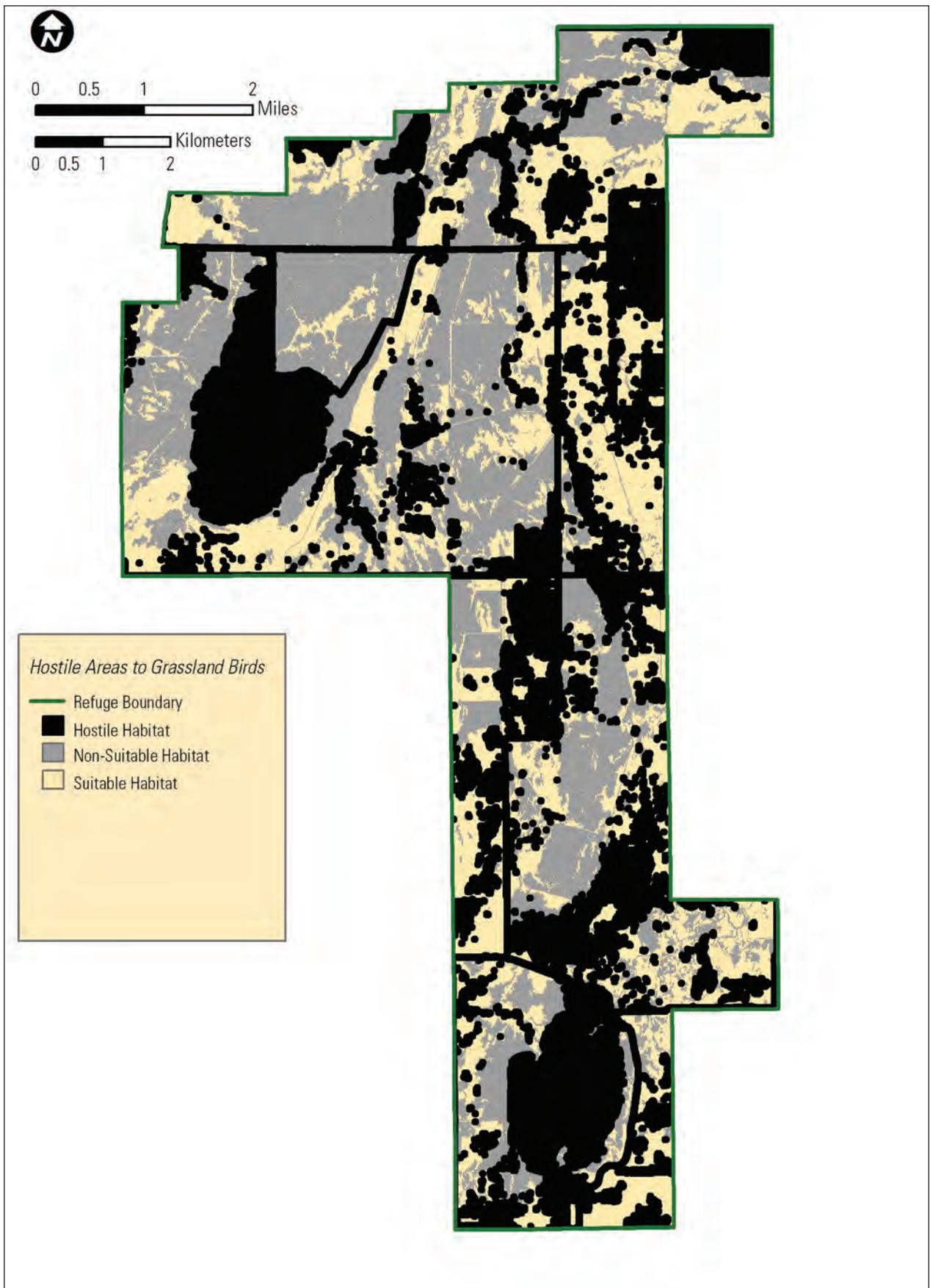


Figure 21. Current grassland conditions at Quivira National Wildlife Refuge, Kansas.

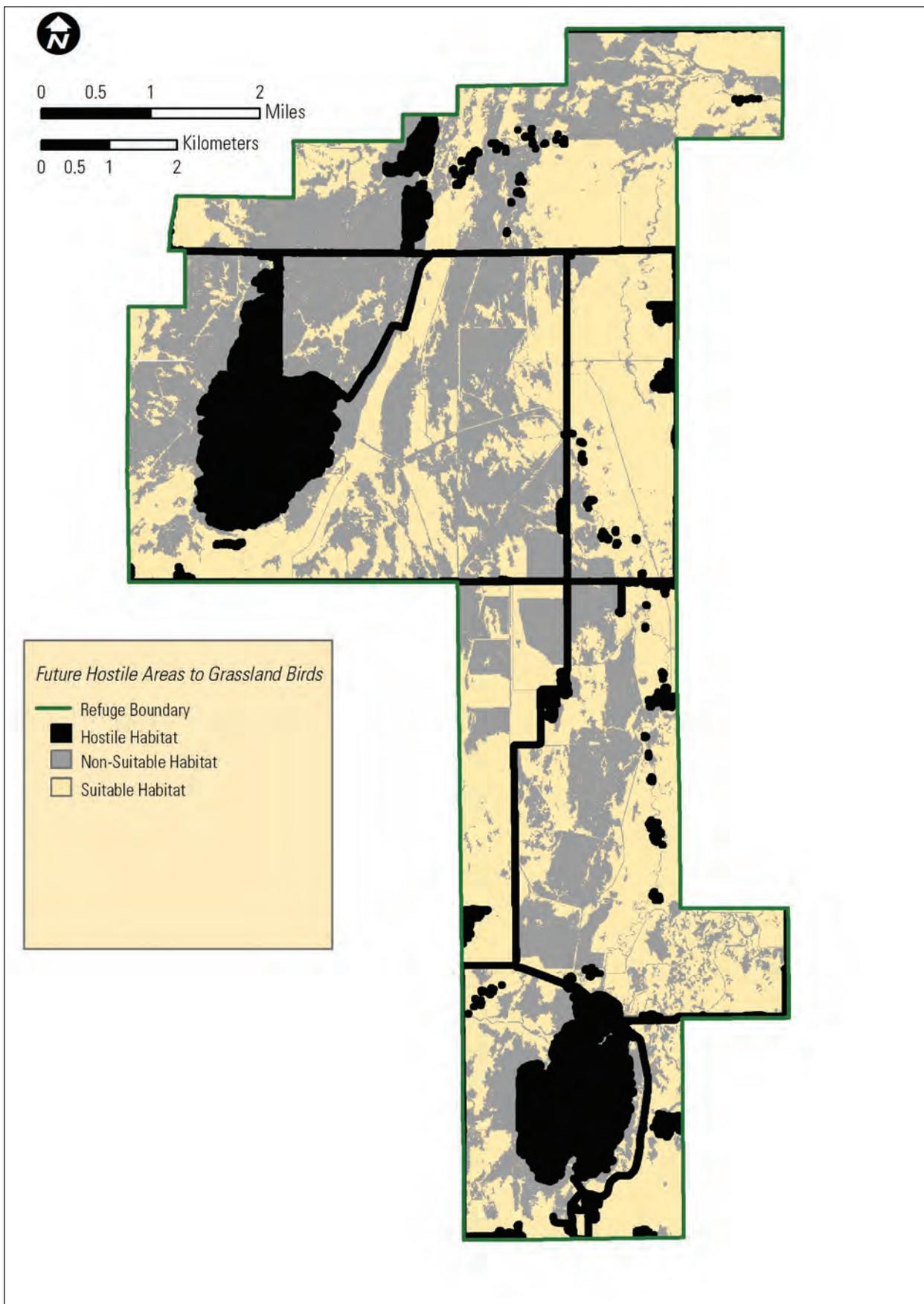


Figure 22. Future grassland conditions at Quivira National Wildlife Refuge, Kansas.

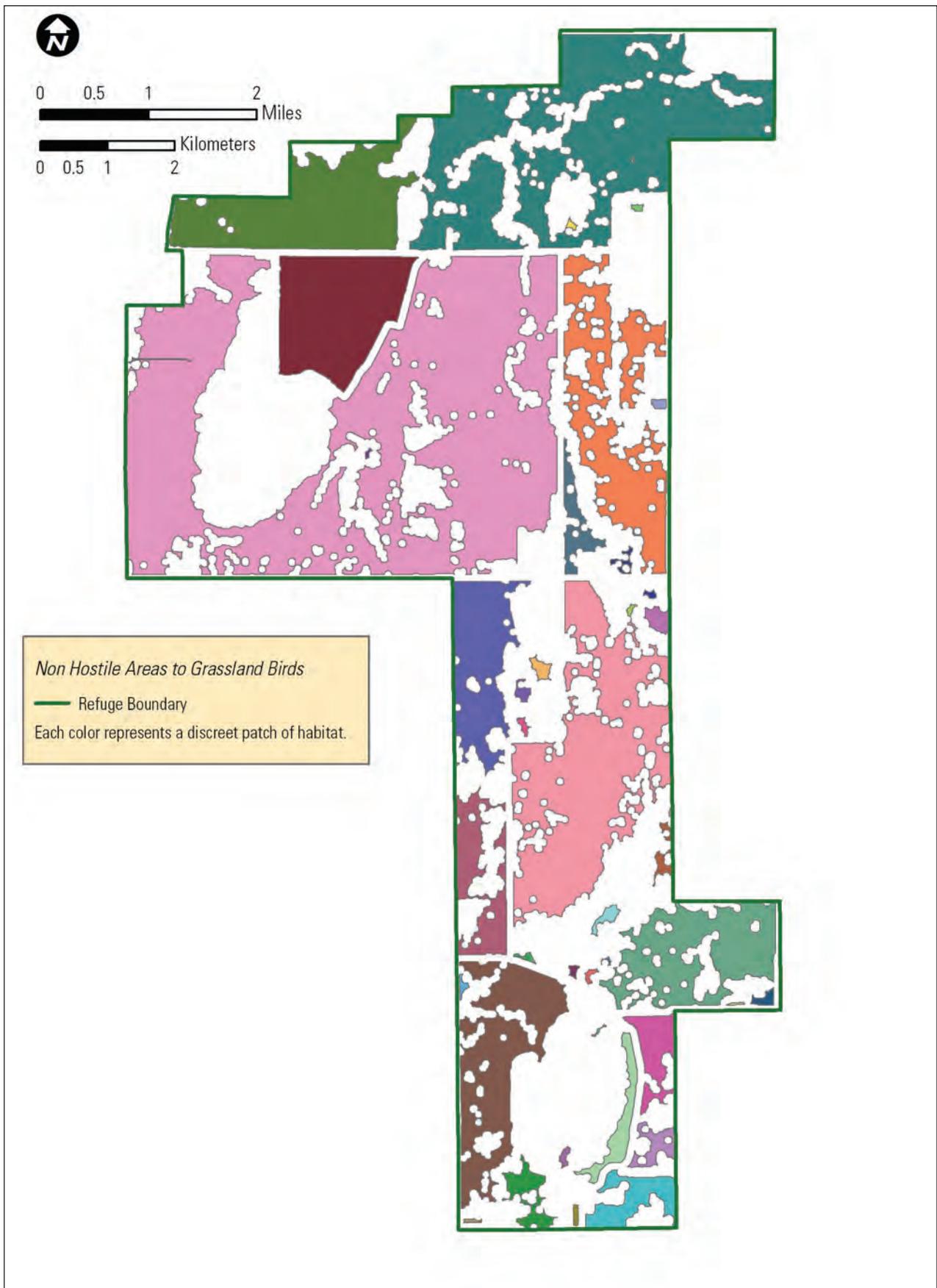


Figure 23. Current nonhostile grassland conditions at Quivira National Wildlife Refuge, Kansas.

Appendix F

Species Lists

This appendix contains the common and scientific names of animals and plants of the Quivira National Wildlife Refuge.

F.1 List of Bird Species

These are the bird species found on Quivira Refuge.

Common name	Scientific name	Spring March– May	Summer June– August	Fall September– November	Winter December– February
Ducks, Geese, and Swans					
Black-bellied Whistling-Duck	<i>Dendrocygna autumnalis</i>		accidental		
Fulvous Whistling-Duck	<i>Dendrocygna bicolor</i>		accidental		
Greater White-fronted Goose	<i>Anser albifrons</i>	common	rare	common	common
Snow Goose	<i>Chen caerulescens</i>	common	rare	common	common
Ross's Goose	<i>Chen rossii</i>	uncommon		uncommon	uncommon
Brant	<i>Branta bernicla</i>	accidental			
Cackling Goose	<i>Branta hutchinsii</i>	common	rare	common	common
Canada Goose*	<i>Branta canadensis</i>	common	common	common	common
Trumpeter Swan	<i>Cygnus buccinator</i>	occasional		occasional	occasional
Tundra Swan	<i>Cygnus columbianus</i>	occasional		occasional	occasional
Wood Duck*	<i>Aix sponsa</i>	common	common	common	occasional
Gadwall*	<i>Anas strepera</i>	common	uncommon	common	occasional
Eurasian Wigeon	<i>Anas penelope</i>	accidental			
American Wigeon*	<i>Anas americana</i>	common	uncommon	common	occasional
American Black Duck	<i>Anas rubripes</i>	rare	rare	rare	rare
Mallard*	<i>Anas platyrhynchos</i>	common	common	common	common
Mottled Duck	<i>Anas fulvigula</i>	rare	rare	rare	
Blue-winged Teal*	<i>Anas discors</i>	common	common	common	
Cinnamon Teal	<i>Anas cyanoptera</i>	uncommon	rare	occasional	rare
Northern Shoveler*	<i>Anas clypeata</i>	common	uncommon	common	uncommon
Northern Pintail*	<i>Anas acuta</i>	common	uncommon	common	common
Green-winged Teal*	<i>Anas crecca</i>	common	occasional	common	uncommon
Canvasback*	<i>Aythya valisineria</i>	common	occasional	common	uncommon
Redhead*	<i>Aythya americana</i>	common	occasional	common	uncommon
Ring-necked Duck	<i>Aythya collaris</i>	common	occasional	common	uncommon
Greater Scaup	<i>Aythya marila</i>	occasional		occasional	occasional
Lesser Scaup*	<i>Aythya affinis</i>	common	occasional	common	uncommon
Surf Scoter	<i>Melanitta perspicillata</i>	accidental			

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
White-winged Scoter	<i>Melanitta fusca</i>	accidental			
Black Scoter	<i>Melanitta Americana</i>	accidental			
Long-tailed Duck	<i>Clangula hyemalis</i>	rare		rare	rare
Bufflehead	<i>Bucephala albeola</i>	uncommon		common	common
Common Goldeneye	<i>Bucephala clangula</i>	common		common	common
Barrow's Goldeneye	<i>Bucephala ialandica</i>	accidental			
Hooded Merganser*	<i>Laphodytes cucullatus</i>	uncommon	rare	uncommon	uncommon
Common Merganser	<i>Mergus merganser</i>	uncommon		rare	common
Red-breasted Merganser	<i>Mergus serrator</i>	rare		occasional	rare
Ruddy Duck*	<i>Oxyura jamaicensis</i>	common	uncommon	common	uncommon
Grouse and Quail					
Ring-necked Pheasant*	<i>Phasianus colchicus</i>	common	common	common	common
Greater Prairie-Chicken*	<i>Tympanuchus cupido</i>	rare	rare	rare	rare
Wild Turkey*	<i>Melagris gallopavo</i>	common	common	common	common
Northern Bobwhite*	<i>Colinus virginianus</i>	uncommon	uncommon	uncommon	uncommon
Loons and Grebes					
Common Loon	<i>Gavia immer</i>	occasional	rare	occasional	rare
Pied-billed Grebe*	<i>Podilymbus podiceps</i>	common	common	common	occasional
Horned Grebe	<i>Podiceps auritus</i>	uncommon		uncommon	occasional
Red-necked Grebe	<i>Podiceps grisegena</i>	accidental			
Eared Grebe*	<i>Podiceps nigricollis</i>	common	occasional	common	rare
Western Grebe	<i>Aechmophorus occidentalis</i>	occasional	rare	occasional	rare
Clark's Grebe	<i>Aechmophorus clarkii</i>	accidental			
Pelicans and Miscellaneous					
American Flamingo	<i>Phoenicopterus ruber</i>	accidental			
Neotropic Cormorant	<i>Phalacrocorax brasilianus</i>	occasional	occasional	rare	
Double-crested Cormorant*	<i>Phalacrocorax auritus</i>	common	common	common	occasional
American White Pelican	<i>Pelecanus erythrorhynchos</i>	common	common	common	occasional
Brown Pelican	<i>Pelecanus accidentalis</i>	accidental			
Hérons, Egrets, and Ibis					
American Bittern*	<i>Botaurus lentiginosus</i>	uncommon	uncommon	uncommon	occasional
Least Bittern*	<i>Ixobrychus exilis</i>	occasional	uncommon	occasional	
Great Blue Heron*	<i>Ardea herodias</i>	common	common	common	uncommon
Great Egret*	<i>Ardea alba</i>	common	common	common	
Snowy Egret*	<i>Egretta thula</i>	common	common	common	
Little Blue Heron*	<i>Egretta caerulea</i>	uncommon	uncommon	occasional	
Tricolored Heron*	<i>Egretta tricolor</i>	rare	rare		
Reddish Egret	<i>Egretta rufescens</i>	accidental			
Cattle Egret*	<i>Bubulcus ibis</i>	common	common	common	
Green Heron*	<i>Butorides virescens</i>	uncommon	uncommon	occasional	
Black-crowned Night-Heron*	<i>Nycticorax nycticorax</i>	common	common	common	rare

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
Yellow-crowned Night-Heron*	<i>Nyctanassa violacea</i>	uncommon	uncommon	occasional	
White Ibis	<i>Eudocimus albus</i>	rare	rare		
Glossy Ibis	<i>Plegadis falcinellus</i>	rare	rare	rare	
White-faced Ibis*	<i>Plegadis chihi</i>	common	common	common	rare
Roseate Spoonbill	<i>Platalea ajaja</i>	accidental			
Wood Stork	<i>Mycteria americana</i>	accidental			
Birds of Prey					
Turkey Vulture*	<i>Cathartes aura</i>	uncommon	uncommon	uncommon	
Osprey	<i>Pandion haliaetus</i>	occasional	rare	occasional	
Mississippi Kite*	<i>Ictinia mississippiensis</i>	uncommon	uncommon	occasional	
Bald Eagle*	<i>Haliaeetus leucocephalus</i>	uncommon	uncommon	uncommon	common
Northern Harrier*	<i>Circus cyaneus</i>	common	occasional	common	common
Sharp-shinned Hawk	<i>Accipiter striatus</i>	uncommon		occasional	uncommon
Cooper's Hawk*	<i>Accipiter cooperii</i>	uncommon	occasional	uncommon	uncommon
Northern Goshawk	<i>Accipiter gentilis</i>			rare	rare
Red-shouldered Hawk	<i>Buteo lineatus</i>			rare	
Broad-winged Hawk	<i>Buteo platypterus</i>			rare	
Swainson's Hawk*	<i>Buteo swainsoni</i>	common	common	occasional	
Red-tailed Hawk*	<i>Buteo jamaicensis</i>	common	common	common	common
Ferruginous Hawk	<i>Buteo regalis</i>	occasional		rare	occasional
Rough-legged Hawk	<i>Buteo lagopus</i>	uncommon		rare	uncommon
Golden Eagle	<i>Aquila chrysaetos</i>	occasional		occasional	occasional
American Kestrel*	<i>Falco sparverius</i>	common	uncommon	common	uncommon
Merlin	<i>Falco columbarius</i>	occasional	rare	uncommon	uncommon
Peregrine Falcon	<i>Falco peregrinus</i>	occasional	occasional	occasional	occasional
Prairie Falcon	<i>Falco mexicanus</i>	rare	rare	occasional	occasional
Rails and Cranes					
Yellow Rail	<i>Coturnicops noveboracensis</i>	accidental			
Black Rail*	<i>Laterallus jamailaris</i>	uncommon	uncommon	rare	
King Rail*	<i>Rallus elegans</i>	uncommon	uncommon	rare	rare
Virginia Rail*	<i>Rallus limicola</i>	common	common	uncommon	occasional
Sora*	<i>Prozana carolina</i>	common	uncommon	common	
Common Moorhen*	<i>Gallinula chloropus</i>	uncommon	uncommon	occasional	
American Coot*	<i>Fulica americana</i>	common	common	common	uncommon
Sandhill Crane	<i>Grus canadensis</i>	common		common	occasional
Common Crane	<i>Grus grus</i>	accidental			
Whooping Crane	<i>Grus americana</i>	occasional		occasional	rare
Shorebirds					
Black-bellied Plover	<i>Pluvialis squatarola</i>	uncommon	uncommon	uncommon	rare
American Golden-Plover	<i>Pluvialis dominica</i>	uncommon	occasional	uncommon	
Snowy Plover*	<i>Charadrius alexandrinus</i>	common	common	common	
Wilson's Plover	<i>Charadrius wilsonia</i>	accidental			

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
Semipalmated Plover	<i>Charadrius semipalmatus</i>	common	uncommon	common	
Piping Plover	<i>Charadrius melodus</i>	uncommon	occasional	occasional	
Killdeer*	<i>Charadrius vociferis</i>	common	common	common	occasional
Mountain Plover	<i>Charadrius montanus</i>	rare		rare	
Black-Necked Stilt*	<i>Himantopus mexicanus</i>	common	common	uncommon	
American Avocet*	<i>Recurvirostra americana</i>	common	common	common	
Spotted Sandpiper*	<i>Actitis macularius</i>	common	uncommon	common	
Solitary Sandpiper	<i>Tringa solitaria</i>	uncommon	uncommon	occasional	
Greater Yellowlegs	<i>Tringa melanoleuca</i>	common	common	common	occasional
Willet	<i>Tringa semipalmata</i>	uncommon	uncommon	uncommon	
Lesser Yellowlegs	<i>Tringa flavipes</i>	common	common	common	rare
Upland Sandpiper*	<i>Bartramia longicauda</i>	common	occasional	occasional	
Whimbrel	<i>Numenius phaeopus</i>	occasional	occasional	occasional	
Long-billed Curlew	<i>Numenius americanus</i>	occasional	occasional	occasional	
Hudsonian Godwit	<i>Limosa haemastica</i>	uncommon	rare	uncommon	
Marbled Godwit	<i>Limosa fedoa</i>	uncommon	uncommon	uncommon	
Ruddy Turnstone	<i>Arenaria interpres</i>	occasional	occasional	occasional	
Red Knot	<i>Calidris canutus</i>	rare	rare	rare	
Sanderling	<i>Calidris alba</i>	occasional	occasional	occasional	
Semipalmated Sandpiper	<i>Calidris pusilla</i>	common	common	common	
Western Sandpiper	<i>Calidris mauri</i>	common	common	common	
Least Sandpiper	<i>Calidris minutilla</i>	common	common	common	
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	common	common	uncommon	
Baird's Sandpiper	<i>Calidris bairdii</i>	common	common	common	
Red-necked Stint	<i>Calidris ruficollis</i>	accidental			
Pectoral Sandpiper	<i>Calidris melantos</i>	uncommon	uncommon	uncommon	
Dunlin	<i>Calidris alpina</i>	uncommon	occasional	uncommon	rare
Curlew Sandpiper	<i>Calidris ferruginea</i>	accidental			
Stilt Sandpiper	<i>Calidris himantopus</i>	common	common	common	
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	occasional	rare	uncommon	
Ruff	<i>Philmachus pugnax</i>	rare	rare		
Short-billed Dowitcher	<i>Limnodromus griseus</i>	uncommon	uncommon	occasional	
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	common	common	common	
Wilson's Snipe	<i>Gallinago delicata</i>	uncommon	rare	uncommon	occasional
American Woodcock	<i>Scolopax minor</i>	rare		rare	
Wilson's Phalarope*	<i>Phalaropus tricolor</i>	common	common	common	
Red-necked Phalarope	<i>Phalaropus lobatus</i>	occasional	rare	occasional	
Red Phalarope	<i>Phalaropus fulicarius</i>	rare		rare	
Gulls and Terns					
Black-legged Kittiwake	<i>Rissa tridactyla</i>	accidental			
Sabine's Gull	<i>Xema sabini</i>	rare	rare	rare	
Bonaparte's Gull	<i>Chroicocephalus philadelphia</i>	occasional	rare	occasional	occasional
Laughing Gull	<i>Leucophaeus atricilla</i>	rare	occasional	rare	

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
Franklin's Gull	<i>Leucophaeus pipixcan</i>	common	uncommon	common	rare
Black-headed Gull	<i>Chroicocephalus ridibundus</i>	accidental			
Ring-billed Gull	<i>Larus delawarensis</i>	common	uncommon	common	uncommon
California Gull	<i>Larus californicus</i>	accidental			
Herring Gull	<i>Larus argentatus</i>	occasional		occasional	occasional
Lesser Black-backed Gull	<i>Larus fuscus</i>	accidental			
Least Tern*	<i>Sternula antillarum</i>	uncommon	uncommon	occasional	
Gull-billed Tern	<i>Gelochelidon nilotica</i>	accidental			
Caspian Tern	<i>Hydroprogne caspia</i>	rare	rare	rare	
Black Tern*	<i>Chidonias niger</i>	common	common	uncommon	
Common Tern	<i>Sterna hirundo</i>	occasional	occasional	occasional	
Arctic Tern	<i>Sterna paradisaea</i>	accidental			
Forster's Tern*	<i>Sterna forsteri</i>	common	common	occasional	
Parasitic Jaeger	<i>Stercorarius parasiticus</i>		rare	rare	
Pigeons and Doves					
Rock Pigeon*	<i>Columba livia</i>	rare	rare	rare	rare
Eurasian Collared-Dove*	<i>Streptopelia decaocto</i>	occasional	occasional	occasional	occasional
White-winged Dove	<i>Zenaidura macroura</i>	accidental			
Mourning Dove*	<i>Zenaidura macroura</i>	common	common	common	occasional
Yellow-billed Cuckoo*	<i>Coccyzus americanus</i>	occasional	uncommon	rare	
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	rare	rare		
Greater Roadrunner	<i>Geococcyx californianus</i>	rare	rare	rare	rare
Owls					
Barn Owl*	<i>Tyto alba</i>	occasional	occasional	occasional	occasional
Eastern Screech-Owl*	<i>Megascops asio</i>	uncommon	uncommon	uncommon	uncommon
Great Horned Owl*	<i>Bubo virginianus</i>	common	common	common	common
Snowy Owl	<i>Bubo scandiacus</i>			rare	rare
Burrowing Owl*	<i>Athene cunicularia</i>	rare	rare	rare	
Barred Owl	<i>Strix varia</i>	occasional	occasional	occasional	occasional
Long-eared Owl*	<i>Asio otus</i>	rare	rare	rare	rare
Short-eared Owl*	<i>Asio flammeus</i>	rare		rare	occasional
Northern Saw-whet Owl	<i>Aegolius acadicus</i>	accidental			
Nightjars and Miscellaneous					
Common Nighthawk*	<i>Chordeiles minor</i>	uncommon	common	uncommon	
Common Poor-will	<i>Phalaenoptilus nuttallii</i>	rare	rare		
Chuck-will's-widow*	<i>Caprimulgus carolinensis</i>	occasional	occasional		
Whip-poor-will	<i>Caprimulgus vociferus</i>	accidental			
Chimney Swift*	<i>Chaetura pelagica</i>	uncommon	uncommon	uncommon	
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	occasional	occasional	occasional	
Belted Kingfisher	<i>Megaceryle alcyon</i>	uncommon	uncommon	uncommon	occasional
Woodpeckers					
Red-headed Woodpecker*	<i>Melanerpes erythrocephalus</i>	common	common	common	

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
Red-bellied Woodpecker*	<i>Melanerpes carolines</i>	uncommon	uncommon	uncommon	uncommon
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	rare		rare	rare
Downy Woodpecker*	<i>Picoides pubescens</i>	uncommon	uncommon	uncommon	uncommon
Hairy Woodpecker*	<i>Picoides villosus</i>	uncommon	uncommon	uncommon	uncommon
Northern Flicker*	<i>Colaptes auratus</i>	common	common	common	common
Flycatchers					
Olive-sided Flycatcher	<i>Contopus cooperi</i>	occasional		occasional	
Eastern Wood-Pewee*	<i>Contopus virens</i>	uncommon	uncommon	occasional	
Willow Flycatcher	<i>Empidonax trailli</i>	occasional		occasional	
Least Flycatcher	<i>Empidonax minimus</i>	uncommon		uncommon	
Eastern Phoebe*	<i>Sayornis phoebe</i>	uncommon	uncommon	uncommon	occasional
Say's Phoebe	<i>Sayornis saya</i>	occasional		occasional	
Great Crested Flycatcher*	<i>Myiarchus crinitus</i>	uncommon	uncommon	occasional	
Cassin's Kingbird	<i>Tyrannus vociferans</i>	accidental			
Western Kingbird*	<i>Tyrannus verticalis</i>	common	common	uncommon	
Eastern Kingbird*	<i>Tyrannus tyrannus</i>	common	common	uncommon	
Scissor-tailed Flycatcher*	<i>Tyrannus forficatus</i>	occasional	occasional	occasional	
Shrikes and Vireos					
Loggerhead Shrike*	<i>Lanius ludovicianus</i>	uncommon	uncommon	uncommon	uncommon
Northern Shrike	<i>Lanius excubitor</i>	rare		occasional	occasional
Bell's Vireo*	<i>Vireo bellii</i>	uncommon	uncommon	occasional	
Yellow-throated Vireo	<i>Vireo flavifrons</i>	accidental			
Blue-headed Vireo	<i>Vireo solitarius</i>	accidental			
Warbling Vireo*	<i>Vireo gilvus</i>	uncommon	uncommon	uncommon	
Philadelphia Vireo	<i>Vireo philadelphicus</i>	accidental			
Red-eyed Vireo*	<i>Vireo olivaceus</i>	occasional	occasional	rare	
Corvids					
Blue Jay*	<i>Cyanocitta cristata</i>	common	common	uncommon	occasional
Western Scrub Jay	<i>Aphelocoma californica</i>	accidental			
Black-billed Magpie	<i>Pica hudsonia</i>	rare	rare	rare	rare
American Crow*	<i>Corvus brachyrhynchos</i>	common	occasional	common	occasional
Larks					
Horned Lark*	<i>Eremophila alpestris</i>	occasional	occasional	occasional	occasional
Swallows					
Purple Martin*	<i>Progne subis</i>	occasional	occasional		
Tree Swallow*	<i>Tachycineta bicolor</i>	common	common	uncommon	
Violet-green Swallow	<i>Tachycineta thalassina</i>	accidental			
Northern Rough-winged Swallow*	<i>Stelgidopteryx serripennis</i>	uncommon	occasional	occasional	
Bank Swallow*	<i>Riparia riparia</i>	common	common	uncommon	
Cliff Swallow*	<i>Petrochelidon pyrrhonota</i>	common	common	common	
Barn Swallow*	<i>Hirundo rustica</i>	common	common	common	
Parids, Wrens, and Miscellaneous					

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
Carolina Chickadee	<i>Poecile carolinensis</i>	accidental			
Black-capped Chickadee*	<i>Poecile atricapillus</i>	occasional	occasional	occasional	occasional
Tufted Titmouse	<i>Bacolopus bicolor</i>	rare		occasional	occasional
Red-breasted Nuthatch	<i>Sitta canadensis</i>	rare		rare	rare
White-breasted Nuthatch*	<i>Sitta carolinensis</i>	uncommon	uncommon	uncommon	uncommon
Brown Creeper	<i>Certhia americana</i>	rare		occasional	occasional
Rock Wren	<i>Salpinctes obsoletus</i>	occasional		occasional	
Carolina Wren*	<i>Thryothorus ludovicianus</i>	occasional	occasional	occasional	occasional
Bewick's Wren*	<i>Thryomanes bewickii</i>	rare	rare		
House Wren*	<i>Troglodytes aedon</i>	common	common	uncommon	
Winter Wren	<i>Troglodytes hiemalis</i>	rare		occasional	occasional
Sedge Wren	<i>Cistothorus platensis</i>	occasional	occasional	occasional	
Marsh Wren	<i>Cistothorus palustris</i>	uncommon		uncommon	uncommon
Blue-gray Gnatcatcher*	<i>Polioptila caerulea</i>	uncommon	uncommon	occasional	
Golden-crowned Kinglet	<i>Regulus satrapa</i>	uncommon		uncommon	uncommon
Ruby-crowned Kinglet	<i>Regulus calendula</i>	uncommon		uncommon	occasional
Thrushes, Pipits, Waxwings, and Miscellaneous					
Eastern Bluebird*	<i>Sialia sialis</i>	common	common	common	uncommon
Mountain Bluebird	<i>Sialia currucoides</i>	rare		rare	rare
Townsend's Solitaire	<i>Myadestes townsendi</i>	rare		rare	rare
Veery	<i>Catharus fuscescens</i>	accidental			
Gray-cheeked Thrush	<i>Catharus minimus</i>	accidental			
Swainson's Thrush	<i>Catharus ustulatus</i>	occasional		occasional	
Hermit Thrush	<i>Catharus guttatus</i>	accidental			
Wood Thrush	<i>Hylocichla mustelina</i>	rare			
American Robin*	<i>Turdus migratorius</i>	common	common	common	uncommon
Gray Catbird*	<i>Dumetella carolinensis</i>	common	common	occasional	
Northern Mockingbird*	<i>Mimus polyglottos</i>	occasional	occasional	occasional	occasional
Brown Thrasher*	<i>Toxostoma rufum</i>	common	common	occasional	rare
European Starling*	<i>Sturnus vulgaris</i>	common	common	common	common
American Pipit	<i>Anthus rubescens</i>	uncommon		uncommon	
Sprague's Pipit	<i>Anthus spragueii</i>	rare		rare	
Bohemian Waxwing	<i>Bombycilla garrulus</i>	accidental			
Cedar Waxwing	<i>Bombycilla cedrorum</i>	occasional	occasional	occasional	occasional
Longspurs					
McCown's Longspur	<i>Rhynchophanes mccownii</i>	accidental			
Lapland Longspur	<i>Calcarius lapponicus</i>	rare		occasional	uncommon
Smith's Longspur	<i>Calcarius pictus</i>	accidental			
Chestnut-collared Longspur	<i>Calcarius ornatus</i>	rare			rare
Snow Bunting	<i>Plectrophenax nivalis</i>	accidental			
Wood Warblers					
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	accidental			

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
Tennessee Warbler	<i>Oreothlypis peregrina</i>	occasional			
Orange-crowned Warbler	<i>Oreothlypis celata</i>	uncommon		uncommon	
Nashville Warbler	<i>Oreothlypis ruficapilla</i>	occasional		occasional	
Northern Parula	<i>Parula pitiayumi</i>	accidental			
Yellow Warbler*	<i>Dendroica petechia</i>	uncommon	uncommon	occasional	
Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>	accidental			
Magnolia Warbler	<i>Dendroica magnolia</i>	accidental			
Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	accidental			
Yellow-rumped Warbler	<i>Dendroica coronata</i>	common		common	uncommon
Black-throated Green Warbler	<i>Dendroica virens</i>	rare		rare	
Blackburnian Warbler	<i>Dendroica fusca</i>	accidental			
Palm Warbler	<i>Dendroica palmarum</i>	occasional			
Blackpoll Warbler	<i>Dendroica striata</i>	rare			
Cerulean Warbler	<i>Dendroica cerulea</i>	accidental			
Black-and-White Warbler	<i>Mniotilta varia</i>	rare		rare	
American Redstart	<i>Setophaga ruticilla</i>	occasional		occasional	
Prothonotary Warbler	<i>Protonotaria citrea</i>	accidental			
Worm-eating Warbler	<i>Helmitheros vermivorum</i>	accidental			
Ovenbird	<i>Seiurus aurocapilla</i>	accidental			
Northern Waterthrush	<i>Parkesia novboracensis</i>	occasional			
Mourning Warbler	<i>Oporornis philadelphia</i>	accidental			
MacGillivray's Warbler	<i>Oporornis tolmiei</i>	accidental			
Common Yellowthroat*	<i>Geothypis trichas</i>	common	common	uncommon	occasional
Wilson's Warbler	<i>Wilsonia pusilla</i>	occasional		occasional	
Canada Warbler	<i>Wilsonia canadensis</i>	accidental			
Painted Redstart	<i>Myioborus pictus</i>	accidental			
Yellow-breasted Chat*	<i>Icteria virens</i>	occasional	rare	rare	
Sparrows and Towhees					
Spotted Towhee	<i>Pipilo maculatus</i>	common		common	rare
Eastern Towhee	<i>Pipilo erythrophthalmus</i>	accidental			
Cassin's Sparrow	<i>Peucaea cassinii</i>	rare			
American Tree Sparrow	<i>Spizella arborea</i>	uncommon		common	common
Chipping Sparrow	<i>Spizella passerina</i>	common	rare	common	
Clay-colored Sparrow	<i>Spizella pallida</i>	common		common	
Field Sparrow*	<i>Spizella pusilla</i>	common	uncommon	common	uncommon
Vesper Sparrow	<i>Poocetes gramineus</i>	common	rare	common	
Lark Sparrow*	<i>Chondestes grammacus</i>	common	uncommon	occasional	
Lark Bunting	<i>Calamospiza melanocrys</i>	occasional	rare	occasional	
Savannah Sparrow	<i>Passerculus sandwichensis</i>	common		common	occasional
Grasshopper Sparrow*	<i>Ammodramus savannarum</i>	uncommon	uncommon	uncommon	
Henslow's Sparrow	<i>Ammodramus henslowii</i>	accidental			
Le Conte's Sparrow	<i>Ammodramus leconteii</i>	occasional		occasional	rare

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
Nelson's Sharp-tailed Sparrow	<i>Ammodramus nelsoni</i>	occasional		occasional	
Fox Sparrow	<i>Passerella iliaca</i>	uncommon		uncommon	uncommon
Song Sparrow	<i>Melospiza melodia</i>	common		common	common
Lincoln's Sparrow	<i>Melospiza lincolni</i>	uncommon		uncommon	rare
Swamp Sparrow	<i>Melospiza georgiana</i>	uncommon		uncommon	uncommon
White-throated Sparrow	<i>Zonotrichia albicollis</i>	uncommon		uncommon	occasional
Harris's Sparrow	<i>Zonotrichia querula</i>	common	rare	common	common
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	uncommon		uncommon	occasional
Golden-crowned Sparrow	<i>Zonotrichia atricapilla</i>	accidental			
Dark-eyed Junco	<i>Junco hyemalis</i>	common		common	common
Summer Tanager	<i>Piranga ruba</i>		rare		
Scarlet Tanager	<i>Piranga olivacea</i>	accidental			
Grosbeaks and Buntings					
Northern Cardinal*	<i>Cardinalis cardinalis</i>	uncommon	uncommon	uncommon	uncommon
Pyrrhuloxia	<i>Cardinalis sinuatus</i>	accidental			
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>	occasional			
Black-headed Grosbeak*	<i>Pheucticus melanocephalis</i>	occasional	rare		
Blue Grosbeak*	<i>Passerina caerulea</i>	uncommon	uncommon	rare	
Lazuli Bunting	<i>Passerina amoena</i>	rare			
Indigo Bunting*	<i>Passerina cyanea</i>	uncommon	occasional	rare	
Painted Bunting	<i>Passerina ciris</i>	accidental			
Dickcissel*	<i>Spiza americana</i>	common	common	rare	
Blackbirds and Allies					
Bobolink*	<i>Dolichonyx oryzivorus</i>	uncommon	uncommon		
Red-winged Blackbird*	<i>Agelaius phoeniceus</i>	common	common	common	common
Eastern Meadowlark*	<i>Sturnella magna</i>	common	common	common	common
Western Meadowlark*	<i>Sturnella neglecta</i>	uncommon	occasional	uncommon	common
Yellow-headed Blackbird*	<i>Xanthocephalus xanthocephalus</i>	common	common	uncommon	rare
Rusty Blackbird	<i>Euphagus carolinus</i>	accidental			
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	occasional	occasional	occasional	occasional
Common Grackle*	<i>Quiscalus quiscula</i>	common	occasional	common	occasional
Great-tailed Grackle*	<i>Quiscalus mexicanus</i>	uncommon	uncommon	uncommon	rare
Brown-headed Cowbird*	<i>Molothrus oryzivorus</i>	common	common	uncommon	uncommon
Orchard Oriole*	<i>Icterus spurius</i>	common	common	occasional	
Bullock's Oriole	<i>Icterus bullockii</i>	accidental			
Baltimore Oriole*	<i>Icterus galbula</i>	common	common	occasional	
Finches					
Purple Finch	<i>Carpodacus purpureus</i>	occasional		rare	occasional
House Finch*	<i>Carpodacus mexicanus</i>	occasional	occasional	occasional	occasional
Common Redpoll	<i>Acanthis flammea</i>	accidental			
Pine Siskin	<i>Spinus pinus</i>	occasional		occasional	occasional
American Goldfinch*	<i>Spinus tristis</i>	common	common	common	common

<i>Common name</i>	<i>Scientific name</i>	<i>Spring March– May</i>	<i>Summer June– August</i>	<i>Fall September– November</i>	<i>Winter December– February</i>
Evening Grosbeak	<i>Coccothraustes verpertines</i>	accidental			
House Sparrow*	<i>Passer domesticus</i>	occasional	occasional	occasional	occasional

* Reported nesting on refuge.

NOTE: Abundance is indicated as follows: common (certain to be seen in suitable habitat), uncommon (present, but not certain to be seen), occasional (seen a few times during season), rare (seen every 2–5 years).

F.2 List of Fish Species

These are the fish species found on Quivira Refuge.

<i>Common name</i>	<i>Scientific name</i>
Bass, Largemouth	<i>Micropterus salmoides</i>
Bluegill	<i>Lepomis macrochirus</i>
Bullhead, Black	<i>Ictalurus melas</i>
Bullhead, Yellow	<i>Ictalurus natalis</i>
Carp	<i>Cyrinus carpio</i>
Carp sucker, River	<i>Carpionodes carpio</i>
Catfish, Channel	<i>Ictalurus punctatus</i>
Catfish, Flathead	<i>Pylodictis olivaris</i>
Crappie, Black	<i>Pomoxis nigromaculatus</i>
Crappie, White	<i>Pomoxis annularis</i>
Darter, Arkansas	<i>Etheostoma cragini</i>
Goldfish	<i>Carassius auratus</i>
Killifish, Plains	<i>Fundulus kansae</i>
Minnow, Fathead	<i>Pimephales promelas</i>
Minnow, Plains	<i>Hybognathus placitus</i>
Minnow, Suckermouth	<i>Phenacobius mirabilis</i>
Mosquitofish	<i>Gambusia affinis</i>
Shiner, Red	<i>Notropis lutrensis</i>
Shiner, Sand	<i>Notropis stramineus</i>
Sunfish, Green	<i>Lepomis cyanellus</i>
Sunfish, Orangespotted	<i>Lepomis humilis</i>

F.3 List of Mammal Species

These are the mammal species found on Quivira Refuge.

<i>Common name</i>	<i>Scientific name</i>
Armadillo, Nine-banded	<i>Dasypus novemcinctus</i>
Badger, American	<i>Taxidea taxus</i>
Beaver, American	<i>Castor canadensis</i>
Bobcat	<i>Lynx rufus</i>
Cottontail, Eastern	<i>Sylvilagus floridanus</i>
Coyote	<i>Canis latrans</i>
Deer, Mule	<i>Odocoileus hemionus</i>
Deer, White-tailed	<i>Odocoileus virginianus</i>
Fox, Red	<i>Vulpes vulpes</i>
Gopher, Plains Pocket	<i>Geomys bursarius</i>
Ground Squirrel, Franklin's	<i>Spermophilus franklinii</i>
Ground Squirrel, Thirteen-lined	<i>Spermophilus tridecemlineatus</i>
Jackrabbit, Black-tailed	<i>Lepus californicus</i>
Mink	<i>Mustela vison</i>
Mole, Eastern	<i>Scalopus aquaticus</i>
Muskrat	<i>Ondatra zibethicus</i>
Opossum	<i>Didelphis virginiana</i>
Porcupine	<i>Erthizon dorsatum</i>
Prairie Dog, Black-tailed	<i>Cynomys ludovicianus</i>
Raccoon	<i>Procyon lotor</i>
Rat, Hispid Cotton	<i>Sigmodon hispidus</i>
Rat, Ord's Kangaroo	<i>Dipodomys ordii</i>
Skunk, Eastern Spotted*	<i>Spilogale putorius</i>
Skunk, Striped	<i>Mephitis mephitis</i>
Squirrel, Eastern Fox	<i>Sciurus niger</i>
Wood Rat, Eastern	<i>Neotoma floridana</i>

F.4 List of Amphibian and Reptile Species

These are the amphibian and reptile species found on Quivira Refuge.

<i>Common name</i>	<i>Scientific name</i>
Bullfrog	<i>Rana catesbiana</i>
Frog, Blanchard's Cricket	<i>Acris blanchardi</i>
Frog, Plains Leopard	<i>Rana blairi</i>
Frog, Western Chorus	<i>Pseudacris maculata</i>
Kingsnake, Prairie	<i>Lampropeltis calligaster</i>
Lizard, Prairie (Fence)	<i>Sceloporus undulatus</i>

<i>Common name</i>	<i>Scientific name</i>
Massasauga	<i>Sistrurus catenatus</i>
Racer	<i>Coluber constrictor</i>
Racerunner, Six-lined	<i>Aspidoscelis sexlineata</i>
Salamander, Tiger	<i>Ambystoma tigrinum</i>
Slider, Red-eared	<i>Trachemys scripta</i>
Snake, Brown	<i>Storeria dekayi</i>
Snake, Common Garter	<i>Thamnophis sirtalis</i>
Snake, Glossy	<i>Arizona elegans</i>
Snake, Gopher (Bull)	<i>Pituophis catenifer</i>
Snake, Graham's Crayfish	<i>Regina grahamii</i>
Snake, Plains Garter	<i>Thamnophis radix</i>
Snake, Western Hognose	<i>Heterodon nasicus</i>
Snake, Western Ribbon	<i>Thamnophis proximus</i>
Toad, Woodhouse's	<i>Bufo woodhousei</i>
Turtle, Ornate Box	<i>Terrapene ornata</i>
Turtle, Painted	<i>Chrysemys picta</i>
Turtle, Snapping	<i>Chelydra serpentina</i>
Turtle, Spiny Softshell	<i>Apalone spinifera</i>
Turtle, Yellow Mud	<i>Kinosternon flavescens</i>
Water Snake, Diamondback	<i>Nerodia rhombifer</i>
Water Snake, Northern	<i>Nerodia sipedon</i>

F.5 List of Odonate Species

These are the odonate species found on Quivira Refuge.

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Amberwing, Eastern	Libellulidae	<i>Perithemis tenera</i>
Bluet, Familiar	Coenagrionidae	<i>Enallagma civile</i>
Clubtail, Jade	Gomphidae	<i>Arigomphus submedianus</i>
Clubtail, Plains	Gomphidae	<i>Gomphus externus</i>
Darner, Blue-eyed	Aeschnidae	<i>Rhionaeschna multicolor</i>
Darner, Common Blue	Aeschnidae	<i>Anax junius</i>
Dasher, Blue	Libellulidae	<i>Pachydiplax longipennis</i>
Forktail, Black-fronted	Coenagrionidae	<i>Ischnura denticollis</i>
Forktail, Citrine	Coenagrionidae	<i>Ischnura hastata</i>
Forktail, Desert	Coenagrionidae	<i>Ischnura barberi</i>
Forktail, Eastern	Coenagrionidae	<i>Ischnura verticalis</i>
Forktail, Fragile	Coenagrionidae	<i>Ischnura posita</i>
Glider, Spot-wing	Libellulidae	<i>Pantala hymenaea</i>
Glider, Wandering	Libellulidae	<i>Pantala flavescens</i>
Meadowhawk, Band-wing	Libellulidae	<i>Sympetrum semicinctum</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Meadowhawk, Blue-faced	Libellulidae	<i>Sympetrum ambiguum</i>
Meadowhawk, Ruby	Libellulidae	<i>Sympetrum rubicundulum</i>
Meadowhawk, Variegated	Libellulidae	<i>Sympetrum corruptum</i>
Pennant, Halloween	Libellulidae	<i>Celithemis eponina</i>
Pondhawk, Eastern	Libellulidae	<i>Erythemis simplicicollis</i>
Rubyspot, American	Calopterygidae	<i>Hetaerina americana</i>
Saddlebags, Black	Libellulidae	<i>Tramea lacerata</i>
Saddlebags, Red	Libellulidae	<i>Tramea onusta</i>
Skimmer, Twelve-spotted	Libellulidae	<i>Libellula pulchella</i>
Skimmer, Widow	Libellulidae	<i>Libellula luctuosa</i>
Spreadwing	Lestidae	<i>Lestes rectangularis</i>
Spreadwing, Southern	Lestidae	<i>Lestes australis</i>
Whitetail, Common	Libellulidae	<i>Libellula lydia</i>

F.6 List of Butterfly Species

These are the butterfly species found on Quivira Refuge.

<i>Common name</i>	<i>Scientific name</i>
Admiral, Red	<i>Vanessa atalanta</i>
Azure, Summer	<i>Celastrina ladon</i>
Blue, Eastern Tailed	<i>Everes comyntas</i>
Blue, Marine	<i>Leptotes marina</i>
Blue, Reakirt's	<i>Hemiargus isola</i>
Blue, Western Pygmy	<i>Brephidium exile</i>
Buckeye	<i>Junonia coenia</i>
Checkerspot, Gorgone	<i>Chlosyne gorgone</i>
Cloak, Mourning	<i>Nymphalis antiopa</i>
Cloudywing, Southern	<i>Thorybes bathyllus</i>
Comma, Eastern	<i>Polygonia comma</i>
Copper, Bronze	<i>Lycaena hyllus</i>
Copper, Gray	<i>Lycaena dione</i>
Crescent, Painted	<i>Phyciodes picta</i>
Crescent, Pearl	<i>Phyciodes tharos</i>
Crescent, Phaon	<i>Phyciodes phaon</i>
Duskywing, Afranius	<i>Erynnis afranius</i>
Duskywing, Funereal	<i>Erynnis funeralis</i>
Duskywing, Horace's	<i>Erynnis horatius</i>
Duskywing, Juvenalis	<i>Erynnis juvenalis</i>
Duskywing, Wild Indigo	<i>Erynnis baptisiae</i>
Emperor, Hackberry	<i>Asterocampa celtis</i>
Emperor, Tawny	<i>Asterocampa clyton</i>

<i>Common name</i>	<i>Scientific name</i>
Fritillary, Great Spangled	<i>Speyeria cybele</i>
Fritillary, Gulf	<i>Agraulis vanillae</i>
Fritillary, Regal	<i>Speyeria idalia</i>
Fritillary, Variegated	<i>Euptoieta claudia</i>
Hairstreak, Coral	<i>Satyrium titus</i>
Hairstreak, Gray	<i>Strymon melinus</i>
Hairstreak, Juniper	<i>Callophrys gryneus gryneus</i>
Lady, American	<i>Vanessa virginiensis</i>
Lady, Painted	<i>Vanessa cardui</i>
Leafwing, Goatweed	<i>Anaea andrea</i>
Monarch	<i>Danaus plexippus</i>
Orange, Sleepy	<i>Euremia nicippe</i>
Queen	<i>Danaus gilippus</i>
Question Mark	<i>Polygonia interrogationis</i>
Sachem	<i>Atalopedes campestris</i>
Scallopwing, Hayhurst's	<i>Staphylus hayhurstii</i>
Skipper, Common Checkered	<i>Pyrgus communis</i>
Skipper, Delaware	<i>Anatrytone logan</i>
Skipper, Eastern Dun	<i>Euphyes vestris</i>
Skipper, Fiery	<i>Hylephila phyleus</i>
Skipper, Nysa Roadside	<i>Amblyscirtes nysa</i>
Skipper, Silver-spotted	<i>Epargyreus clarus</i>
Snout, Common	<i>Libytheana carinenta</i>
Sootywing, Common	<i>Pholisora catullus</i>
Sulphur, Clouded	<i>Colias philodice</i>
Sulphur, Cloudless	<i>Phoebis sennae</i>
Sulphur, Dainty	<i>Nathalis iole</i>
Sulphur, Orange	<i>Colias eurhytheme</i>
Swallowtail, Black	<i>Papilio polyxenes</i>
Swallowtail, Eastern Tiger	<i>Papilio glaucus</i>
Swallowtail, Pipevine	<i>Battus philenor</i>
Viceroy	<i>Limenitis archippus</i>
White, Cabbage	<i>Pieris rapae</i>
White, Checkered	<i>Pontia protodice</i>
Wood Nymph, Common	<i>Cercyonis pegala</i>
Yellow, Little	<i>Eurema lisa</i>

F.7 List of Plant Species

These are the plant species found on Quivira Refuge.

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Wild Petunia	Acanthaceae	<i>Ruellia humilis</i>
Boxelder	Aceraceae	<i>Acer negundo</i>
Silver Maple	Aceraceae	<i>Acer saccharinum</i>
Soapweed Yucca	Agavaceae	<i>Yucca glauca</i>
Sea Purslane	Aizoaceae	<i>Sesuvium verrucosum</i>
Northern Water Plantain	Alismataceae	<i>Alisma triviale</i>
Grassleaf Arrowhead	Alismataceae	<i>Sagittaria graminea</i> var. <i>graminea</i>
Broadleaf Arrowhead	Alismataceae	<i>Sagittaria latifolia</i>
Sandhill Amaranth	Amaranthaceae	<i>Amaranthus arenicola</i>
Tall Waterhemp	Amaranthaceae	<i>Amaranthus tuberculatus</i>
Snake-cotton	Amaranthaceae	<i>Froelichia floridana</i> var. <i>campestris</i>
Fragrant Sumac	Anacardiaceae	<i>Rhus aromatica</i>
Smooth Sumac	Anacardiaceae	<i>Rhus glabra</i>
Poison Ivy	Anacardiaceae	<i>Toxicodendron rydbergii</i>
Cut-leaf Water Parsnip	Apiaceae	<i>Berula erecta</i> var. <i>incisa</i>
Common Water Hemlock	Apiaceae	<i>Cicuta maculata</i>
Floating Marsh Pennywort	Apiaceae	<i>Hydrocotyle ranunculoides</i>
Red River Scaleseed	Apiaceae	<i>Spermolepis inermis</i>
Indian Hemp	Apocynaceae	<i>Apocynum cannabinum</i>
Blunt-leaved Milkweed	Asclepiadaceae	<i>Asclepias amplexicaulis</i>
Sand Milkweed	Asclepiadaceae	<i>Asclepias arenaria</i>
Swamp Milkweed	Asclepiadaceae	<i>Asclepias incarnata</i> ssp. <i>incarnata</i>
Showy Milkweed	Asclepiadaceae	<i>Asclepias speciosa</i>
Butterfly Milkweed	Asclepiadaceae	<i>Asclepias tuberosa</i> ssp. <i>interior</i>
Whorled Milkweed	Asclepiadaceae	<i>Asclepias verticillata</i>
Green Antelopehorn	Asclepiadaceae	<i>Asclepias viridis</i>
Common Yarrow	Asteraceae	<i>Achillea millefolium</i> ssp. <i>lanulosa</i>
Western Ragweed	Asteraceae	<i>Ambrosia psilostachya</i>
Giant Ragweed	Asteraceae	<i>Ambrosia trifida</i>
Cudweed Sagewort	Asteraceae	<i>Artemisia ludoviciana</i> ssp. <i>ludoviciana</i>
White Panicked Aster	Asteraceae	<i>Aster lanceolatus</i> ssp. <i>lanceolatus</i>
Willow Baccharis	Asteraceae	<i>Baccharis salicina</i>
Spanish Needles	Asteraceae	<i>Bidens bipinnata</i>
Tall Thistle	Asteraceae	<i>Cirsium altissimum</i>
Wavyleaf Thistle	Asteraceae	<i>Cirsium undulatum</i>
Bull Thistle	Asteraceae	<i>Cirsium vulgare</i>
Horseweed	Asteraceae	<i>Conyza canadensis</i>
Plains Coreopsis	Asteraceae	<i>Coreopsis tinctoria</i>
Hooker's Scratchdaisy	Asteraceae	<i>Croptilon hookerianum</i> var. <i>validum</i>
Philadelphia Fleabane	Asteraceae	<i>Erigeron philadelphicus</i>
Daisy Fleabane	Asteraceae	<i>Erigeron strigosus</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Boneset	Asteraceae	<i>Eupatorium perfoliatum</i>
Alkali Yellowtops	Asteraceae	<i>Flaveria campestris</i>
Curly-cup Gumweed	Asteraceae	<i>Grindelia ciliata</i>
Annual Sunflower	Asteraceae	<i>Helianthus annuus</i>
Maximilian Sunflower	Asteraceae	<i>Helianthus maximiliani</i>
Prairie Sunflower	Asteraceae	<i>Helianthus petiolaris</i>
Jerusalem Artichoke	Asteraceae	<i>Helianthus tuberosus</i>
Goldenaster	Asteraceae	<i>Heterotheca latifolia</i>
Camphorweed	Asteraceae	<i>Heterotheca subaxillaris ssp. latifolia</i>
Carolina Woollywhite	Asteraceae	<i>Hymenopappus scabiosaeus</i>
Marshelder	Asteraceae	<i>Iva annua</i>
Prickly Lettuce	Asteraceae	<i>Lactuca serriola</i>
Lanceleaf Blazing Star	Asteraceae	<i>Liatris lancifolia</i>
Prairie Blazing Star	Asteraceae	<i>Liatris pycnostachya</i>
Scaly Blazing Star	Asteraceae	<i>Liatris squarrosa var. glabrata</i>
Marsh Fleabane	Asteraceae	<i>Pluchea odorata</i>
Rabbit-tobacco	Asteraceae	<i>Pseudognaphalium obtusifolium</i>
Tuberous Desert-chicory	Asteraceae	<i>Pyrrhopappus grandiflorus</i>
Prairie Coneflower	Asteraceae	<i>Ratibida columnifera</i>
Viscid Tansyaster	Asteraceae	<i>Rayjacksonia annua</i>
Canada Goldenrod	Asteraceae	<i>Solidago altissima var. altissima</i>
Missouri Goldenrod	Asteraceae	<i>Solidago missouriensis</i>
Downy Goldenrod	Asteraceae	<i>Solidago petiolaris</i>
Sow Thistle	Asteraceae	<i>Sonchus asper</i>
Annual Saltmarsh Aster	Asteraceae	<i>Symphotrichum divaricatum</i>
White Heath Aster	Asteraceae	<i>Symphotrichum ericoides var. ericoides</i>
Red-seed Dandelion	Asteraceae	<i>Taraxacum laevigatum</i>
Common Dandelion	Asteraceae	<i>Taraxacum officinale</i>
Green Threads	Asteraceae	<i>Thelesperma megapotamicum</i>
Common Salsify	Asteraceae	<i>Tragopogon dubius</i>
Prairie Ironweed	Asteraceae	<i>Vernonia fasciculata ssp. corymbosa</i>
Cocklebur	Asteraceae	<i>Xanthium strumarium</i>
Trumpet Creeper	Bignoniaceae	<i>Campsis radicans</i>
Southern Catalpa	Bignoniaceae	<i>Catalpa bignonioides</i>
Northern Catalpa	Bignoniaceae	<i>Catalpa speciosa</i>
Little Catseye	Boraginaceae	<i>Cryptantha minima</i>
Bindweed Heliotrope	Boraginaceae	<i>Heliotropium convolvulaceum</i>
Salt Heliotrope	Boraginaceae	<i>Heliotropium curassavicum var. curassavicum</i>
Seaside Heliotrope	Boraginaceae	<i>Heliotropium curassavicum var. obovatum</i>
Stickseed	Boraginaceae	<i>Lappula redowskii</i>
Fringed Puccoon	Boraginaceae	<i>Lithospermum incisum</i>
Spring Forget-me-not	Boraginaceae	<i>Myosotis verna</i>
Shepherd's Purse	Brassicaceae	<i>Capsella bursa-pastoris</i>
Whitetop	Brassicaceae	<i>Cardaria draba</i>
Western Tansymustard	Brassicaceae	<i>Descurainia pinnata var. brachycarpa</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Common Pepperweed	Brassicaceae	<i>Lepidium densiflorum</i>
Water-cress	Brassicaceae	<i>Nasturtium officinale</i>
Winged Rockcress	Brassicaceae	<i>Sibara virginica</i>
Plains Prickly-pear	Cactaceae	<i>Opuntia phaeacantha</i>
Waterstarwort	Callitrichaceae	<i>Callitriche heterophylla</i>
Cardinal Flower	Campanulaceae	<i>Lobelia cardinalis</i>
Great Blue Lobelia	Campanulaceae	<i>Lobelia siphilitica</i>
Holzinger's Venus' Looking-glass	Campanulaceae	<i>Triodanis holzingeri</i>
Narrowleaf Rombopod	Capparaceae	<i>Cleomella angustifolia</i>
Rocky Mountain Beeplant	Capparaceae	<i>Peritoma serrulata</i>
James' Clammyweed	Capparaceae	<i>Polanisia jamesii</i>
American Elder	Caprifoliaceae	<i>Sambucus canadensis</i>
Coralberry	Caprifoliaceae	<i>Symphoricarpos orbiculatus</i>
Thymeleaf Sandwort	Caryophyllaceae	<i>Arenaria serpyllifolia</i>
Mouse-ear Chickweed	Caryophyllaceae	<i>Cerastium brachypodium</i>
Sleepy Catchfly	Caryophyllaceae	<i>Silene antirrhina</i>
Silverscale	Chenopodiaceae	<i>Atriplex argentea</i>
Saline Saltbush	Chenopodiaceae	<i>Atriplex dioica</i>
Halberd-leaved Orache	Chenopodiaceae	<i>Atriplex patula</i>
Lamb's Quarters	Chenopodiaceae	<i>Chenopodium album</i>
Desert Goosefoot	Chenopodiaceae	<i>Chenopodium pratericola</i>
Red Goosefoot	Chenopodiaceae	<i>Chenopodium rubrum</i>
Winged Pigweed	Chenopodiaceae	<i>Cycloloma atriplicifolium</i>
Kochia, Fireweed	Chenopodiaceae	<i>Kochia scoparia</i>
Red Saltwort	Chenopodiaceae	<i>Salicornia rubra</i>
Russian Thistle	Chenopodiaceae	<i>Salsola iberica</i>
Western Seepweed	Chenopodiaceae	<i>Suaeda calceoliformis</i>
Poison Suckle	Chenopodiaceae	<i>Suckleya suckleyana</i>
Bee Spiderflower	Cleomaceae	<i>Cleome serrulata</i>
Common Saint John's Wort	Clusiaceae	<i>Hypericum perforatum</i>
Dayflower	Commelinaceae	<i>Commelina erecta</i> var. <i>angustifolia</i>
Prairie Spiderwort	Commelinaceae	<i>Tradescantia occidentalis</i>
Prostrate Evolvulus	Convolvulaceae	<i>Evolvulus nuttallianus</i>
Bush Morning-glory	Convolvulaceae	<i>Ipomoea leptophylla</i>
Pickering's Dawnflower	Convolvulaceae	<i>Stylisma pickeringii</i> var. <i>pattersonii</i>
Roughleaf Dogwood	Cornaceae	<i>Cornus drummondii</i>
Buffalo-gourd	Cucurbitaceae	<i>Cucurbita foetidissima</i>
Eastern Redcedar	Cupressaceae	<i>Juniperus virginiana</i> var. <i>virginiana</i>
Cusp Dodder	Cuscutaceae	<i>Cuscuta cuspidata</i>
Rope Dodder	Cuscutaceae	<i>Cuscuta glomerata</i>
Cosmopolitan Bulrush	Cyperaceae	<i>Bolboschoenus maritimus</i> ssp. <i>paludosus</i>
Southern Sedge	Cyperaceae	<i>Carex australis</i>
Shortbeak Sedge	Cyperaceae	<i>Carex brevior</i>
Buxbaum Sedge	Cyperaceae	<i>Carex buxbaumii</i>
Emory's Sedge	Cyperaceae	<i>Carex emoryi</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Fescue Sedge	Cyperaceae	<i>Carex festucacea</i>
Smooth-cone Sedge	Cyperaceae	<i>Carex laeviconica</i>
Wooly-fruit Sedge	Cyperaceae	<i>Carex lasiocarpa</i>
Mead's Sedge	Cyperaceae	<i>Carex meadii</i>
Wooly Sedge	Cyperaceae	<i>Carex pellita</i>
Clustered Field Sedge	Cyperaceae	<i>Carex praegracilis</i>
Awlfruit Sedge	Cyperaceae	<i>Carex stipata</i> var. <i>stipata</i>
Fox Sedge	Cyperaceae	<i>Carex vulpinoidea</i>
Taperleaf Flatsedge	Cyperaceae	<i>Cyperus acuminatus</i>
Yellow Nutsedge	Cyperaceae	<i>Cyperus esculentus</i>
Great Plains Flatsedge	Cyperaceae	<i>Cyperus lupulinus</i>
Sand Flatsedge	Cyperaceae	<i>Cyperus schweinitzii</i>
Lean Flatsedge	Cyperaceae	<i>Cyperus setigerus</i>
Bald Spikerush	Cyperaceae	<i>Eleocharis erythropoda</i>
Pale Spikerush	Cyperaceae	<i>Eleocharis macrostachya</i>
Sand Spikerush	Cyperaceae	<i>Eleocharis montevidensis</i>
Beaked Spikerush	Cyperaceae	<i>Eleocharis rostellata</i>
Hairy Fimbry	Cyperaceae	<i>Fimbristylis puberula</i> var. <i>interior</i>
Hairy Fimbry	Cyperaceae	<i>Fimbristylis puberula</i> var. <i>puberula</i>
Hardstem Bulrush	Cyperaceae	<i>Schoenoplectus acutus</i> var. <i>acutus</i>
Common Threesquare	Cyperaceae	<i>Schoenoplectus pungens</i>
Common Threesquare	Cyperaceae	<i>Schoenoplectus pungens</i> var. <i>longispicatus</i>
Softstem Bulrush	Cyperaceae	<i>Schoenoplectus tabernaemontani</i> ssp. <i>validus</i>
Pale Bulrush	Cyperaceae	<i>Scirpus pallidus</i>
Hanging Bulrush	Cyperaceae	<i>Scirpus pendulus</i>
Persimmon	Ebenaceae	<i>Diospyros virginiana</i>
Russian Olive	Elaeagnaceae	<i>Elaeagnus angustifolia</i>
Smooth Horsetail	Equisetaceae	<i>Equisetum laevigatum</i>
Geyer's Sandmat	Euphorbiaceae	<i>Chamaesyce geyeri</i>
Rip-seed Sandmat	Euphorbiaceae	<i>Chamaesyce glyptosperma</i>
Sand Spurge	Euphorbiaceae	<i>Chamaesyce missurica</i> var. <i>intermedia</i>
Sand Croton	Euphorbiaceae	<i>Croton glandulosus</i> var. <i>septentrionalis</i>
Texas Croton	Euphorbiaceae	<i>Croton texensis</i>
David's Spurge	Euphorbiaceae	<i>Euphorbia davidii</i>
Snow-on-the-Mountain	Euphorbiaceae	<i>Euphorbia marginata</i>
Roughpod Spurge	Euphorbiaceae	<i>Euphorbia spathulata</i>
False Indigo	Fabaceae	<i>Amorpha fruticosa</i>
Platte Milkvetch	Fabaceae	<i>Astragalus plattensis</i>
Blue Wild Indigo	Fabaceae	<i>Baptisia australis</i> var. <i>minor</i>
Partridge Pea	Fabaceae	<i>Chamaecrista fasciculata</i>
Purple Prairie-clover	Fabaceae	<i>Dalea purpurea</i> var. <i>purpurea</i>
Hairy Prairie-clover	Fabaceae	<i>Dalea villosa</i> var. <i>villosa</i>
Illinois Bundleflower	Fabaceae	<i>Desmanthus illinoensis</i>
Honeylocust	Fabaceae	<i>Gleditsia triacanthos</i>
Wild Licorice	Fabaceae	<i>Glycyrrhiza lepidota</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Kentucky Coffeetree	Fabaceae	<i>Gymnocladus dioica</i>
Round-head Lespedeza	Fabaceae	<i>Lespedeza capitata</i>
American Birdsfoot Trefoil	Fabaceae	<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>
White Sweetclover	Fabaceae	<i>Melilotus albus</i>
Yellow Sweetclover	Fabaceae	<i>Melilotus officinalis</i>
Catclaw Sensitive-briar	Fabaceae	<i>Mimosa nuttallii</i>
Palmleaf Indian Breadroot	Fabaceae	<i>Pedimelum digitatum</i>
Dune Scurfpea	Fabaceae	<i>Psoralidium lanceolatum</i>
Black Locust	Fabaceae	<i>Robinia pseudoacacia</i>
Stick-seed Fuzzybean	Fabaceae	<i>Strophostyles leiosperma</i>
Goat's-rue	Fabaceae	<i>Tephrosia virginiana</i>
Hairy Vetch	Fabaceae	<i>Vicia villosa</i> ssp. <i>villosa</i>
Bur Oak	Fagaceae	<i>Quercus macrocarpa</i>
Smallflower Fumewort	Fumariaceae	<i>Corydalis micrantha</i>
Prairie Gentian	Gentianaceae	<i>Eustoma grandiflorum</i>
Carolina Geranium	Geraniaceae	<i>Geranium carolinianum</i>
Golden Currant	Grossulariaceae	<i>Ribes aureum</i> var. <i>villosum</i>
American Watermilfoil	Haloragaceae	<i>Myriophyllum sibiricum</i>
Common Waternymph	Hydrocharitaceae	<i>Najas guadalupensis</i>
Blue-eyed Grass	Iridaceae	<i>Sisyrinchium montanum</i>
Black Walnut	Juglandaceae	<i>Juglans nigra</i>
Tapertip Rush	Juncaceae	<i>Juncus acuminatus</i>
Baltic Rush	Juncaceae	<i>Juncus arcticus</i> var. <i>balticus</i>
Tuftedstem Rush	Juncaceae	<i>Juncus brachyphyllus</i>
Dudley Rush	Juncaceae	<i>Juncus dudleyi</i>
Inland Rush	Juncaceae	<i>Juncus interior</i>
Field Rush	Juncaceae	<i>Juncus tenuis</i>
Torrey Rush	Juncaceae	<i>Juncus torreyi</i>
False Pennyroyal	Lamiaceae	<i>Hedeoma hispida</i>
Henbit	Lamiaceae	<i>Lamium amplexicaule</i>
American Bugleweed	Lamiaceae	<i>Lycopus americanus</i>
Wild Bergamot	Lamiaceae	<i>Monarda punctata</i> ssp. <i>occidentalis</i>
Catnip	Lamiaceae	<i>Nepeta cataria</i>
Blue Sage	Lamiaceae	<i>Salvia azurea</i>
Blue Skullcap	Lamiaceae	<i>Scutellaria lateriflora</i>
American Germander	Lamiaceae	<i>Teucrium canadense</i> var. <i>canadense</i>
Lesser Duckweed	Lemnaceae	<i>Lemna aequinoctialis</i>
Common Duckweed	Lemnaceae	<i>Lemna minor</i>
Minute Duckweed	Lemnaceae	<i>Lemna perpusilla</i>
Turion Duckweed	Lemnaceae	<i>Lemna turionifera</i>
Wild Onion	Liliaceae	<i>Allium canadense</i> var. <i>fraseri</i>
Wild Asparagus	Liliaceae	<i>Asparagus officinalis</i>
False Lily-of-the-Valley	Liliaceae	<i>Maianthemum</i> sp.
False Lily-of-the-Valley	Liliaceae	<i>Maianthemum stellatum</i>
Wild Flax	Linaceae	<i>Linum</i> sp.

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Purple Ammannia	Lythraceae	<i>Ammannia coccinea</i>
Grand Redstem	Lythraceae	<i>Ammannia robusta</i>
California Loosestrife	Lythraceae	<i>Lythrum californicum</i>
Velvetleaf Mallow	Malvaceae	<i>Abutilon theophrasti</i>
Plains Poppymallow	Malvaceae	<i>Callirhoe alcaeoides</i>
Purple Poppymallow	Malvaceae	<i>Callirhoe involucrata</i>
Common Mallow	Malvaceae	<i>Malva neglecta</i>
Hairy Waterclover	Marsileaceae	<i>Marsilea vestita</i>
Moonseed	Menispermaceae	<i>Menispermum canadense</i>
Carpetweed	Molluginaceae	<i>Mollugo verticillata</i>
Osage-orange	Moraceae	<i>Maclura pomifera</i>
White Mulberry	Moraceae	<i>Morus alba</i>
American Lotus	Nelumbonaceae	<i>Nelumbo lutea</i>
Four-o'clock	Nyctaginaceae	<i>Mirabilis exaltata</i>
Smooth Four-o'clock	Nyctaginaceae	<i>Mirabilis glabra</i>
Four-o'clock	Nyctaginaceae	<i>Mirabilis linearis</i>
Heart-leaved Four-o'clock	Nyctaginaceae	<i>Mirabilis nyctaginea</i>
Green Ash	Oleaceae	<i>Fraxinus pennsylvanica</i>
Yellow Sundrops	Onagraceae	<i>Calylophus serrulatus</i>
Velvetweed	Onagraceae	<i>Gaura mollis</i>
Bushy Seedbox	Onagraceae	<i>Ludwigia alternifolia</i>
Hooker's Evening Primrose	Onagraceae	<i>Oenothera elata ssp. hirsutissima</i>
Largeflower Evening Primrose	Onagraceae	<i>Oenothera grandis</i>
Cut-leaf Evening Primrose	Onagraceae	<i>Oenothera laciniata</i>
Four-point Evening Primrose	Onagraceae	<i>Oenothera rhombipetala</i>
Hairy Evening Primrose	Onagraceae	<i>Oenothera villosa ssp. villosa</i>
Great Plains Ladies-tresses	Orchidaceae	<i>Spiranthes magnicamporum</i>
Slender Yellow Woodsorrel	Oxalidaceae	<i>Oxalis dillenii</i>
Yellow Woodsorrel	Oxalidaceae	<i>Oxalis stricta</i>
Prickly-poppy	Papaveraceae	<i>Argemone polyanthemus</i>
Devil's Claw	Pedaliaceae	<i>Proboscidea louisianica</i>
Pokeweed	Phytolaccaceae	<i>Phytolacca americana var. americana</i>
Austrian Pine	Pinaceae	<i>Pinus nigra</i>
Longleaf Plantain	Plantaginaceae	<i>Plantago elongata</i>
Wooly Plantain	Plantaginaceae	<i>Plantago patagonica var. patagonica</i>
Dwarf Plantain	Plantaginaceae	<i>Plantago pusilla</i>
Virginia Plantain	Plantaginaceae	<i>Plantago virginica</i>
Goatgrass	Poaceae	<i>Aegilops cylindrica</i>
Redtop Bent	Poaceae	<i>Agrostis gigantea</i>
Winter Bentgrass	Poaceae	<i>Agrostis hyemalis</i>
Creeping Bentgrass	Poaceae	<i>Agrostis stolonifera</i>
Big Bluestem	Poaceae	<i>Andropogon gerardii</i>
Sand Bluestem	Poaceae	<i>Andropogon hallii</i>
Forked Three-awn	Poaceae	<i>Aristida basiramea</i>
Prairie Three-awn	Poaceae	<i>Aristida oligantha</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Caucasian Bluestem	Poaceae	<i>Bothriochloa bladhii</i>
Silver Bluestem	Poaceae	<i>Bothriochloa saccharoides</i>
Sideoats Grama	Poaceae	<i>Bouteloua curtipendula</i>
Blue Grama	Poaceae	<i>Bouteloua gracilis</i>
Smooth Brome	Poaceae	<i>Bromus inermis</i>
Japanese Brome	Poaceae	<i>Bromus japonicus</i>
Cheatgrass	Poaceae	<i>Bromus tectorum</i>
Buffalograss	Poaceae	<i>Buchloe dactyloides</i>
Bluejoint Reedgrass	Poaceae	<i>Calamagrostis canadensis</i>
Narrowspike Reedgrass	Poaceae	<i>Calamagrostis stricta</i>
Prairie Sandreed	Poaceae	<i>Calamovilfa gigantea</i>
Sandbur	Poaceae	<i>Cenchrus longispinus</i>
Windmill Grass	Poaceae	<i>Chloris verticillata</i>
Bermudagrass	Poaceae	<i>Cynodon dactylon</i>
Orchardgrass	Poaceae	<i>Dactylis glomerata</i>
Hotsprings Panicum	Poaceae	<i>Dichanthelium acuminatum ssp. fasciculatum</i>
Scribner Panicum	Poaceae	<i>Dichanthelium oligosanthes ssp. scribnerianum</i>
Carolina Crabgrass	Poaceae	<i>Digitaria cognata ssp. cognata</i>
Slender Crabgrass	Poaceae	<i>Digitaria filiformis</i>
Hairy Crabgrass	Poaceae	<i>Digitaria sanguinalis</i>
Inland Saltgrass	Poaceae	<i>Distichlis spicata var. stricta</i>
Barnyard Grass, Millet	Poaceae	<i>Echinochloa crus-galli var. crus-galli</i>
Rough Barnyard Grass	Poaceae	<i>Echinochloa muricata var. microstachya</i>
Goosegrass	Poaceae	<i>Eleusine indica</i>
Canada Wildrye	Poaceae	<i>Elymus canadensis</i>
Quackgrass	Poaceae	<i>Elymus repens</i>
Stinkgrass	Poaceae	<i>Eragrostis cilianensis</i>
Weeping Lovegrass	Poaceae	<i>Eragrostis curvula</i>
Tufted Lovegrass	Poaceae	<i>Eragrostis pectinacea</i>
Red Lovegrass	Poaceae	<i>Eragrostis secundiflora ssp. oxylepis</i>
Purple Lovegrass	Poaceae	<i>Eragrostis spectabilis</i>
Sand Lovegrass	Poaceae	<i>Eragrostis trichodes</i>
Prairie Cupgrass	Poaceae	<i>Eriochloa contracta</i>
Tall Fescue	Poaceae	<i>Festuca pratensis</i>
Foxtail Barley	Poaceae	<i>Hordeum jubatum</i>
Little Barley	Poaceae	<i>Hordeum pusillum</i>
Rice Cutgrass	Poaceae	<i>Leersia oryzoides</i>
Sprangletop	Poaceae	<i>Leptochloa fusca</i>
Alkali Muhly	Poaceae	<i>Muhlenbergia asperifolia</i>
Nodding Muhly	Poaceae	<i>Muhlenbergia bushii</i>
Wirestem Muhly	Poaceae	<i>Muhlenbergia racemosa</i>
Witchgrass	Poaceae	<i>Panicum capillare var. barbipulvinatum</i>
Witchgrass	Poaceae	<i>Panicum capillare var. brevifolium</i>
Fall Panicum	Poaceae	<i>Panicum dichotomiflorum</i>
Panic Grass	Poaceae	<i>Panicum praecoxious</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Redtop Panicum	Poaceae	<i>Panicum rigidulum</i>
Panic Grass	Poaceae	<i>Panicum vilosissimum</i>
Switchgrass	Poaceae	<i>Panicum virgatum</i>
Western Wheatgrass	Poaceae	<i>Pascopyrum smithii</i>
Sand Paspalum	Poaceae	<i>Paspalum setaceum</i> var. <i>stramineum</i>
Timothy	Poaceae	<i>Phleum pratense</i>
Common Reed	Poaceae	<i>Phragmites australis</i>
Texas Bluegrass	Poaceae	<i>Poa arachnifera</i>
Plains Bluegrass	Poaceae	<i>Poa arida</i>
Canada Bluegrass	Poaceae	<i>Poa compressa</i>
Kentucky Bluegrass	Poaceae	<i>Poa pratensis</i>
Tumblegrass	Poaceae	<i>Schedonnardus paniculatus</i>
Little Bluestem	Poaceae	<i>Schizachyrium scoparium</i>
Cultivated Rye	Poaceae	<i>Secale cereale</i>
Yellow Foxtail	Poaceae	<i>Setaria glauca</i>
Marsh Foxtail	Poaceae	<i>Setaria parviflora</i>
Green Foxtail	Poaceae	<i>Setaria viridis</i>
Indiangrass	Poaceae	<i>Sorghastrum nutans</i>
Johnsongrass	Poaceae	<i>Sorghum halepense</i>
Alkali Cordgrass	Poaceae	<i>Spartina gracilis</i>
Prairie Cordgrass	Poaceae	<i>Spartina pectinata</i>
Prairie Wedgegrass	Poaceae	<i>Sphenopholis obtusata</i> var. <i>obtusata</i>
Alkali Sacaton	Poaceae	<i>Sporobolus airoides</i>
Composite Dropseed	Poaceae	<i>Sporobolus compositus</i> var. <i>compositus</i>
Sand Dropseed	Poaceae	<i>Sporobolus cryptandrus</i>
Puffsheath Dropseed	Poaceae	<i>Sporobolus neglectus</i>
Texas Dropseed	Poaceae	<i>Sporobolus texanus</i>
Intermediate Wheatgrass	Poaceae	<i>Thinopyrum intermedium</i>
Purpletop	Poaceae	<i>Tridens flavus</i>
Longspike Tridens	Poaceae	<i>Tridens strictus</i>
Purple Sandgrass	Poaceae	<i>Triplasis purpurea</i> var. <i>purpurea</i>
Eastern Gamagrass	Poaceae	<i>Tripsacum dactyloides</i>
Sixweeks Fescue	Poaceae	<i>Vulpia octoflora</i>
Annual Eriogonum	Polygonaceae	<i>Eriogonum annuum</i>
Climbing False Buckwheat	Polygonaceae	<i>Fallopia scandens</i>
Water Knotweed	Polygonaceae	<i>Persicaria amphibia</i>
Pink Smartweed	Polygonaceae	<i>Persicaria bicornis</i>
Swamp Smartweed	Polygonaceae	<i>Persicaria hydropiperoides</i>
Curlytop Knotweed	Polygonaceae	<i>Persicaria lapathifolia</i>
Bushy Knotweed	Polygonaceae	<i>Polygonum ramosissimum</i> ssp. <i>prolificum</i>
Yellow-flowered Knotweed	Polygonaceae	<i>Polygonum ramosissimum</i> ssp. <i>ramosissimum</i>
Curly Dock	Polygonaceae	<i>Rumex crispus</i>
Dock	Polygonaceae	<i>Rumex fueginus</i>
Narrowleaf Dock	Polygonaceae	<i>Rumex stenophyllus</i>
Blue Mudplantain	Pontederiaceae	<i>Heteranthera limosa</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Prairie Fameflower	Portulacaceae	<i>Phemeranthus rugospermus</i>
Common Purslane	Portulacaceae	<i>Portulaca oleracea</i>
Kiss-me-quick	Portulacaceae	<i>Portulaca pilosa</i>
Long-leaf Pondweed	Potamogetonaceae	<i>Potamogeton nodosus</i>
Pondweed	Potamogetonaceae	<i>Stuckenia pectinatus</i>
Western Rock-jasmine	Primulaceae	<i>Androsace occidentalis</i>
Carolina Anemone	Ranunculaceae	<i>Anemone caroliniana</i>
Prairie Larkspur	Ranunculaceae	<i>Delphinium carolinianum</i> ssp. <i>penardii</i>
Tiny Mousetail	Ranunculaceae	<i>Myosurus minimus</i>
Celeryleaf Buttercup	Ranunculaceae	<i>Ranunculus sceleratus</i> var. <i>sceleratus</i>
New Jersey Tea	Rhamnaceae	<i>Ceanothus herbaceus</i>
Agrimony	Rosaceae	<i>Agrimonia parviflora</i>
White Avens	Rosaceae	<i>Geum canadense</i>
American Plum	Rosaceae	<i>Prunus americana</i>
Sand Plum	Rosaceae	<i>Prunus angustifolia</i>
Chokecherry	Rosaceae	<i>Prunus virginiana</i>
Prairie Rose	Rosaceae	<i>Rosa arkansana</i>
Multiflora Rose	Rosaceae	<i>Rosa multiflora</i>
Buttonbush	Rubiaceae	<i>Cephalanthus occidentalis</i>
Bedstraw	Rubiaceae	<i>Galium aparine</i>
Spiral Ditchgrass	Ruppiaceae	<i>Ruppia cirrhosa</i>
Plains Cottonwood	Salicaceae	<i>Populus deltoides</i> ssp. <i>monilifera</i>
Peachleaf Willow	Salicaceae	<i>Salix amygdaloides</i>
Sandbar Willow	Salicaceae	<i>Salix exigua</i> ssp. <i>interior</i>
Black Willow	Salicaceae	<i>Salix nigra</i>
Western Soapberry	Sapindaceae	<i>Sapindus drummondii</i>
Slenderleaf False-foxglove	Scrophulariaceae	<i>Agalinis tenuifolia</i>
Roundleaf Monkeyflower	Scrophulariaceae	<i>Mimulus glabratus</i> var. <i>fremontii</i>
Texas Toadflax	Scrophulariaceae	<i>Nuttallanthus texanus</i>
Common Mullein	Scrophulariaceae	<i>Verbascum thaspus</i>
Purslane Speedwell	Scrophulariaceae	<i>Veronica peregrina</i> var. <i>xalapensis</i>
Tree-of-Heaven	Simaroubaceae	<i>Ailanthus altissima</i>
Bristly Greenbrier	Smilacaceae	<i>Smilax hispida</i>
Jimsonweed	Solanaceae	<i>Datura stramonium</i>
Groundcherry	Solanaceae	<i>Physalis hispida</i>
Long-leaf Groundcherry	Solanaceae	<i>Physalis longifolia</i> var. <i>longifolia</i>
Horsenettle	Solanaceae	<i>Solanum carolinense</i>
Deadly Nightshade	Solanaceae	<i>Solanum interius</i>
Buffalo-bur	Solanaceae	<i>Solanum rostratum</i>
Saltcedar	Tamaricaceae	<i>Tamarix ramosissima</i>
Southern Cattail	Typhaceae	<i>Typha domingensis</i>
Broadleaf Cattail	Typhaceae	<i>Typha latifolia</i>
Hackberry	Ulmaceae	<i>Celtis occidentalis</i>
Dwarf Hackberry	Ulmaceae	<i>Celtis tenuifolia</i>
American Elm	Ulmaceae	<i>Ulmus americana</i>

<i>Common name</i>	<i>Family</i>	<i>Scientific name</i>
Chinese Elm	Ulmaceae	<i>Ulmus parvifolia</i>
Siberian Elm	Ulmaceae	<i>Ulmus pumila</i>
False Nettle	Urticaceae	<i>Boehmeria cylindrica</i>
Pennsylvania Pellitory	Urticaceae	<i>Parietaria pensylvanica</i>
Fog-fruit	Verbenaceae	<i>Phyla lanceolata</i>
Prostrate Vervain	Verbenaceae	<i>Verbena bracteata</i>
Blue Vervain	Verbenaceae	<i>Verbena hastata</i>
Hoary Vervain	Verbenaceae	<i>Verbena stricta</i>
Field Pansy	Violaceae	<i>Viola bicolor</i>
Common Blue Violet	Violaceae	<i>Viola sororia</i>
Virginia Creeper	Vitaceae	<i>Parthenocissus inserta</i>
Riverbank Grape	Vitaceae	<i>Vitis riparia</i>
Horned Pondweed	Zannichelliaceae	<i>Zannichellia palustris</i>
Puncture-vine	Zygophyllaceae	<i>Tribulus terrestris</i>

Bibliography

- Adamcik, R.S.; Bellantoni, E.S.; Delong, D.C., Jr.; Schomaker, J.H.; Hamilton, D.B.; Laubhan, M.K.; Schroeder, R.L. 2004. Writing refuge management goals and objectives: a handbook. Washington, DC: U.S. Fish and Wildlife Service. 34 p.
- Aldous, A.E. 1935. Management of Kansas permanent pastures. Agricultural Experiment Station Bulletin 272, Kansas State College of Agriculture and Applied Science, Manhattan, KS. 43 p.
- Althoff, D.; Gibson, P.; Meggers, G.; Hilley, D.; Sellers, J. 2006. White-tailed deer spotlight survey trends on Quivira National Wildlife Refuge, 1989–2005. In: Proceedings of the North American Prairie Conference; [name of conference; date of conference; City, State of conference. City, State: Publisher unknown]. 20:297–306.
- Anderson, R.C. 2006. Evolution and origin of the central grassland of North America: climate, fire, and mammalian grazers. *Journal of the Torrey Botanical Society* 133(4):626–647.
- Arbogast, A.F. 1995. Paleoenvironments and desertification on the Great Bend Sand Prairie in Kansas. [Ph.D. Dissertation]. Lawrence, KS: University of Kansas. 385 p.
- Arbogast, A.E.; Johnson, W.C. 1998. Late-Quaternary landscape response to environmental change in south-central Kansas. *Annals of the Association of American Geographers* 88(1):126–145.
- Armbruster, M.J. 1990. Characterization of habitat used by whooping crane during migration. USFWS, Biological Report 90(4). 16 p.
- Bakker, K.K. 2003. The effect of woody vegetation on grassland nesting birds: an annotated bibliography. In: Proceedings of the South Dakota Academy of Science; [name of conference; date of conference; City, State of conference. City, State: Publisher unknown]. 82:119–141.
- Bakker, K.K.; Naugle, D.E.; Higgins, K.F. 2002. Incorporating landscape attributes into models for migratory grassland bird conservation. *Conservation Biology* 16(6):1638–1646.
- Bangsund, D.A.; Leistriz, F.L.; de Silva, L.L.; Steadman, E.N.; Harju, J.A. 2005. Terrestrial carbon sequestration potential in southwest North Dakota. [Internet] [Revised date unknown]. <<http://www.undeerc.org/PCOR/newsandpubs/pdf/TerrestrialCarbonSequestration.pdf>> [accessed date unknown].
- Basin Management Team. 2010. Rattlesnake Creek 2009 field analysis summary. Topeka, KS: Kansas Department of Agriculture, Division of Water Resources. 32 p.
- Basin Management Team. 2011. Rattlesnake Creek 2010 field summary. Kansas. [City, State unknown]: Department of Agriculture, Division of Water Resources. 32 p.
- Basin Management Team. 2012. Rattlesnake Creek Partnership, draft third four-year review of management program 2009–2012. Topeka, KS: Kansas Department of Agriculture, Division of Water Resources. 50 p.
- Blackmar, F.W. 2002. Quivira. Transcribed from: Vol. II, Kansas: a cyclopedia of state history, embracing events, institutions, industries, counties, cities, towns, and prominent persons; 1912. Chicago, IL: Standard Publishing Company. [Pages unknown].
- Blecha, K.; Conard, J.; Wisely, S. 2011. Deer density, movement patterns, and group dynamics on Quivira National Wildlife Refuge: assessing potential for chronic wasting disease transmission. In: Final U.S. Fish and Wildlife Report. Manhattan, KS: Kansas State University; and Sterling, KS: Sterling College. 197 p.
- Bolenbaugh, J.R.; Kremetz, D.G.; Lehnen, S.E. 2011. Secretive marsh bird species co-occurrences and habitat associations across the Midwest, USA. *Journal of Fish and Wildlife Management* 2(1):49–60.
- Bollinger, E.K.; Gavin, T.A. 2004. Responses of nesting bobolinks (*Dolichonyx oryzivorus*) to habitat edges. *Auk* 121(3):767–776.
- Briggs, J.R.; Knapp, A. K.; Blair, J.M.; Heisler, J.L.; Hoch, G.A.; Lett, M.S.; McCarron, J.K. 2005. An ecosystem in transition: causes and consequences of the conversion of mesic grassland to shrubland. *BioScience* 55(3):243–254.
- Brown, M.; Dinsmore, J.J. 1986. Implications of marsh size and isolation for marsh bird management. *Journal of Wildlife Management* 50:392–397.
- Brown, S.; Hickey, C.; Harrington, B.; Gill, R. (editors). 2001. The U.S. shorebird conservation plan, 2nd edition. Manomet, MA: Manomet Center for Conservation Sciences. [Pages unknown].

- Buller, G. 1976. Indian chapter. In: Broken hoops and plains people – a catalogue of ethnic resources in the humanities: Nebraska and surrounding area. [City, State unknown]: Nebraska Curriculum Development Center. [Pages unknown].
- Bureau of Economic Analysis. 2012. Local area personal income. Table CA25N NAICS (2001-2010), total employment by industry. [Internet]. [Revised date unknown]. <<http://www.bea.gov/regional/reis/>> accessed October 22, 2012.
- Burns and McDonnell. 1999. Quivira National Wildlife Refuge water resources study additional investigations. [City, State: Publisher unknown]. [Pages unknown]. Prepared for U.S. Fish and Wildlife Service.
- Carver, E. and Caudill, J. 2007. Banking on nature 2006: the economic benefits to local communities of National Wildlife Refuge visitation. Washington, DC: U.S. Fish and Wildlife Service, Division of Economics. [pages unknown].
- Castelli, R.M.; Chambers, J.C.; Tausch, R.J. 2000. Soil-plant relations along a soil-water gradient in Great Basin riparian meadows. *Wetlands* 20(2):251–266.
- Chapman, R.N.; Engle, D.M.; Masters, R.E.; Leslie, D.M., Jr. 2004. Tree invasion constrains the influence of herbaceous structure in grassland bird habitats. *Ecoscience* 11(1):55–63.
- Christensen, V.G. 2001. Characterization of surface water quality based on real-time monitoring and regression analysis, Quivira National Wildlife Refuge, south-central Kansas, December 1998 through June 2001. In: Water-Resources Investigations Report 01–4248. Lawrence, KS: U.S. Geological Survey. 28 p.
- Christensen, J.H.; Hewitson, B.; Busuioc, A.; Chen, A.; Gao, X.; Held, I.; Jones, R.; Kolli, R.K.; Kwon, W. T.; Laprise, R.; Magaña Rueda, V.; Mearns, L.; Menéndez, C.G.; Räisänen, J.; Rinke, A.; Sarr, A.; Whetton, P. 2007: Regional climate projections. In: Solomon, S.; Qin, D.; Manning, M.; Chen, Z; Marquis, M.; Averyt, K.B.; Tignor, M.; Miller, H.L.; editors. *Climate change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK; New York: Cambridge University Press. [Internet]. [Revised date unknown]. <http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm> [accessed date unknown].
- Cody, R.L., editor. 1985a. *Habitat selection in birds*. New York: Academic Press. Pages unknown].
- Cody, R.L. 1985b. *Habitat selection in grassland and open-country birds*. *Physiological Ecology Service* p. 191–226.
- Collins, J.T.; Collins, S.L.; Taggart, T.W. 2010. *Amphibians, reptiles, and turtles of Kansas*. [City unknown], UT: Eagle Mountain Publishing. XVI + 312 p.
- Cooper, B.S. 2009. *Sand plum relationships with avian abundance in Oklahoma*. [master's thesis], Stillwater, OK: Oklahoma State University. 65 p.
- Coppedge, B.R.; Engle, D.M.; Masters, R.E.; Gregory, M.S. 2001. Avian response to landscape change in fragmented southern Great Plains grasslands. *Ecological Applications* 11(1):47–59.
- Coppedge, B.R.; Engle, D.M.; Masters, R.E.; Gregory, M.S. 2004. Predicting juniper encroachment and CRP effects on avian community dynamics in southern mixed-grass prairie, USA. *Biological Conservation* 115:431–441.
- Coppedge, B.R.; Fuhlendorf, S.D.; Harrell, W.C.; Engle, D.M. 2008. Avian community response to vegetation and structural features in grasslands managed with fire and grazing. *Biological Conservation* 141:1196–1203.
- Cross, D.; Vohs, P., editors. 1988. *Waterfowl management handbook*. Fort Collins, CO: U.S. Fish and Wildlife Service. [Pages unknown].
- Cutler, W.G. 1883. *History of the State of Kansas*. Chicago, IL: A.T. Andreas. [Pages unknown].
- Davis, C. 2001. Abundance and habitat associations of birds wintering in the Platte River Valley, Nebraska. *Great Plains Research* 11:233–248.
- Dobb, E. 1998. Reality check: the debate behind the lens. *Audubon*: January–February. [Pages unknown].
- Dodge, D.A.; Hoffman, B.R.; Horsch, M.L. 1978. *Soils survey of Stafford County, Kansas*. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service. [Pages unknown].
- (DOI) U. S. Department of the Interior. 2012. *Safetynet*. [Internet]. Revised September 25, 2012. <www.doi.gov/safetynet/#scorecard> [access date unknown].
- Dolin, E.J. 2010. *Fur, fortune, and empire: the epic history of the fur trade in America*. New York: W.W. Norton & Company Inc. 464 p.
- Dunkin, S.W.; Guthery, F.S. 2010. Bird nesting in Chickasaw plum related to age of plum in Oklahoma. *American Midland Naturalist* 164(1):151–156.
- Eberle, M.E.; Welker, T.L.; Welker, T.L. 1996. Survey of fishes from Rattlesnake Creek in central Kansas. *Transactions of the Kansas Academy of Science*. 99(1/2):29–38.
- Economic Research Service. 2012. *State fact sheets: Kansas*. [Internet]. <<http://www.ers.usda.gov/data-products/state-fact-sheets/state-data.aspx?StateFIPS=20&StateName=Kansas>> accessed December 20, 2012.

- Edvarchuk, K.A.; Ransom, C. 2012. Inventory of invasive non-native plant on Quivira National Wildlife Refuge. [Unpublished draft: weed science research project report no. CR1101A 2011]. City, UT: Utah State University, Plants, Soils, and Climate Department for U.S. Fish and Wildlife Service. 34 p. [On file at location unknown].
- (EPA) Environmental Protection Agency. 2011a. National Ambient Air Quality Standards (40 CFR part 50). [Internet]. [Revised date unknown]. <<http://www.epa.gov/air/criteria.html>> accessed December 23, 2011.
- Environmental Protection Agency. 2011b. Science and technology. [Internet]. [Revised date unknown]. <<http://www.epa.gov/gateway/science/air.html>> accessed December 23, 2011.
- Environmental Protection Agency. 2011c. [Title unknown]. [Internet]. Revised September 13, 2011. <<http://www.epa.gov/amad/EcoExposure/index.html>> accessed December 23, 2011.
- Erwin, K.L. 2009. Wetlands and global climate change: the role of wetland restoration in a changing world. *Wetlands Ecology and Management* 17:71–84.
- Estep, M.A. 2000. Quivira National Wildlife Refuge water conservation plan. Lakewood, CO: U.S. Fish and Wildlife Service. [Pages unknown].
- Euliss, N.H., Jr.; LaBaugh, J.W.; Fredrickson, L.H.; Mushet, D.M.; Laubhan, M.K.; Swanson, G.A.; Winter, T.C.; Rosenberry, D.O.; Nelson, R.D. 2004. The wetland continuum: a conceptual framework for interpreting biological studies. *Wetlands* 24:448–458.
- Faber-Langedoen, D., editor. 2001. Plant communities of the Midwest: classification in an ecological context. Arlington, VA: Association for Biodiversity Information. [Internet]. [Revised date unknown]. <www.natureserve.org/library/kansas-subset.pdf> [accessed date unknown].
- Fader, S.W.; Stullken, L.E. 1978. Geohydrology of the Great Bend prairie, south-central Kansas. Irrigation Series No. 4. Lawrence, KS: Kansas Geological Survey. [Pages unknown].
- Farr, K.; Laubhan, R. 2011. Quivira National Wildlife Refuge vegetation mapping project. [Unpublished report]. On file at U.S. Fish and Wildlife Service, [City, State unknown].
- Federal Geographic Data Committee. 2008. National vegetation classification standard. [Internet]. [Revised date unknown]. <<http://biology.usgs.gov/npsveg/vncs.html>> [accessed date unknown].
- Fent, O.S. 1950. Pleistocene drainage history of central Kansas. *Transactions of the Kansas Academy of Science* 53(1):81–90.
- Fuhlendorf, S.D. 1999. Ecological considerations for woody plant management. *Rangelands* 21(1):12–15.
- Fredrickson, L.H.; Taylor, T.S. 1982. Management of seasonally flooded impoundments for wildlife. Resource Publication 148. Washington, DC: U.S. Fish and Wildlife Service. 36 p.
- Gates, F.C. 1937. Grasses in Kansas. In: Report of the Kansas State Board of Agriculture for the Quarter Ending December, 1936. Topeka, KS: Kansas State Printing Plant. [Pages unknown].
- Gazda, R.J.; Meidinger, R.R.; Ball, I.J.; Connelly, J.W. 2002. Relationships between Russian olive and duck nest success in southeastern Idaho. *Wildlife Society Bulletin* 30(2):337–344.
- GEI Consultants, Inc. and Burns and McDonnell. 1998. Quivira National Wildlife Refuge water resource study. Document No. 97–806–4. [City, State: Publisher unknown]. [Pages unknown].
- Geist, V.; Mahoney, S.P.; Organ, J.F. 2001. Why hunting has defined the North American model of wildlife conservation. In: *Transactions of the North American Wildlife and Natural Resources conference*; March 20, 2001; Washington, DC. Washington, DC: Wildlife Management Institute 66:175–85.
- Geist, V.; Organ, J.F. 2004. The public trust foundation of the North American model of wildlife conservation. *Northeast Wildlife* 58:49–56.
- Ghedotti, M.J. 1998. An annotated list of the crayfishes of Kansas with first records of *Orconectes macrus* and *Procambarus acutus* in Kansas. *Transactions of the Kansas Academy of Science* 101 (1–2):54–57.
- Grajeda, R. 1976. Chicano chapter. In: *Broken hoops and plains people—a catalogue of ethnic resources in the humanities: Nebraska and surrounding area*. [City, State unknown]: Nebraska Curriculum Development Center. [Pages unknown].
- Grant, T.A.; Madden, E.; Berkey, G.B. 2004. Tree and shrub invasion in northern mixed-grass prairie: implications for breeding grassland birds. *Wildlife Society Bulletin* 32:807–818.
- Grover, P.B.; Knopf, F.L. 1982. Habitat requirements and breeding success of Charadriiform birds nesting at Salt Plains National Wildlife Refuge, Oklahoma. *Journal of Field Ornithology* 53(2):139–148.
- Hammersmark, C.T.; Rains, M.C.; Wickland, A.C.; Mount, J.F. 2009. Vegetation and water-table relationships in a hydrologically restored riparian meadow. *Wetlands* 29(3):785–797.
- Hands, H.M. 2008. Shorebird (Charadriiformes) migration at selected sites throughout Kansas during 2002–2006. *Transactions of the Kansas Academy of Science* 111(1/2):61–78.
- Harris, M.R. 1999. Diatom survey of Quivira National Wildlife Refuge. [master's thesis]. Fort Hays, KS: Fort Hays State University. 42 p.

- Hathaway, L.R.; Galle, O.K.; Waugh, T.C.; Dickey, H.P. 1978. Chemical quality of irrigation waters in Ford County and the Great Bend prairie of Kansas. Chemical Quality Series 7. Lawrence, KS: Kansas Geological Survey, University of Kansas. 48 p.
- Hauer, F.R.; Spencer, C.N. 1998. Phosphorus and nitrogen dynamics in streams associated with wildfire—a study of immediate and long-term effects. *International Journal of Wildland Fire* 8:183–98.
- Hay, R. 1890. A geological reconnaissance in southwestern Kansas [type of map unknown]. U.S. Geological Survey Bulletin 57. 1–49.
- Heisler, J.L.; Briggs, J.M.; Knapp, A.K. 2003. Long-term patterns of shrub expansion in a C4-dominated grassland: fire frequency and the dynamics of shrub cover and abundance. *American Journal of Botany* 90(3):423–428.
- Heitmeyer, M.E.; Laubhan, R.A.; Artmann, M.J. 2012. Hydrogeomorphic evaluation of ecosystem restoration and management options for Quivira National Wildlife Refuge. Greenbrier Wetland Services Report 12–04. Bloomfield, MO: Blue Heron Conservation Design and Printing LLC. Prepared for U.S. Fish and Wildlife Service, Region 6, Denver, CO.
- Helzer, C.J. 2010. The ecology and management of prairies in the central United States. Iowa City, IA University of Iowa Press. 225 p.
- Helzer, C.J.; Jelinski, D.E. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. *Ecological Applications* 9(4):1448–1458.
- Henszey, R.J.; Pfeiffer, K.; Keough, J.R. 2004. Linking surface- and ground-water levels to riparian grassland species along the Platte River in central Nebraska, USA. *Wetlands* 24(3):665–687.
- Herkert, J.R.; Reinking, D.L.; Wiedenfeld, D.A.; Winter, M.; Zimmerman, J.L.; Jensen, W. E.; Finck, E.J.; Koford, R.R.; Wolfe, D.H.; Sherrod, S.K.; Jenkins, M.A.; Faaborg, J.; Robinson, S.K. 2003. Effects of prairie fragmentation on the nest success of breeding birds in the midcontinental United States. *Conservation Biology* 17(2):587–594.
- Homer, C.H., Fry, J.A., Barnes, C.A. 2012. The national land cover database, U.S. Geological Survey fact sheet 2012–3020. 4 p.
- Huner, J.V. 2000. Macroscopic: crawfish and water birds. *American Scientist* 88(4):301–303.
- Igl, L.D.; Ballard, B.M. 1999. Habitat associations of migrating and overwintering grassland birds in southern Texas. *Condor* 101:771–782.
- Jian, X. 1998. Simulation of canal and control-pond operation at the Quivira National Wildlife Refuge, south-central Kansas. U.S. Geological Survey Water Resources Investigations Report 97–4289.
- Johnsgard, P.A. 1978. The ornithogeography of the Great Plains states. *Prairie Naturalist* 10(4):97–112.
- Johnsgard, P.A. 2009. Birds of the Great Plains (revised edition). [Internet]. [Revised date unknown]. <<http://digitalcommons.unl.edu/biosci-birdsgreatplains/>> accessed July 17, 2012.
- Johnson, R.G.; Temple, S.A. 1990. Nest predation and brood parasitism of tallgrass prairie birds. *Journal of Wildlife Management* 54(1):106–111.
- Kane, S.A. 2011. Breeding habitat structure and use by Kansas-occurring black rail. [master's thesis] Fort Hays, KS: Fort Hays State University. 56 p.
- Kansas Corporation Commission. 2008. 30 meter average windspeed map. [Internet]. [Revised date unknown]. <http://www.kcc.state.ks.us/energy/wind_maps.htm> [accessed date unknown].
- Kansas Department of Agriculture. 2000. Rattlesnake Creek partnership management proposal. [Internet]. [Revised date unknown]. <http://www.ksda.gov/includes/document_center/subbasin/Rattlesnake/RSC_Management.pdf> [accessed date unknown].
- Kansas Department of Agriculture. 2006. Report on the Rattlesnake Creek subbasin. [Internet]. [Revised date unknown]. <<http://www.ksda.gov/subbasin/content/201>> [accessed date unknown].
- Kansas Department of Health and Environment. 2010. Kansas water quality and assessment strategy, 2011–2015. [Internet]. [Revised date unknown]. <<http://www.kdheks.gov/bar/index.html>> accessed December 23, 2011. 47 p.
- (KDWPT) Kansas Department of Wildlife, Parks and Tourism. 2011. Species of concern. [Internet]. [Revised November 14, 2011]. <<http://kdwpt.state.ks.us/news/Services/Threatened-and-Endangered-Species/Threatened-and-Endangered-Species/County-Lists/Stafford-County>> accessed January 5, 2012.
- Kansas Geological Survey and Kansas State University 1997 Final report for the computer model in the Rattlesnake Creek basin. [Internet]. [Revised date unknown]. <<http://www.ksda.gov/dwr/content/367>> [accessed date unknown].
- Kansas Natural Heritage Program, Kansas Biological Survey. 2008. [Title or description of text unknown]. [Internet]. [Revised date unknown]. <<http://www.ksnhi.ku.edu/data/html/avail.gtm>> accessed January 11, 2012.
- Kansas Scenic Byways Program, Wetlands and Wildlife National Scenic Byway. [Internet]. [Revised date unknown]. <<http://www.kansaswetlandsandwildlifescenicbyway.com/index.php>> accessed December 15, 2012.

- Klein, M.L. 1993. Waterbird behavioral responses to human disturbances. *Wildlife Society Bulletin* 21:31–9.
- Klug, P.; Jackrel, S.L.; With, K.A. 2010. Linking snake habitat use to nest predation risk in grassland birds: the dangers of shrub cover. *Oecologia* 162:803–813.
- Klug, P.; Wolfenbarger, L.; McCarty, J.P. 2009. The nest predator community of grassland birds responds to agroecosystem habitat at multiple scales. *Ecography* 32:973–982.
- Knapp, A.K.; McCarron, J.K.; Silletti, A.M.; Hoch, G.A.; Heisler, J.L.; Lett, M.S.; Blair, J.M.; Briggs, J.M.; Smith, M.D. 2008. Ecological Consequences of the replacement of native grassland by *Juniperus virginiana* and other woody plants. In: Van Auken, O.W.; editor. *Western North American Juniperus communities: a dynamic vegetation type*. [City, State unknown]: Springer. 156–169.
- Knopf, F.L. 1986. Changing landscapes and the cosmopolitanism of eastern Colorado avifauna. *Wildlife Society Bulletin* 14:132–142.
- Küchler, A.W. 1974. A new vegetation map of Kansas. *Ecology* 55(3):586–604.
- Latta, B.F. 1950. Geology and ground-water resources of Barton and Stafford Counties, Kansas. *Kansas Geological Survey Bulletin No. 88*. [Pages unknown].
- Laubhan, M.K.; Fredrickson, L.H. 1997. Wetlands of the Great Plains: habitat characteristics and vertebrate aggregations. *Ecological Studies* 125:20–48.
- Laubhan, M.K.; Roelle, J.E. 2001. Managing wetlands for waterbirds. In: Rader, R.B.; Batzer, D.P.; Wissinger, S.; editors. *Biomonitoring and management of North American freshwater wetlands*. New York: John Wiley and Sons, New York. 387–411.
- Laubhan, M.K.; King, S.L.; Fredrickson, L.H. 2012. Managing inland wetlands for wildlife. In: Silvy, N.J.; editor. *The wildlife techniques manual, volume 2*. 7th edition. Baltimore, MD: The Johns Hopkins University Press. 95–132.
- Laughland, A.; Caudill, J. 1997. Banking on nature: the economic benefits to local communities of national wildlife refuge visitation. Washington, DC: U.S. Fish and Wildlife Service. 118 p.
- Lyons, J.; Trimble, S.W.; Paine, L.K. 2000. Grass versus trees: managing riparian areas to benefit streams of central North America. *Journal of the American Water Resources Association* 36(4):919–930.
- Ma, Z.; Cai, Y.; Li, B.; Chen, J. 2010. Managing wetland habitats for waterbirds: an international perspective. *Wetlands* 30:15–27.
- Matthews, J.H. 2008. Anthropogenic climate change in the Playa Lakes Joint Venture region; understanding impacts, discerning trends, and developing responses. Corvallis, OR: World Wildlife Fund. 40 p. Prepared for the Playa Lakes Joint Venture.
- Matthews, W.J.; Endress, A.G. 2008. Performance criteria, compliance success, and vegetation development in compensatory mitigation wetlands. *Environmental Management* 41:130–141.
- Macfarlane, P.A.; Combes, J.; Turbek, S., Kirshen, D. 1993. Shallow subsurface bedrock geology and hydrostratigraphy of southwestern Kansas. *Kansas Geological Survey Open-File Report 93–1a*. [Internet]. [Revised date unknown]. <http://www.kgs.ku.edu/Hydro/Publications/1993/OFR93_1a/> [accessed date unknown].
- McEachern P.; Prepas, E.E.; Gibson, J.J.; Dinsmore, P. 2000. The forest fire induced impacts on phosphorus, nitrogen and chlorophyll a concentrations in boreal sub-arctic lakes of northern Alberta. *Canadian Journal of Fisheries and Aquatic Sciences* 57(Supplement 2):73–81.
- Mitsch, W.J.; Gosselink, J.G. 2003. *Wetlands*. 2nd edition. New York: Van Nostrand Reinhold. 722 p.
- Moreno-Mateos, D.; Power, M.E.; Comín, F.A.; Yockteng, R. 2012. Structural and functional loss in restored wetland ecosystems. *PLoS Biology* 10(1):1–8.
- Morton, J. M. 1995. Management of human disturbance and its effects on waterfowl. In: Whitman, W.R.; Strange, T.; Widjeskog, L.; Whittemore, R.; Kehoe, P.; Roberts, L.; editors. *Waterfowl habitat restoration, enhancement and management in the Atlantic flyway*. 3rd edition. Dover, DE: Environmental Management Committee, Atlantic Flyway Council Technical Section; Delaware Division of Fish and Wildlife. F59–F86.
- Murkin, H.R.; Murkin, E.J.; Ball, J.P. 1997. Avian habitat selection and prairie wetland dynamics: a 10-year experiment. *Ecological Applications* 7(4):1144–1159.
- (Refuge System) National Wildlife Refuge System. 2011. *Conserving the future: wildlife refuges and the next generation*. [City, State: publisher unknown]. 93 p.
- Naugle, D.E.; Higgins, K.F.; Nusser, S.M. 1999. Effects of woody vegetation on wetland birds. *Canadian Field-Naturalist* 113(3):487–492.
- (NOAA) National Oceanic and Atmospheric Administration. 2006. *National climatic data center*. [Internet]. [Revised date unknown]. <<http://www.ncdc.noaa.gov/oa/ncdc.html>> accessed October 25, 2006.
- (NRCS) Natural Resource Conservation Service. 2010. *Ecological site information system, ecological site description*. Quivira National Wildlife Refuge. [Internet]. [Revised date unknown].

- <<http://esis.sc.egov.usda.gov/about.aspx>> [accessed date unknown].
- Ogle, G.A., and Company 1904. Standard atlas of Stafford County, Kansas including a plat book of the villages, cities, and townships of the county. Chicago, IL: Geo. A. Ogle and Company Publishers and Engravers. [Pages unknown].
- Olson, D. and Lindall, S. 1999. IMPLAN professional software, analysis and data guide. [City,State unknown]: Minnesota IMPLAN Group, Inc. [Pages unknown].
- Peterson, G.; Allen, C. R.; Holling, C. S. 1998. Ecological resilience, biodiversity, and scale. *Ecosystems* 1(1):6-18.
- Peterson, D. L.; Egbert, S. L.; Price, K.P.; Martinko, E.A. 2004. Identifying historical and recent land-cover changes in Kansas using post-classification change detection techniques. *Transactions of the Kansas Academy of Science* 107:105-118.
- Poole, A., editor. 2005. The birds of North America online. Cornell laboratory of Ornithology, Ithaca, NY. [Internet]. [Revised date unknown]. <<http://bna.birds.cornell.edu/BNA/>> [accessed date unknown].
- Ratajezak, Z.; Nippert, J.B.; Harman, J.C.; Ocheltree, T.W. 2011. Positive feedbacks amplify rates of woody encroachment in mesic tallgrass prairie. *Ecosphere* 2(11):121. 1-14.
- Rattlesnake Creek/Quivira Partnership. 2000. Rattlesnake Creek management program proposal. Kansas Department of Agriculture, Division of Water Resources. [Internet]. [Revised date unknown]. <<http://www.ksda.gov/subbasin/cid/749>> [accessed date unknown].
- Reinke, D.C. 1981. Enteromorpha, a marine alga in Kansas. *Transactions of the Kansas Academy of Science* 84(4):228-230.
- Reiss, S.A. 1995. Sport in industrial America, 1850-1920. The American history series. Wheeling, IL: Harlan Davidson, Inc. 178 p.
- Reynolds, J.D. 2011. A review of ecological interactions between crayfish and fish, indigenous and introduced. *Knowledge and Management of Aquatic Ecosystems* 401(10). 21 p.
- Ribic, C.A.; Guzy, M.J.; Sample, D.W. 2009. Grassland bird use of remnant prairie and Conservation Reserve Program fields in an agricultural landscape in Wisconsin. *American Midland Naturalist* 161(1):110-122.
- Rosenberg, N.J. 2010. Climate change, agriculture, water resources: what do we tell those that need to know? *Climate Change* 100:113-117.
- Rubin, H.; Young, D.P.; Buddemeier, R.W. 2001. Sources, transport, and management of salt contamination in the ground water of south-central Kansas. Kansas Geological Survey, Open-File Report 2000-60. Version 2.0.
- Samson, F.; Knopf, F.L. 1994. Prairie conservation in North America. *BioScience* 44(6):418-421.
- Sauer, J.R.; Hines, J.E.; Fallon, J. 2008. The North American Breeding Bird Survey, results, and analysis 1966-2007. Version 5.15.2008. Laurel, MD: USGS Patuxant Wildlife Research Center. [Pages unknown].
- Sauer, J.R.; Link, W.A. 2011. Analysis of the North American Breeding Bird Survey using hierarchical models. *Auk* 128(1):87-98.
- Schlager, E.; Heikkila, T. 2011. Left high and dry? Climate change, common-pool resource theory, and the adaptability of western water compacts. *Public Administration Review* May/June 461-470.
- Schoewe, W.H. 1949. The geography of Kansas: part II. physical geography. *Transactions of the Kansas Academy of Science* 52(3):261-333.
- Sexson, K.; Hlavachick, B.; van Zwoll, W. 1985. Kansas deer—resource on the rebound. *Kansas Wildlife* 42:9-24.
- Sexson, K.; Montei, D.; Hlavachick, B. 1985. Landowner deer survey winter 1984-1985. Statewide Wildlife Surveys Federal Aid Project FW-9-P-3. 50 p.
- Sexton, N.R.; Dietsch, A.M.; Don Carlos, A.W.; Koontz, L.; Solomon, A.N.; Miller, H.M. 2012. National Wildlife Refuge System visitor survey 2010/2011: individual refuge results for Quivira National Wildlife Refuge. Fort Collins, CO: U.S. Geological Survey. 25 p. plus appendixes.
- Short, H.L. 1989. A wildlife habitat model for predicting effects of human activities on nesting birds. In: Sharitz, R.R.; Gibbons, J.W.; editors. *Freshwater wetlands and wildlife*. CONF-8603101, Symposium Series No. 61 (NTIS No. DE90-005-384). Oak Ridge, TN: U.S. Department of Energy. 957-973.
- Schoewe, W.H. 1949. Geography of Kansas II; physical geography. *Transactions of the Kansas Academy of Science* 52(3):261-333.
- Sheridan, R. 1956. Economic development in south central Kansas. Lawrence, KS: University of Kansas, School of Business, Bureau of Business SPELL OUT Res. In: Ungar, I.A. 1961. An ecological study of the vegetation of the Big Salt Marsh, Stafford County, Kansas. [Ph.D. dissertation]. Lawrence, KS: University of Kansas. 212 p.
- Skagen, S.K.; Knopf, F.L. 1993. Towards conservation of midcontinental shorebird migrations. *Conservation Biology* 7(3):533-541.
- Skagan, S.K.; Knopf, F.L. 1994. Migrating shorebirds and habitat dynamics at a prairie wetland complex. *Wilson Bulletin* 106(1):91-105.
- Skinner, R.M. 1975. Grassland use patterns and prairie bird populations in Missouri. In: Wali, M.K.; editor. *Prairie: a multiple view*. Grand Forks, ND: University of North Dakota Press. 171-180.

- Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. 2010. Soil survey geographic (SSURGO) database for Stafford, Reno, and Rice Counties, Kansas. [Internet]. [Revised April 12, 2011]. <<http://soildatamart.nrcs.usda.gov>> accessed March 1, 2010.
- Sophocleous, M.A.; Ma, T.S. 1998. A decision support model to assess saltwater vulnerability in the Great Bend prairie aquifer of Kansas. *Ground Water* 36(3):476–483.
- Sophocleous, M.; McAllister, J.A. 1987. Basinwide water-balance modeling with emphasis on spatial distribution of ground water recharge. *Water Resources Bulletin* 23(6):997–1010.
- Sophocleous, M.A.; Perkins, S.P. 1992. Stream-aquifer and mineral intrusion modeling of the lower Rattlesnake Creek with emphasis on the Quivira National Wildlife Refuge, Kansas. Final report. Kansas Geological Survey, Open-File Report 92–6, 204 p.
- Sophocleous, M.A. 1997. Water budget and stream routing study for the Quivira National Wildlife Refuge. [City, State unknown]:Kansas Geological Survey. [Pages unknown]. Report to U.S. Fish and Wildlife Service.
- Sophocleous, M.A. 2000. Quantification and regionalization of groundwater recharge in south-central Kansas: integrating field characterization, statistical analysis, and GIS. *The Compass, University of Kansas, Special Issue* 75(2–3):101–115.
- Sophocleous, M.A. 2003. Groundwater recharge and water budgets of the Kansas high plains and related aquifers. Geological Survey, Kansas Water Resources Institute Report No. KWR102–02. Lawrence, KS: University of Kansas. Kansas 166 p.
- Sophocleous, M.A.; Koelliker, J.K.; Govindaraju, R.S.; Birdie, T.; Ramireddygar, S.R.; Perkins, S.P. 1997. A computer model for water management in the Rattlesnake Creek Basin, Kansas. Final report to Division of Water Resources, Kansas Department of Agriculture. +225 p.
- Staudinger, M.D.; Grimm, N.B.; Amanda Staudt, A.; Carter, S.L.; Chapin III, F.S.; Kareiva, P.; Ruckelshaus, M.; Stein, B.A. 2012. Impacts of climate change on biodiversity, ecosystems, and ecosystem services: technical input to the 2013 national climate assessment. Cooperative report to the 2013 national climate assessment. [Internet]. <<http://assessment.globalchange.gov>> [date accessed unknown]. 296 p.
- Steele, F.A. 1953. History of Stafford County. [City, State: publisher unknown]. [Pages unknown].
- Stynes, D. 1998. Guidelines for measuring visitor spending. [City, State unknown]: Michigan State University, Department of Parks, Recreation and Tourism Resources. [Pages unknown].
- Striffler, P.S. 2011. Quivira National Wildlife Refuge water resource inventory and assessment [Unpublished draft report on file at U.S. Fish and Wildlife Service, Division of Water Resources, Lakewood, CO]. [Pages unknown].
- Thompson, R.A. 1871. Original survey data located at the state auditor's office, Topeka, KS. In: Ungar, I.A. 1961. An ecological study of the vegetation of the Big Salt Marsh, Stafford County, Kansas. [Ph.D. dissertation]. Lawrence, KS: University of Kansas. 212 p.
- Towne, E.G.; Hartnett, D.C.; Cochran, R.C. 2005. Vegetation trends in tallgrass prairie from bison and cattle grazing. *Ecological Applications* 15(5):1550–1559.
- Townsend, M.A.; Young, D.P. 1995. Factors affecting nitrate concentrations in ground water in Stafford County, Kansas. Kansas Geological Survey, Current Research in Earth Sciences, Bulletin 238, part 1. [Internet]. [Revised date unknown]. <<http://www.kgs.ku.edu/Current/1995/Townsend/index.html>> [accessed date unknown].
- Ungar, I.A. 1961. An ecological study of the vegetation of the Big Salt Marsh, Stafford County, Kansas. [Ph.D. dissertation]. Lawrence, KS: University of Kansas. 212 p.
- Ungar, I.A. 1964. A phytosociological analysis of the Big Salt Marsh, Stafford County, Kansas. *Transactions of the Kansas Academy of Science* 67(1):50–64.
- Ungar, I.A. 1965. An ecological study of the vegetation of the Big Salt Marsh, Stafford County, Kansas. *University of Kansas Science Bulletin* 46: 1–98.
- U. S. Census Bureau. 2010a. American fact finder: selected economic characteristics. [Internet]. [Revised date unknown]. <<http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?ref=top&refresh=t>> [accessed date unknown].
- U. S. Census Bureau. 2012b. State & County Quick-Facts. [Internet]. [Revised date unknown]. <<http://quickfacts.census.gov/qfd/index.html>> accessed online December 1, 2012.
- U.S. Department of Agriculture. 2007. State and county profiles: Kansas. Washington, D.C.: National Agriculture Statistics Service. [Internet]. [Revised date unknown]. <http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Kansas/index.asp> accessed December 21, 2012.
- (USFWS) U.S. Fish and Wildlife Service. 1953. Memorandum no. 46 procedure, Great Salt Marsh

- National Wildlife Refuge, Kansas. [City, State: publisher unknown]. [Pages unknown].
- U.S. Fish and Wildlife Service. 1962. Master plan for physical and biological development of Quivira National Wildlife Refuge. Stafford, KS: U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife. [Pages unknown].
- U.S. Fish and Wildlife Service. 1994. An assessment of alternatives for management of upland habitats at the Quivira National Wildlife Refuge. Environmental assessment. [City, State unknown]: [publisher unknown]. [Pages unknown].
- U.S. Fish and Wildlife Service. 1999. Fulfilling the Promise. Arlington, VA: U.S. Department of the Interior, U.S. Fish and Wildlife Service. 94p.
- U.S. Fish and Wildlife Service. 2008a. Birds of conservation concern 2008. Arlington, VA: U. S. Department of Interior, U.S. Fish and Wildlife Service, Division of Migratory Bird Management. 85 p.
- U.S. Fish and Wildlife Service. 2008b. Staffing model for field stations—final report. [Unpublished report on file at Quivira National Wildlife Refuge, Stafford, Kansas]. 22 p.
- U.S. Fish and Wildlife Service. 2011. Environmental assessment use of genetically-modified glyphosate-tolerant soybeans and corn on National Wildlife Refuge lands in the Mountain–Prairie Region (Region 6) [City, State: publisher unknown]. [Pages unknown].
- U.S. Fish and Wildlife Service. 2012a. 2011 National survey of fishing, hunting, and wildlife-associated recreation. [Internet]. [Revised date unknown]. <<http://digitalmedia.fws.gov/cdm/ref/collection/document/id/858>> [date accessed unknown].
- U.S. Fish and Wildlife Service. 2012b. Quivira National Wildlife Refuge. [Internet]. [Revised date unknown]. <<http://www.fws.gov/refuge/quivira/>> accessed December 15, 2012.
- U.S. Fish and Wildlife Service. 2012c. Species by county report, Stafford, KS. [Internet]. [Revised date unknown]. <http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=20185> accessed January 5, 2012.
- U.S. Fish and Wildlife Service. 2012d. Species profile for Arkansas Darter. [Internet]. [Revised July 23, 2012]. <<http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E06H>> [accessed date unknown].
- U.S. Fish and Wildlife Service; Canadian Wildlife Service. 1986. North American waterfowl management plan—a strategy for cooperation. Washington, DC: U.S. Department of the Interior; Gatineau, QC Canada: Environment Canada. 26 p.
- (USGS) U.S. Geological Survey. 2006. Strategic habitat conservation. [Internet]. [Revised date unknown]. <http://training.fws.gov/CSP/Resources/SHC/shc_finalrpt.pdf> [Date accessed unknown].
- U.S. Geological Survey. 2012a. National Wildlife Refuge visitor survey results: 2010/2011: U.S. Geological Data Series 685. [Internet]. [Revised date unknown]. <<http://pubs.usgs.gov/ds/685/>> [Date accessed unknown].
- U.S. Geological Survey. 2012b. Rattlesnake Creek subbasin, hydrologic unit code 11030009. [Internet]. [Revised February 1, 2012]. <<http://water.usgs.gov/lookup/getwatershed?11030009>> [accessed date unknown].
- U.S. Geological Survey. 2012c. Regional economic impacts of current and proposed management alternatives for Quivira National Wildlife Refuge. [City, State unknown]: United States Geological Survey. 17 p.
- U.S. Geological Survey. 2012d. Zenith gage station water data. [Internet]. [Revised date unknown]. <http://waterdata.usgs.gov/nwis/nwisman/?site_no=07142575&agency_cd=USGS> accessed December 20, 2012.
- The University of Kansas Institute for Policy and Social Research. 2012. Population projections for Kansas, by county 2010–2040, selected years. [Internet]. <<http://www.ipsr.ku.edu/ksdata/ksah/population/2pop17.pdf>> accessed December 21, 2012.
- VerCauteren, T.; Gillihan, S.W. 2004. Integrating bird conservation into range management. [City unknown], CO: Rocky Mountain Bird Observatory. [Pages unknown].
- Wasson, T., Yasui, L.; Brunson, K.; Amend, S.; Ebert, V. 2005. A future for Kansas wildlife, Kansas' comprehensive wildlife conservation strategy. [City, State unknown]: Dynamic Solutions, Inc. in cooperation with Kansas Department of Wildlife, Parks and Tourism. 170 p.
- Wedel, W.R. 1942. Prehistory and environment in the central Great Plains. Transactions of the Kansas Academy of Science 50(1):1–18.
- Weller, M.W.; Spatcher, C.S. 1965. Role of habitat in the distribution and abundance of marsh birds. Agriculture and Home Economics Experiment Station Special Report 43. Ames, IA: Iowa State University of Science and Technology. [Pages unknown].
- West, R.R.; Miller, K.B.; Watney, W.L. 2010. The Permian system in Kansas. Kansas Geological Survey Bulletin 257. [Internet]. [Revised date unknown]. <<http://www.kgs.ku.edu/Publications/Bulletins/257/index.html>> [accessed date unknown].
- Whited, D.; Galatowitsch; Tester, J.R.; Schik, K.; Lehtinen, R.; Husveth, J. 2000. The importance of local and regional factors in predicting effective conservation planning strategies for wetland bird

- communities in agricultural and urban landscapes. *Landscape and Urban Planning* 49:49–65.
- Wichita State University. 2011. Kansas county population forecast; summary and methodology. [Internet]. [Revised date unknown]. <<http://www.cedbr.org/content/2012/kspopulationforecast.pdf>>, accessed December 21, 2012.
- Wiens, J.A. 1973. Patterns and process in grassland bird communities. *Ecological Monographs* 43:237–270.
- Wiens, J.A.; Bachelet, D. 2010. Matching the multiple scales of conservation with the multiple scales of climate change. *Conservation Biology* 24(1):51–62.
- Wilcox, I.B. 1870. Original survey data location at the state auditor's office, Topeka, KS. . In: Ungar, I.A. 1961. An ecological study of the vegetation of the Big Salt Marsh, Stafford County, Kansas. [Ph.D. dissertation]. Lawrence, KS: University of Kansas. 212 p.
- Winter, M.; Johnson, D.H.; Faaborg, J. 2000. Evidence for edge effects on multiple levels in tall-grass prairie. *Condor* 102(2):256–266.
- Winter, M.; Johnson, D.H.; Shaffer, J.A. 2006a. Does body size affect a bird's sensitivity to patch size and landscape structure? *Condor* 108:808–816.
- Winter, M.; Johnson, D.H.; Shaffer, J.A.; Donovan, T.M.; Svedarsky, W.D. 2006b. Patch size and landscape effects on density and nesting success of grassland birds. *Journal of Wildlife Management* 70(1):158–172.
- With, K.A.; King, A.W.; Jensen, W.E. 2008. Remaining large grasslands may not be sufficient to prevent grassland bird declines. *Biological Conservation* 141:3152–3167.
- Zedler, J.B.; Kercher, S. 2005. Wetland resources: status, trends, ecosystem services, and restorability. *Annual Review of Environmental Resources* 30:39–74.
- Zeller, D.E., editor. 1968. The stratigraphic succession in Kansas. *Kansas Geological Survey Bulletin* 189. [Revised date unknown]. <<http://www.kgs.ku.edu/Publications/Bulletins/189/index.html>> accessed June 20, 2012.

