RICH COUNTY COORDINATED RESOURCE MANAGEMENT GREATER SAGE-GROUSE (*CENTROCERCUS UROPHASIANUS*) CONSERVATION PLAN
FINAL DRAFT

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Rich County Coordinated Resource Management Sage-grouse Subcommittee

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Rich County Greater Sage-grouse (*Centrocercus urophasianus*)
Local Conservation Plan

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I. Executive Summary

The Rich County Greater Sage-grouse Conservation Plan is the culmination of a year of effort by the Rich County Coordinated Resource Management Sage-grouse Subcommittee (hereafter referred to as the CRM SAGR Subcommittee). CRM SAGR Subcommittee members include representatives from state and federal land management and resource agencies, non-governmental organizations, and private landowners. CRM SAGR Subcommittee formed in 2005 at the behest of the Rich County Coordinated Resource Management group (hereafter referred to as the CRM) to proactively manage Greater Sage-grouse (*Centrocercus urophasianus*) populations and their habitats in their local area in response to increasing concern about the status of sage-grouse populations rangewide and within their local area. The impetus for the writing of this Plan came from a mandate by the Utah Division of Wildlife Resources (UDWR) in their Statewide Strategic Management Plan which was passed by the Wildlife Board in 2002.

The Plan provides an assessment of the status of the Rich County sage-grouse population. The intent of the Plan is to provide guidance and recommendations to meet the overall goal of maintaining and, where possible, increasing sage-grouse populations and improving habitat conditions in Rich County. The Plan is designed to meet the guidelines set forth by the USFWS in their Policy for Evaluation of Conservation Efforts (PECE) standards.

The Plan directly and indirectly addresses the 5 USFWS listing factors as they apply to Greater Sage-grouse in Rich County. Recommendations and guidance suggested within the Plan can be adopted by all CRM partners on a voluntary basis. The CRM SAGR Subcommittee encourages participation and adoption of these practices, where applicable, by private landowners in the local area. Participation by private landowners and consideration of the landowners' needs are critical for management of sage-grouse populations and habitat located on private lands and will be of great importance to meet the overall goals of the Plan. True success cannot be achieved without managing on an overall landscape scale. The Plan provides an opportunity to promote ecologically sound management of private and public lands for sage-grouse without impinging on private property rights.

Information contained in the Plan is based on a thorough review of the published and unpublished literature relevant to sage-grouse and sagebrush habitats as well as an in-depth, local knowledge possessed by CRM SAGR Subcommittee partners who live and work in Rich County. Because a wealth of general information exists about sage-grouse and is available in published documents, we provide only a brief overview of general sage-grouse ecology and tried to focus on conditions and issues specific to Rich County. Knowledge gaps are also identified.

Sage-grouse are a sagebrush obligate species that depend on a variety of habitats throughout their annual life cycle. Between March and May, sage-grouse congregate on lek sites to display and mate. Lek sites are typically located in openings in the sagebrush with shorter vegetation. Hens often nest near lek sites (within two miles), where they will build a shallow depression nest under a sagebrush bush or other shrub of suitable height. Broods hatch after about 32 days and typically stay near the nest site if suitable habitat is available. As summer progresses, sage-grouse broods move to wetter areas where available, or to higher elevations where food resources are more abundant. Males and unsuccessful hens follow similar habitat-use patterns in late summer. Sage-grouse lack a well-developed gizzard and eat soft plant parts, sagebrush

leaves, and insects. Young sage-grouse especially depend on succulent forbs and insects for nutrition and protein as they grow. In winter, sage-grouse congregate in larger flocks in areas where sagebrush remains uncovered by snow, as their primary food source in winter is sagebrush leaves. Some populations of sage-grouse are migratory, moving >10km to winter habitat, while others are non-migratory and remain near breeding habitat throughout the year.

Rich County is among the largest populations of sage-grouse in Utah. There are 8 lek complexes in Rich County with a total of 46 active and historic lek sites. The UDWR has been monitoring sage-grouse lek sites and the number of strutting males in Rich County since 1959. Early counts often included less than 10 lek sites and were likely under-representative of the total number of leks and, therefore, the total breeding population. In the last 5 years, over 30 leks have been monitored and previously unknown lek sites are discovered regularly. Although sage-grouse populations in Rich County seem to be experiencing an increasing trend since 1959, this could simply be due to increased monitoring efforts and an increase in the number of leks monitored.

Threats currently or potentially affecting sage-grouse and sagebrush habitats in Rich County were analyzed by CRM SAGR Subcommittee partners. Threats identified and analyzed by CRM SAGR Subcommittee partners included livestock grazing, predation, home/cabin development, renewable and nonrenewable energy development, historic vegetation treatments, drought, roads, and power lines/fences/other tall structures. The Threat Analysis, combined with recommended strategies and actions provides a framework for implementation of the Plan for the next ten years by the CRM..

Implementation of Plan strategies and actions will be conducted within an adaptive resource management framework. As relevant information from a local and rangewide perspective becomes available, it will be used to modify and refine management strategies, priorities, and general understanding of sage-grouse ecology in Rich County. Annual evaluation and reporting will be conducted by the CRM SAGR Subcommittee to track progress on the strategies and actions outlined in this Plan.

Information contained in the Plan is based on a thorough review of the published and unpublished literature relevant to sage-grouse and sagebrush habitats and also on the intimate, local knowledge possessed by CRM SAGR Subcommittee partners who live and work in the local area. Because a wealth of general information exists about sage-grouse and is available in published documents, we only provide a brief overview of general sage-grouse ecology and have tried to focus on conditions and issues specific to Rich County. Knowledge gaps are also identified.

II. Introduction

A. Purpose

The mission of the Rich County Adaptive Resource Management Sage-grouse Conservation Plan (Plan) is to help reach the goal of maintaining and improving current abundance and viability of Greater Sage-grouse (*Centrocercus urophasianus*) populations and their habitat in Rich County while taking into consideration historical land uses and long term social economic issues. The Plan will help to meet this goal by providing local management solutions based on local or compatible data and research to the extent practicable. In addition, the CRM SAGR Subcommittee hopes to develop management solutions that will result in diverse and productive sagebrush habitat for sage-grouse while recognizing healthy sagebrush habitats are valuable to the existence of other species. The Plan will identify management areas, key local issues, conservation strategies, population information, research and monitoring needs, and support long term funding. Adaptive management will be used to maintain the Plan as a continuously evolving document. In addition, the Plan will coordinate development of project proposals with the Northern Region Utah Partners for Conservation and Development Regional Team to maintain and enhance sage-grouse habitat.

This Plan was called for in, and builds on the Utah Greater Sage-grouse Strategic Management Plan (Strategic Plan) that was passed by the Utah Wildlife Board in 2002. The Strategic Plan was developed by the Utah Greater Sage-grouse Working Group, which included representatives from state and federal natural resource agencies and local conservation organizations concerned with the health and proper management of Greater Sage-grouse and sagebrush-steppe ecosystems throughout Utah. The primary purpose of the Strategic Plan was to address declining populations of sage-grouse and to develop a framework for agencies to work under. Further, the Strategic Plan identified certain management units throughout the state where local community group could be organized to identify local issues and implement local adaptive resource management plans to address declining sage-grouse populations, and the loss, degradation, and fragmentation of sagebrush steppe communities, and the protection and conservation of these and other natural resources into the future.

The Plan contains conservation and management strategies and actions designed to meet the guidelines promulgated by the USFWS in their Policy for Evaluation of Conservation Efforts (PECE) standards. The USFWS uses PECE standards as a guideline to evaluate whether conservation efforts will be considered when making listing decisions. The Plan was also written to address the USFWS' 5 Listing Factors:

1. Present or threatened destruction, modification, or curtailment of its habitat or range
2. Over-utilization for commercial, recreational, scientific, or educational purposes
3. Disease or predation
4. Authorities and inadequacy of existing regulatory mechanisms
5. Other natural or man-made factors affecting its continued existence

The Plan directly and indirectly address the 5 USFWS listing factors as they apply to Greater Sage-grouse (hereafter referred to as sage-grouse) in Rich County. In addition, the Plan will identify issues, potential strategies, and provide for implementation of proposed conservation actions. The Plan is neither a National Environmental Policy Act (NEPA) decision document

nor a federal or state recovery plan. Any Candidate Conservation Agreement with Assurances developed by the UDWR will be based on the Plan, but will include the NEPA process. Use of this plan by agencies, private enterprise, and private individuals is strictly voluntary. State and federal resource management agencies involved with sage-grouse management, however, are required to manage sage-grouse populations and habitat by various state and federal statutes and policies. The information contained in the Plan is intended to serve as a set of guidelines for those state and federal agencies to maintain and enhance sage-grouse habitat and sage-grouse populations in Rich County. Participation by private landowners and consideration of the landowners' needs are critical for management of sage-grouse populations and habitat located on private lands and will be of great importance to meet the overall goals of the Plan. True success cannot be achieved without managing on an overall landscape scale. The Plan provides an opportunity to promote ecologically sound management of private and public lands for sage-grouse without impinging on private property rights.

B. Goals and Scope

The goals of the Plan are separated into 2 categories: Assessment and Strategy Goals. The goals are not listed in any particular order.

Assessment Goals:

The Plan will provide an assessment of the status of Rich County sage-grouse population by accomplishing the following goals:

1. Estimate current population size and evaluate population trends; estimate amount and condition of habitat.
2. Identify research needs and knowledge gaps.
3. Determine population and habitat needs for the future.
4. Identify and discuss threats that potential impact sage-grouse in Rich County, especially those associated with the 5 USFWS Listing Factors.

Strategy Goals:

The intent of the Plan is to maintain and, where possible, increase sage-grouse populations and improve habitat conditions in Rich County by meeting the following goals:

1. Implement appropriate management strategies to conserve sage-grouse and their habitats.
2. Increase effective communication with all potential stakeholders in Rich County and the state of Utah through outreach, information distribution, and education.
3. Address and prioritize threats to aid in prioritizing management solutions.
4. Identify and pursue funding sources, or support partners in their pursuance of funding for projects that will help achieve specific strategies and actions.

Scope

This Plan is designed to span multiple land ownerships and multiple land uses throughout its geographic area. It is hoped that through implementation of this adaptive plan specific conservation issues will be addressed, implemented, and monitored across geographic and

political boundaries to increase consistency of practices implemented and information collected. The assessment and strategies described herein are specific to Rich County and were developed with the unique ecological, social, and economic concerns of that area in mind. A detailed description of the location and characteristics of Rich County is provided later in the Plan.

C. Plan Duration

The Plan was designed and written to be a dynamic, adaptive document that can change with the needs of the local sage-grouse population, habitats, and local community as necessary. The CRM SAGR Subcommittee will re-evaluate sage-grouse populations and habitats and will review progress on strategies listed in the Plan annually. The Plan was written to support conservation actions over a 10-year period. Early termination of the Plan would occur if the sage-grouse was listed under the Endangered Species Act (ESA) or if sage-grouse were removed from the UDWR's Sensitive Species list. Species on the Sensitive Species list include species that are federally listed, are candidates for federal listing, or for which there is "credible scientific evidence to substantiate a threat to continued population viability" (UDWR 2006).

D. Rich County Coordinated Resource Management Sage-grouse Subcommittee

In June of 2002 the Rich County Commission determined that the county should take a cooperative and proactive role in the future health of the public lands and sustainability of livestock operations within the county. The Rich County Coordinated Resource Management (CRM) Committee was formed under the direction of the commission involving a wide diversity of interest groups and agency representatives from inside and outside the county. By building trust, leadership, and respect, the group provided a vision for the resources in Rich County: A rich, healthy ecosystem, with sustainable agriculture industry and wildlife populations, containing diverse recreational opportunities and a vibrant rural community.

In response to the Strategic Plan, the CRM Committee elected to form a subcommittee in 2005 that would deal specifically with issues related to sage-grouse. Since that time, the CRM SAGR Subcommittee and has worked consistently and cooperatively toward the completion and implementation of this Plan. The CRM SAGR Subcommittee was facilitated by Sarah G. Lupis of Utah's Community-Based Conservation Program (CBCP), a collaborative partnership between the UDWR and Utah State University Extension Services, with support from the Jack H. Berryman Institute. Ms. Lupis also served as the technical writer and compiler of the Plan itself. The CRM SAGR Subcommittee is comprised of state and federal agency personnel, non-profit organizations, academic institutions, and private individuals. The agencies, organizations, and individuals who contributed to the Plan through their participation in the CRM SAGR Subcommittee are listed in Table 1. When "we" or "our" is used in the Plan it refers to the CRM SAGR Subcommittee.

The role of CRM SAGR Subcommittee participants was to guide the development of the Plan and to represent their agencies and/or organizations. After completion of the plan, CRM SAGR Subcommittee participants will continue to meet to update the Plan, incorporating the results of research and monitoring efforts, new information, and lessons learned through an adaptive management process. Guidance for continued operation of the CRM SAGR Subcommittee can be found in the CRM System Manual (CRM 2005).

Prior to writing the Plan, we reviewed several local sage-grouse conservation plans, statewide plans, and rangewide plans and assessments (UDWR 2002, Armentrout et al. 2004, Lincoln County Sage-grouse Technical Review Team 2004, Northwest Colorado Greater Sage-Grouse Working Group 2004), to determine the most appropriate structure and content. In addition, a thorough literature review was conducted to ensure that the Plan contained the most recent information available on sage-grouse ecology, life history, and habitat requirements. Annual meetings, work plans, and accomplishment reports will monitor progress toward meeting the goals of the Plan. The Plan is intended to be an evolving document. Incorporating principles of adaptive management and changing as new information arises will help to ensure success of the Plan and the CRM.

Table 1. Rich County Coordinated Resource Management Sage-grouse Subcommittee agency, industry, and private partners.

Utah Division of Wildlife Resources (UDWR)
USDA Forest Service (USFS)
Bureau of Land Management (BLM)
Utah State University Extension (USU/EXT)
Wild Utah Project (WUP)
The Nature Conservancy (TNC)
Foundation for Quality Resource Management (QRM)
Deseret Land and Livestock (DLL)

Management strategies and recommendations described in the Plan will be periodically updated to incorporate results of research efforts, new information, and the results of management actions through annual reviews and progress reports.

The CRM SAGR Subcommittee operates through an open public process based on consensus decision making. For decisions regarding the Plan, consensus was reached by participating members and/or those present at the time the decision was made. Sections 5 and 6 of the ESA direct state and federal agencies to cooperate to develop conservation activities that protect candidate species. Because the responsibility lies with state and federal agencies, ultimately decisions are limited to them. However, all agencies felt that it was important to involve the public in the decision making and planning process to the greatest extent possible. The importance of public-private partnerships was highlighted in the Statewide Strategic Management Plan (UDWR 2002):

> "An important part of solving the habitat management problems that face sage-grouse, is to work together closely so that all landowners and land managers are aware of the needs of local populations and how to meet them."

The CRM SAGR Subcommittee provided regular opportunities for public involvement, participation, and comment on the Plan. Regular meetings were scheduled to meet the needs of the greatest number of CRM SAGR Subcommittee participants possible. Meetings were

announced via direct mailings, on the CBCP web site (www.extension.usu.edu/cbcp), via email, and through personal phone calls and invitations. During the planning process, the CRM SAGR Subcommittee meet at least every other month and often every month. Meeting minutes and critical updates were provided via email, direct mailing, and on the CBCP web site. In addition, an regular progress reports were delivered to the CRM Committee on the activities of the CRM SAGR Subcommittee to solicit participation and comment from local stakeholders. The CBCP provided informational material to County Extension offices for display and distribution to the local community and CBCP personnel met regularly with County governments (commissions and councils) to update them on the CRM SAGR Subcommittee activities and the Plan's progress. The final draft of the Plan was endorsed by the CRM and the UDWR and was then made available to the public. Comments on the final document will be accepted and considered as part of an adaptive management process.

E. Socio-economic Considerations Including Consequences of Federal Listing

Communities in the Intermountain West are reflective of diverse and complicated relationships between natural resource extraction industries (agriculture, minerals, energy development, etc.), landownership (private vs. public) and local, state, and federal laws and regulations. These rural communities are also reflective of cyclic (boom/bust) economics and global economics that drive commodity prices. In order to be successful, management recommendations and solutions designed to improve sage-grouse populations and habitats must be reflective and sensitive to local socio-economic issues.

State and federal agencies will coordinate with local landowners, county, and local governments to develop solutions that will meet ecological requirements while maintaining social and economic values of the local community to the greatest extent possible. Participation by local stakeholders in the planning process has also helped to ensure that recommendations and guidelines presented in the Plan will meet the needs of the local community. In many instances, cooperation between landowners and agencies results in more effective, cost-effective, and efficient habitat improvement projects that ultimately benefit both sage-grouse and local interests.

Listing the sage-grouse under the provisions of ESA could have a variety of local impacts. Activities that could be affected include noxious weed control, maintenance of rights of ways, subdivisions and land development, livestock grazing management, big game wildlife management, and recreational land use. Broadly applying "take" regulations under the ESA could have a significant local impact. There will likely be an increase in bureaucratic processes in environmental permitting and compliance. Ultimately, the listing could result in delays and/or the elimination of new projects because of the increased cost of environmental permitting and compliance.

In the event of listing, this Plan, along with other local conservation plans, statewide conservation plans, and rangewide conservation assessments and strategies will be used by the USFWS to develop a federal recovery plan. Should these events transpire, the USFWS will also strive to consider social and economic needs to the maximum extent possible. In the July 1, 1994 Federal Register (59 FR 34272) the USFWS issued a policy to involve stakeholders in the preparation of federal recovery plans to help minimize the social and economic impacts of implementing recovery actions.

F. Management and Legal Authorities

Existing state, federal, and county regulations offer protection to sage-grouse in Rich County. State laws restrict possession of individual birds. Funding programs in Utah support population and habitat conservation and monitoring activities. Federal agencies including the Bureau of Land Management (BLM), U.S. Forest Service (USFS), National Park Service (NPS), Natural Resources Conservation Service (NRCS), and USFWS have laws, regulations, policies, and funding programs that authorize and support conservation efforts.

Utah Division of Wildlife Resources

Title 23 of the Utah Code is the Wildlife Resources Code of Utah and provides the UDWR with the powers, duties, rights, and responsibilities to protect, propagate, manage, conserve, and distribute wildlife throughout the state. Section 23-13-3 declares that wildlife existing within the state, not held by private ownership and legally acquired, is property of the state. Sections 23-14-18 and 23-14-19 authorize the Utah Wildlife Board to prescribe rules and regulations for the taking and/or possession of protected wildlife.

The UDWR's wildlife management philosophy is captured in its Mission Statement, Strategic Plan, and Comprehensive Wildlife Conservation Strategy (CWCS) approved in 2005 (also known as the Utah Wildlife Action Plan). The mission of the Division of Wildlife Resources is "…to serve the people of Utah as trustee and guardian of the state's wildlife, and to ensure its future and values through management, protection, conservation and education." There are three goals associated with this mission. The resource goal states that the UDWR intends to, "Expand wildlife populations and conserve sensitive species by protecting and improving wildlife habitat." The UDWR 2005-2015 Strategic Plan calls for focusing efforts on increasing the abundance, distribution, and range for species of conservation need by sustaining and restoring habitat functions. A ten-year, 2005-2015 Comprehensive Wildlife Strategy (a.k.a. Utah Wildlife Action Plan) was approved in 2005 to address species and habitat of greatest conservation need, priorities for conservation, and actions and future implementation opportunities through partnerships.

Sage-grouse are classified as "State Species of Concern" and are among the terrestrial species identified as being in the second tier (i.e., Tier II) of 3 priority categories of species identified in the CWCS. Approximately 60 species across 5 taxa in Utah are identified as being potentially petitioned for placement on the ESA defined Threatened and/or Endangered Species list.

Counties

The Board of Commission for Rich County serves as the executive and legislative branch of local government. The Board has the authority to 1) protect and promote the health, welfare, and safety of the people of Rich County 2) regulate land use, land planning, and quality and protection of natural resources; and 3) has duly adopted regulations and policies to exercise such authorities including the review and approval or denial of proposed activities and uses of land and natural resources (CRM 2005).

Natural Resources Conservation Service

The USDA NRCS has authority to conserve sage-grouse through: 1) the Soil Conservation and Domestic Allotment Act of 1936, as amended (P.L. 74-46; 2) the Department of Agriculture reorganization Act of 1994 (P.L. 409-354; 7 U.S.C. 6962); and the Farm Security and Rural Investment Act (Farm Bill) of 2002 (P.L. 107-171).

The NRCS and Farm Service Agency (FSA) jointly implements programs, which provides landowners with technical and financial assistance to restore and protect grassland, rangeland, pastureland, shrub land and certain other lands, through long-term agreements and easements.

The USDA NRCS offers help to private land owners through the 2002 Farm Bill programs to improve their range and pasture land to improve sage grouse habitat. These practices include watershed practices on their private lands such as water developments and fencing for prescribed grazing to improve livestock distribution. Vegetative or brush management practices with the seeding of introduced and native species of grasses and forbs for forage improvement to benefit both wild life and domestic animals. Other Farm Bill programs include wildlife enhancement, conservation easements, watershed and riparian programs and programs to reduce soil erosion.

Bureau of Land Management

The United Sates Department of Interior (USDI) BLM has authority for conservation of sage-grouse through: 1) the Federal Land Management Policy Act (FLMPA) of 1976 (43 U.S.C. 1701 et seq.; 90 stat. 2743; PL 94-579; 2) the Sikes Act, Title II (16 U.S.C. 670 et seq.), as amended; and 3) the BLM Manual 6840, Special Status Species Management. Specifically, the FLMPA guidance on sensitive species authorizes that "the public lands be managed in a manner tat will protect the quality of scientific, scenic, historical, ecological, and environmental, air, and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals…(43 U.S.C. 1701 Sec. 102 (a) (8))."

The 6840 Manual defines Special Status Species as "…any species which is listed, or proposed for listing, as threatened or endangered by the U.S. Fish and Wildlife Service or National Marine Fisheries Service under the provisions of the Endangered Species Act; any species designated by the U.S. Fish and Wildlife Service as a 'listed', 'candidate', 'sensitive' or 'species of concern', and any species which is listed by the State in a category implying potential danger of extinction." The Manual provides for the BLM to implement management plans that conserve these species and their habitats, and to ensure that actions authorize, funded, or carried out by the BLM do not contribute to the need for the species to become listed under provisions of the ESA. In addition, the USFWS Policy: State-Federal Relationships (43CFR part 24.4 (c)) contends that the Secretary of the Interior is responsible for the management of non-wilderness BLM lands for multiple uses, including the conservation of fish and wildlife populations. Finally, the BLM provides conservation guidelines for management of sage-grouse on BLM lands in the National Sage-grouse Habitat Conservation Strategy (BLM 2005a).

School and Institutional Trust Lands Administration

The Utah School and Institutional Trust Lands Administration (SITLA) was created in 1994 to manage 12 real estate trusts granted to the state at statehood (1896) to Utah by the United States

federal government. SITLA is an independent agency of state government established to manage those lands for the support of common schools and other beneficiary institutions, under the Utah Enabling Act (Title 53C-School and Institutional Trust Lands Management Act).

Title to these trust lands is vested in the state as trustee to be administered for the financial support of the trust beneficiaries. As trustee, SITLA must manage the lands and revenues generated from the lands in the most prudent and profitable manner possible, and not for any purpose inconsistent with the best interest of the trust beneficiaries. The trust principles impose fiduciary duties upon the state, including a duty of undivided loyalty to, and a strict requirement to administer the trust corpus for the exclusive benefit of, the trust beneficiaries. The beneficiaries do not include other governmental institutions or agencies, the public at large, or the general welfare of the state. SITLA must be concerned with both incomes for the current beneficiaries and the preservation of the trust corpus for future beneficiaries, which requires a balancing of short and long-term interests so that long-term benefits are not lost in an effort to maximize short-term gains. SITLA has no jurisdiction over wildlife populations on trust lands. Management of rangelands is addressed in Section 53C-5-101 of the School and Institutional Trust Lands Management Act, which states: 1) The director is responsible for the efficient management of all range resources on lands under the director's administration, consistent with his fiduciary duties of financial support to the beneficiaries; and 2) This Management shall be based on sound resource management principles.

United States Forest Service

The United States Department of Agriculture (USDA) Forest Service (USFS) has authority for conservation of sage-grouse though: 1) the Multiple-Use Sustained Yield Act (MUSY) of 1960 (P.L. 86-517, 74 Stat. 215, 16 U.S.C. 528, 528-531); 2)the Sikes Act of 1960 (P.L. 86-797, 74 Stat. 1052, 16 U.S.C 670 et seq., as amended); 3) the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 (P.L. 93-378, 88 Stat. 476, as amended; 16 U.S.C. 1600, 1600-1614); 4) the National Forest Management Act (NFMA) of 1976 (P.L. 94-588, 90 Stat. 2949, 16 U.S.C. 472 et seq.) and its implementing regulations (36 CFR 219) (USFS 2005); 5) Public rangelands Improvement Act of 1978 (P.L. 95-514, 92 Stat. 1806, 43 U.S.C. 1901-1908); and 6) USDA Regulation 9500-4 and the Forest Service Manual (FSM) Chapter 2600. MUSY directs the USFS to administer the National Forest for multiple uses including fish and wildlife purposes, in cooperation with interested State and local governmental agencies and others. “Multiple use” refers to the congruent and coordinated management of the various surface renewable resources so that they are utilized in a manner that will best meet the needs of the American people. The Sikes Act provides authority for cooperative planning, habitat improvement, and providing adequate protection for species considered to be threatened, rare, or endangered by a State agency. RPA and NFMA provide for comprehensive, integrated planning that will provide for the diversity of plant and animal communities to met overall multiple-use objectives. USDA Regulation 9500-4 directs the USFS to manage me “habitats for all existing native and desired nonnative plants, fish and wildlife species in order to maintain at least viable populations of such species.” USFS policy includes provisions for the development of conservation strategies for species that could be negatively affected by forest plans or proposed projects (FSM 2621.2).

Memorandum of Understanding

There are 2 Memoranda of Understanding (MOU) that address conservation of sage-grouse. The first was signed in 1999 by members of the Western Association of Fish and Wildlife Agencies (WAFWA) to promote conservation and management of sage-grouse and their habitats. Thirteen states, including Utah, and 2 Canadian provinces were signatories to that MOU. The second MOU, signed in 2000, is between WAFWA, USFS, BLM, and the USFWS. This MOU provides for cooperation among state, provincial, and federal agencies in the development of a rangewide strategy to direct conservation of sage-grouse and their sagebrush habitats.

G. Policy for Evaluation of Conservation (PECE) Standards

The PECE Standards set criteria for the USFWS to use in determining whether a formalized conservation effort contributes to making listing a species unnecessary or contributes to forming a basis for listing a species as threatened rather than endangered. The draft PECE was published on June 13, 2000 (65 FR 37102), and was finalized on March 28th, 2003 (68 FR 15100-115). The PECE contains 9 criteria the USFWS will use to evaluate that the conservation effort will be implemented, and 6 criteria to determine if the action will be effective. Conservation efforts included under this policy include those identified in conservation agreements, conservation plans, management plans, or similar documents developed by federal agencies, state and local governments, tribal governments, businesses, organizations, individuals, and a combination of the above. The criteria are not considered comprehensive; the USFWS will consider all appropriate factors and unique, specific circumstances when evaluating formalized conservation actions.

PECE reviews will be conducted on individual conservation actions (rather than conservation plans). Should Greater sage-grouse be petitioned for listing or be listed under the ESA, this Plan and subsequent annual reports on the progress of this Plan, will be reviewed and assessed as part of the preparation of a listing decision, and will follow the most recent procedural guidance.

III. Conservation Assessment

A. General Sage-grouse Biology/Ecology

Numerous authors have described various aspects of sage-grouse biology, ecology, and life history; several more have, in recent years, published summaries. For the purposes of this document, we have included the summary from the Statewide Strategic Plan (UDWR 2002) and would also recommend the Conservation of Sage-grouse and Sagebrush Habitats by Connelly et al. (2004) for a thorough discussion.

Physical Description

The sage-grouse is the largest grouse species in North America. Adult males are larger than adult females. Adult males weigh 4-7 pounds (1.7-2.9 kg) and are 27-32 inches (65-75 cm) long compared to adult females weighing 2-4 pounds (1.0-1.8 kg) and measuring 20-25 inches (50-60 cm) long. Both sexes have narrow, pointed tails and a variegated pattern of grayish brown, buff, and black on the upper parts of the body and a diffuse black abdominal pattern. Males have blackish brown throats and a dark V-shaped pattern on the neck, and white breast feathers. When strutting, males inflate two gular sacs of olive green skin and erect hair-like black feathers (filoplumes) on the back of the neck. Females lack the V-shaped pattern, their throats are buff and their lower throats and breasts are barred with blackish brown (Schroeder et al. 1999).

There are noticeable morphological differences between Greater Sage-Grouse and Gunnison Sage-Grouse. Gunnison Sage-Grouse are two-thirds the size of Greater Sage-Grouse. Gunnison Sage-Grouse tail feathers have horizontal white barring along their length compared to a variegated pattern found in Greater Sage-Grouse. The filoplumes, found only on male sage-grouse, are much thicker and dense in Gunnison Sage-Grouse than in Greater Sage-Grouse. There are also noticeable differences in the strutting behavior of the two sage-grouse species (Young et al. 2000).

Seasonal Movements and Home Range

Sage-grouse populations can be defined as one of two types: 1) non-migratory - grouse do not make long-distance movements between seasonal ranges; and 2) migratory - grouse make long-distance movements between distinct seasonal ranges. Seasonal movements between seasonal ranges can exceed 45 miles (75 km) (Connelly et al. 1993).

Home range size for migratory sage-grouse populations can exceed 540 mi^2 (1,500 km^2) (Hulet 1983). For non-migratory sage-grouse populations, home range size varies from 4-11 mi^2 (11 to 31 km^2). Sage-grouse exhibit high fidelity to seasonal ranges (Fischer et al. 1993). Females return to the same area to nest each year and may nest near their previous year's nesting site (Bunnell et al. 2000, Gates 1983).

Breeding

The center of breeding activity for sage-grouse is the "lek" or strutting ground. Male sage-grouse begin to congregate on leks in early March and perform a ritualized courtship display. Use of leks may continue as late as early June. Mating occurs on the lek. Fifty to ninety percent

of the males utilize leks during the breeding season. As sage-grouse populations decline, the number of males attending leks may decline or the use of some leks may be discontinued. Likewise, as populations increase, male attendance on leks may increase and/or new leks may be established or old leks reoccupied (Connelly et al. 1981).

Nesting/Reproduction

Nesting generally takes place 1-2 weeks after mating and may continue as late as early June (Wallestad 1975). Sage-grouse generally have lower reproductive rates and higher survival rates than other species of upland game birds (Connelly and Braun 1997). Nesting rates vary from year to year and from area to area (Bergerud 1988, Connelly et al. 1993, Schroeder 1997, Coggins 1998,). Connelly et al. (1993) reported that in Idaho up to 45% of yearling and 22% of adult female sage-grouse do not nest each year. Schroeder (1997) found that essentially all female sage-grouse in Washington nested. The variation is most likely a result of the quality of nutrition available and the health of pre-laying females (Barnett and Crawford 1994). Renesting by sage-grouse varies regionally from 20% (Hulet 1983, Connelly et al. 1993) to greater than 80% (Schroeder 1997). In summary, sage-grouse have the lowest reproduction rate of any North American game bird and as a result populations are not able to recover from low numbers as quickly as those of most other game birds.

Sage-grouse nest success varies from 12 to 86% (Trueblood 1954, Gregg 1991, Schroeder et al. 1999). Adult females may experience higher nest success rates that yearling females (Wallestad and Pyrah 1974). However, differential nest success between age groups has not been observed in other studies (Connelly et al. 1993, Schroeder 1997). Nest success is dependent on vegetation cover type (Gregg 1991). Gregg (1991) reported that the highest nest success occurred in mountain big sagebrush (*A. t. vaseyana*) cover type. Greater cover of medium-height shrubs with grass 7 inches (>18 cm) in height increases sage-grouse nest success (Gregg et al. 1994).

Clutch size of sage-grouse is extremely variable and relatively low compared to other species of game birds (Schroeder 1997). Average clutch size for first nests varies from 6.0 to 9.5 throughout the species range (Schroeder 1997, Sveum 1998). These differences may be related to habitat quality and overall health of pre-laying females (Coggins 1998).

Survival Rates

Annual survival rates for yearling and adult female sage-grouse vary from 35% to 85%; adult male survival rates vary from 38% to 54% (Wallestad 1975, Zablan 1993, Connelly et al. 1994). Lower survival rates for males may be related to physiological demands of sexual dimorphism and higher predation rates on males during the breeding season (Swenson et al.1987).

Sage-grouse predators include raptors, coyotes, ravens, squirrels, and skunks. The increase in urban development has resulted in the addition of non-native predators such as dogs, cats and foxes (Connelly et al. 1991).

Little information has been published on mortality of juvenile sage-grouse or the level of production necessary to maintain a stable population. Among western states, long-term juvenile to hen ratios have varied from 1.40 to 2.96 juveniles per hen in the fall. In recent years, this ratio

has declined to 1.21 to 2.19 juveniles per hen (Connelly and Braun 1997). It is thought that at least 2.25 juveniles per hen should be present in the fall population to allow for stable to increasing sage-grouse populations (Connelly and Braun 1997, Edelmann et al. 1998).

B. Habitat Requirements

Breeding/Nesting Habitat

Leks, or strutting grounds, tend to be traditional. In general, the same areas are used year after year. Leks typically occur in open areas surrounded by sagebrush (Patterson 1952, Gill 1965). Examples of lek sites include landing strips, old lakebeds or playas, low sagebrush flats, openings on ridges, roads, cropland, and burned areas (Connelly et al. 1981, Gates 1985). Sage-grouse males appear to form leks opportunistically at sites within or adjacent to potential nesting habitat. The lek is considered to be the center of year-round activity for non-migratory grouse populations (Eng and Schladweiler 1972, Wallestad and Pyrah 1974, Wallestad and Schladweiler 1974), but this may not be the case for migratory populations (Connelly et al. 1988, Wakkinen et al. 1992). Average distances between nests and the nearest leks vary from 0.6-3.9 miles (1.1-6.2 km), however, some females may nest > 12.5 miles (20 km) away from the lek (Autenrieth 1981, Wakkinen et al. 1992, Fischer 1994, Hanf et al. 1994).

Habitat used by pre-laying hens is also part of the general breeding habitat. These areas provide hens with forbs high in calcium, phosphorus, and protein, all of which are necessary for egg production. The condition and availability of these areas are thought to have a significant effect on reproductive success (Barnett and Crawford 1994, Coggins 1998).

Most sage-grouse nests are located under sagebrush plants (Patterson 1952, Gill 1965, Gray 1967, Wallestad and Pyrah 1974); however, nests have been found under other plant species (Griner 1939, Connelly et al. 1991, Gregg 1991). Sage-grouse nesting under sagebrush experience a higher nest success than those nesting under other plant species (Connelly et al. 1991). Research on sage-grouse nesting habitat has documented that sage-grouse tend to select sites under sagebrush plants that have large canopies. The canopies provide overhead cover and an herbaceous understory, thus providing lateral cover and allowing birds to be hidden from view (Patterson 1952, Gray 1967, Klebenow 1969, Wallestad and Pyrah 1974, Wakkinen 1990, Gregg 1991, Fischer 1994, DeLong et al. 1995, Bunnell et al. 2000). Herbaceous cover associated with nest sites may provide scent, visual, and physical barriers to potential predators (DeLong et al. 1995).

Brood-rearing Habitat

Early brood-rearing habitat generally occurs relatively close to nest sites, but movements of individual broods may be highly variable (Connelly 1982, Gates 1983). Early brood-rearing habitats may be relatively open (#14 percent canopy cover) stands of sagebrush when compared to optimum nesting habitat (Martin 1970, Wallestad 1971), but need > 15% canopy cover of forbs and grasses (Sveum et al. 1998, Bunnell et al. 2000). High plant species richness with abundant forbs and insects characterize brood areas (Dunn and Braun 1986, Klott and Lindzey 1989, Drut et al. 1994, Apa 1998). Insects, especially ants and beetles, are an important food component of early brood-rearing habitat (Drut et al. 1994, Fischer 1996). As herbaceous plants mature and dry, hens usually move their broods to more mesic sites during June and July where more succulent vegetation is available (Gill 1965, Klebenow 1969, Connelly and Markham 1981, Connelly et al. 1988, Fischer et al. 1996, Bunnell et al. 2000). Sage-grouse broods occupy a variety of habitats during summer including sagebrush, relatively small burned areas within

sagebrush, wet meadows, farmland, and other irrigated areas adjacent to sagebrush habitats (Savage 1969, Martin 1970, Connelly et al. 1981, Gates 1983, Connelly et al. 1988, Pyle and Crawford 1996).

Late brood-rearing habitats are highly variable. Patterson (1952) reported that grouse move from summer to winter range in October but during mild weather in late fall some birds may still use summer range. Fall movements to winter range are slow and meandering and occur from late August to December (Connelly et al. 1988). Wallestad (1975) documented a shift in feeding habits from September, when grouse were consuming a large amount of forbs, to December when birds were feeding only on sagebrush.

Winter Habitat

Sage-grouse winter habitats are relatively similar throughout most of their range. Because their winter diet consists almost exclusively of sagebrush, winter habitats must provide adequate sagebrush that is accessible through the winter. Eng and Schladweiler (1972) and Wallestad (1975) indicated that most observations of sage-grouse during winter in Montana occurred in sagebrush habitats with >20% canopy cover. However, Robertson (1991) indicated that sage-grouse used sagebrush habitats that had average canopy cover of 15%. Sage-grouse tend to select areas with both high canopy cover and taller big sagebrush (*Artemisia tridentata*).

During winter, sage-grouse feed almost exclusively on leaves of sagebrush (Patterson 1952, Wallestad 1975). Big sagebrush dominates the diet of sage-grouse in most portions of their range (Patterson 1952, Wallestad 1975, Remington and Braun 1985, Welch et al. 1988) but low sagebrush (*A. arbuscula*), black sagebrush (*A. nova*) (Dalke et al. 1963, Beck 1977), fringed sagebrush (*A. frigida*) (Wallestad 1975) and silver sagebrush (*A. cana*) (Aldridge 1998) are also consumed in many areas depending on the availability. Sage-grouse in some areas apparently prefer Wyoming big sagebrush (*A. t. wyomingensis*) (Remington and Braun 1985, Meyers 1992) and in other areas mountain big sagebrush (*A. t. vaseyana*) (Welch et al. 1988). Some of the differences in selection may be due to preferences for higher levels of protein (Remington and Braun 1985).

It is critical that sagebrush be exposed at least 10-12 inches (25 cm) above snow level (Hupp and Braun 1989). This provides both food and cover for wintering sage-grouse. In situations where snow covers the sagebrush, birds will move to areas where sagebrush is exposed.

During winter, sage-grouse will either partially or completely bury themselves in snow (snow roosting) for added thermal protection from winter temperatures.

C. Distribution and Abundance

Populations of Greater Sage-grouse have been declining for the past 25 years (Braun 1995, Connelly and Braun 1997, Beck et al. 2003, Connelly et al. 2004). Concerns about population status and distribution have heightened awareness about the appropriateness of various monitoring efforts and techniques. Connelly et al. (2000) indicated that monitoring was a key component of sage-grouse management. Utah's Strategic Management Plan (UDWR 2002) also emphasizes the need to monitor sage-grouse populations and habitats. Further, the MOU signed by WAFWA representatives in 1999 and with federal agencies (2000) call for consistent monitoring and data collection.

Several techniques have historically been utilized in Utah and in Rich County to assess sage-grouse population trends, status, and distribution including lek counts, brood surveys, field bag checks, wing barrels, and hunter surveys. Currently, the primary technique employed by biologists in Utah and in Rich County is lek counts. This method is described in detail later in this section.

Historic Distribution of Sage-grouse

Determining historic distribution of sage-grouse is difficult and problematic for several reasons, but primarily because scientific studies are not available from historic time frames in question. For many areas, no written or zoological records exist. It is thought that sage-grouse once existed in all 29 Utah counties. Today sage-grouse are found in 26 counties in Utah and are thought to occupy 50% of the habitat they once did (UDWR 2002).

The Rangewide Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats (hereafter referred to as the Rangewide Assessment) (Connelly et al. 2004) analyzed the historic distribution of sage-grouse based on historical sage-grouse distribution maps, habitat maps, sage-grouse museum specimens, known lek locations, and research on sage-grouse movement patterns and habitat use. The authors define historic distribution as a "pre-settlement" distribution, occurring prior to 1800 when rapid settlement by people of European descent began.

The Rangewide Plan describes potential historic distribution of sage-grouse in Rich County as part of an evaluation of historic range in the Wyoming Basin (Connelly et. al. 2004). The authors state that there are no records of sage-grouse observations in the eastern portion of the Wyoming Basin in what is now Rich County but are unable to account for this discrepancy with current observations of the species in this area.

Lek Counts

During the breeding season, sage-grouse congregate on a relatively small number of sites, called leks, to display and breed. Because sage-grouse demonstrate high fidelity to lek sites, they offer the best opportunity for monitoring populations (Jenni and Hartzler 1978, Beck and Braun 1980, Connelly et al. 2000, 2003a, 2004). Lek count methodology was first described by Patterson (1952), who studied sage-grouse in Wyoming and was based on a count of the maximum number of males observed on a lek over a series of 3-4 visits. The method described by Patterson (1952) results in an index of the population. Population indices, commonly used by wildlife managers,

involve a count or measurement of some aspect of the population that is both convenient to measure and thought to be related to abundance (e.g. bird calls, pellet counts, roadside observations, track surveys). The shortcomings of this type of sampling were described by Anderson (2001) whose primary criticism was that they fail to lead to defensible estimate of population size or status. With regards specifically to lek counts, Beck and Braun (1980) noted that they only lead to conclusions about population size and status when the following information is known: total number of leks in an area, attendance patters of adult and yearling males, inter-lek movements patterns, and the ratio of males to females (i.e. the relationship between the maximum count and the size of the population).

Despite the problems associated with indices and lek counts, specifically, they remain the best and primary means for assessing population trends and estimating population size and status available (Autenrieth et al. 1982, Connelly et al. 2000). Throughout Utah, lek counts are conducted between late February and May (depending on weather conditions and access to lek sites) on all known leks to the greatest extent possible. Leks are counted 3-4 times during this period and counts are made between 30 minutes before and 1 hour after sunrise. An estimate of population size is calculated based on the following assumptions: 1) 75 % of all males were counted on strutting grounds and 2) that the male:female ratio in the population is 1:2 (UDWR 2002).

The number of active leks in an area can also be used as an indicator of population size. Cannon and Knoph (1981) noted that lek numbers seem to increase roughly in proportion to population size. There is evidence that as population size increases, established, “traditional” lek attendance increases and smaller “satellite” leks appear and then disappear as population size decreases again. In Utah, and lek is defined as a site or area traditionally used for display. Leks are considered “active” when at least 2 males have been observed for at least 3 years. Conversely, leks are considered “inactive” when birds have been absent from a traditional site for >3 years. The use of the number of “active” or “traditional” leks as an indicator of population size is also problematic. Satellite leks are typically smaller and are likely to be less noticeable, lek detection is likely to vary with both density of leks and population density, and search effort likely plays a large role in detection and consistency of measurement.

D. Assessment of Local Population

Plan Area

The Rich County is located in northeastern Utah. Rich County encompasses 661,760 acres managed by the U.S. Forest Service (USFS), Bureau of Land Management (BLM), State Institutional Trust lands (SITLA), and private land owners. Rich County is defined by the Utah-Wyoming border to the east, the Utah-Idaho border to the north, the Rich-Summit County border to the south, and is bordered by several Utah counties to the west (Figure 1). The southern half of Bear Lake and the Bear Lake Valley are located in the northern portion of Rich County. Elevation in Rich ranges from 1,800-2,600 m.

Rich County is characterized by hot summers and cold winters. The high elevation conditions of much of the County make it one of the coldest areas in the state. Winter temperatures (measured in the town of Woodruff) often fall below -29º C (-20º F); summer temperatures often exceed 32º C (90º F). Annual precipitation is variable but averages approximately 50 cm at high elevations and 23 cm at low elevations; September, May, and June are the wettest months (Danvir 2002).

Landownership

Most of Rich County is private land (Table 2). Landowership patterns differ between subunit (Table 2, Figure 1). The distribution of landownership is depicted in Figure 1.

Table 2. Landownership in the Rich County, by subunit.

Landowner/Manager*	Subunit	Acres	Miles^2	% of Total
Private	Northeast	57,435	90	8.75
Private	Central	99,408	155	15.14
Private	Southern	169,010	264	25.74
Private	Crawford	54,693	85	8.33
US Forest Service	Central	37,000	58	5.64
US Forest Service	Southern	13,022	20	1.98
Bureau of Land Management	Northeast	24,715	39	3.76
Bureau of Land Management	Central	90,850	142	13.84
Bureau of Land Management	Southern	29,325	46	4.47
Bureau of Land Management	Crawford	26,593	42	4.05
State of Utah	Northeast	27,689	43	4.22
State of Utah	Central	13,314	21	2.03
State of Utah	Southern	4,318	7	0.66
State of Utah	Crawford	7,259	11	1.11
*Water comprises 1,953 acres (3 mi^2) and represents 0.30% of Rich County's total area.				

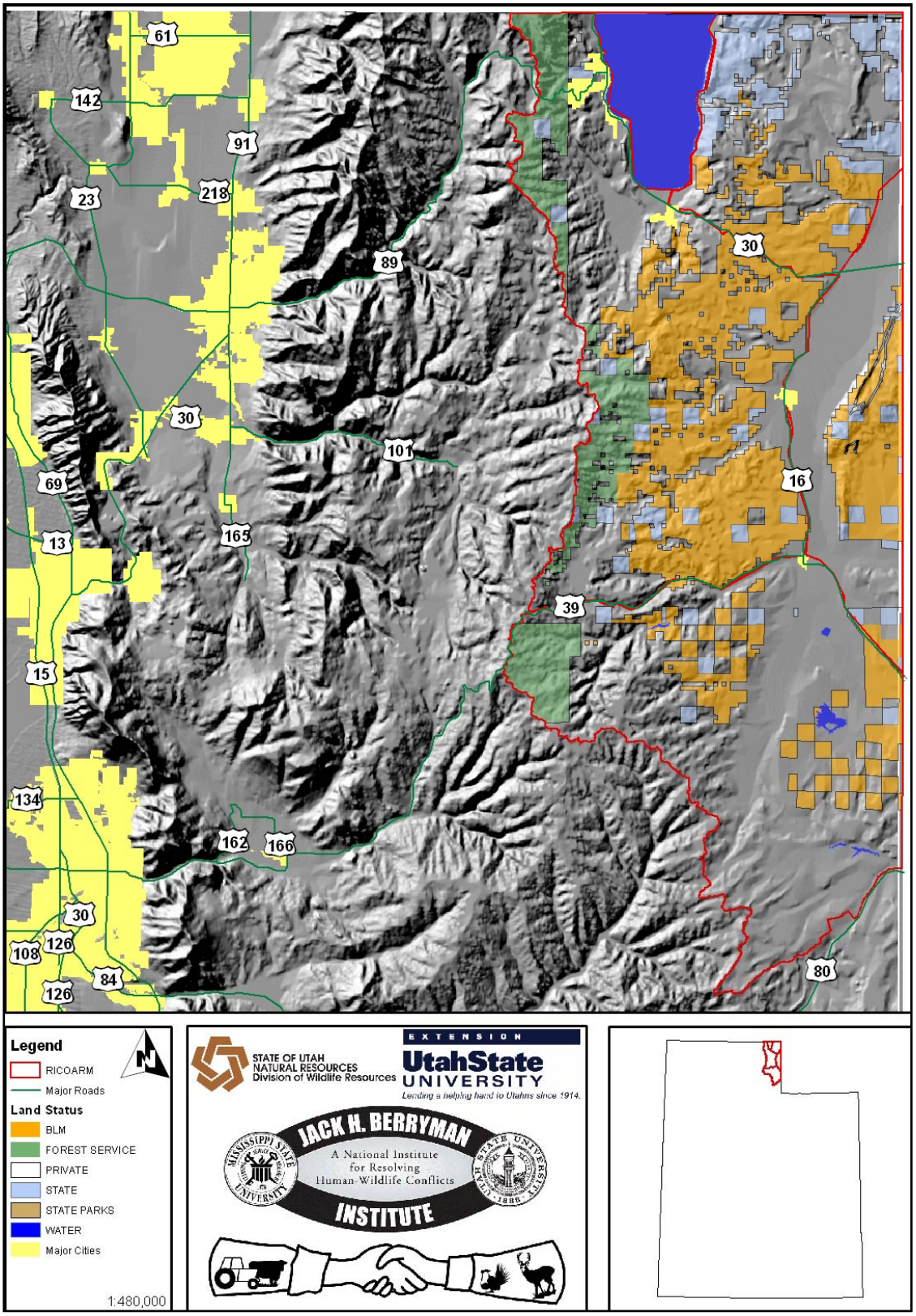

Figure 1. Rich County with sage-grouse management subunits and land management and landownership designated.

Wildlife Populations

Several species of birds, small mammals, and reptiles are found only in sagebrush environments. Passerine birds obligated to use sagebrush environments include Brewer's sparrow (*Spizella breweri*), sage sparrow (*Amphispiza belli*), and sage thrasher (*Oreoscoptes montanus*). Additionally, though not obligated to use only sagebrush environments, vesper sparrow (*Poecetes gramineus*) and loggerhead shrike (*Lanius ludovicianus*) are also commonly found in sagebrush communities in Rich County. Other obligate species include the sagebrush vole (*Lemmiscus*), *curtatus* pygmy rabbit (*Brachylaus idahoensis*), and the sagebrush lizard (*Sceloporus graciosus*). In addition to these obligates, a large number of other birds, small mammals and reptiles commonly make use of sagebrush environments within Rich County.

While sage-grouse populations in Rich County have been counted and studied, little or nothing is known about the local status of these other wildlife species listed above. It is assumed that their numbers and geographic extent are tied to the condition and extent of big sagebrush communities. This plan operates with the intent that maintenance of substantial areas of high quality sagebrush steppe, measured by healthy populations of sage-grouse, will provide sufficient habitat for these other sagebrush obligate species to thrive in Rich County.

Human Populations

The earliest known inhabitants of Rich County and the Bear Lake Valley were the Bannock and Shoshoni Tribes. Fur trappers frequented the Bear Lake Valley in the early 1800s and met for rendezvous on the south shore of Bear Lake in 1827 and 1828.

With the passage of the Homestead Act of 1862, Brigham Young sent explorers to the area in search of suitable settlement sites. Early settlements were established near present day Paris, Idaho. Other settlements were founded soon after including Round Valley in 1863, Kennedyville and Laketown in 1864, Woodruff in 1865, Randolph in 1870, and Argyle in 1875. Origionally part of Green River County, the county became Richland County in 1864, and was shortened to Rich County in 1968.

In recent years, Rich County has become a vacation and recreation destination for residents of neighboring counties in Utah and nearby Idaho and Wyoming. Most population growth has occurred in and around towns associated with Bear Lake such as Laketown and Garden City. Recreational activities are also found in the more rural parts of the County in and around Randolph and Woodruff however, most growth is occurring in association with Bear Lake.

Livestock Grazing

The history and place of herbivory in the Intermountain West often leads to debate about the appropriateness of domestic livestock grazing on federal lands. (Vavra et. al 1994, Clifford 2002.) Young (1994), Young et. al. (1976), Vale (1975) and Daubermine (1970) have all indicated our current plant communities are different than those present "pre European contact." All have listed numerous reasons for this difference including grazing, fire, introduced plants, agriculture and more recently, climatic change. However, as Rich County falls on the very periphery of the Intermountain West and is part of the Wyoming Basin Ecoregion, this area was

probably grazed historically herds of bison (Shields 1968, Haines 1965). Excavations at the Woodruff Bison Kill (located on Deseret Land and Livestock in the Southern Subunit of the Resource Area) estimated at least 340 bison butchered below kill-cliff by Fremont Culture aboriginal hunters about 600 A.D. (Shields 1968). In addition, the Osborne-Russell journals note numerous sightings of bison, pronghorn and elk in upper Bear River drainage, including Rich County (Haines 1965). Thus, many would argue that carefully managed livestock could act in some fashion as a "surrogate" for bison activity in this region.

Livestock grazing was introduced into the intermountain west in the mid to late 1800's. Livestock grazing in Rich County likely also began at this time. Historical numbers of livestock varied and, like other areas in the west, were affected by weather, markets, regulation, and other factors. In general, the number of sheep being grazed in Rich County has declined over the past 20 years while the number of cattle and calves has been largely maintained (USDA NASS 2002). Danvir and Kearl (1996) estimated the number of domestic sheep and cattle to be 100,000 and 5,000 respectively circa 1920-25; and at 17,000 and 10,000 respectively circa 1990-95 in the Morgan-South Rich County DWR Wildlife Management unit.

Farming

Agricultural production in Rich County began with homesteading in the late 1800s. Although farming is not as prominent a business as livestock production, the number of farms (approximately 150) and the amount of cropland harvested (approximately 50,000 acres, 78 mi^2) in Rich County has remained stable since the mid-1980s (USDA NASS 2005).

Population Status and Distribution

Grouse are believed to have existed as a species in North America for approximately 350,000 years. Sage-grouse likely were historically found in all 29 Utah counties and were likely abundant where suitable habitat existed throughout Utah until the early 1900s (Beck et al. 2003). Today, sage-grouse are found in 26 of Utah's counties and are thought to occupy only 50% of the geographic area they once did (Beck et al. 2003).

Rich County is among the largest populations of sage-grouse in Utah (Beck et al. 2003). There are 8 lek complexes in Rich County with a total of 46 active and historic lek sites. The UDWR has been monitoring sage-grouse lek sites and the number of strutting males in Rich County since 1959. Early counts often included less than 10 lek sites and were likely under-representative of the total number of leks and, therefore, the total breeding population. In the last 5 years, over 30 leks have been monitored and previously unknown lek sites are discovered regularly. Although sage-grouse populations in Rich County seem to be experiencing an increasing trend since 1959 (Figure 2), this could simply be due to increased monitoring efforts and an increase in the number of leks monitored.

Observations of the number of males per lek is another index used to evaluate sage-grouse population trends. Because this index accounts for the number of leks counted, i.e. the amount of effort, this index may, in cases where effort is variable, be a more useful illustration of the population trend. In Rich County, the number of males per lek has fluctuated around approximately 40 males/lek since the early 1970s (Figure 3).

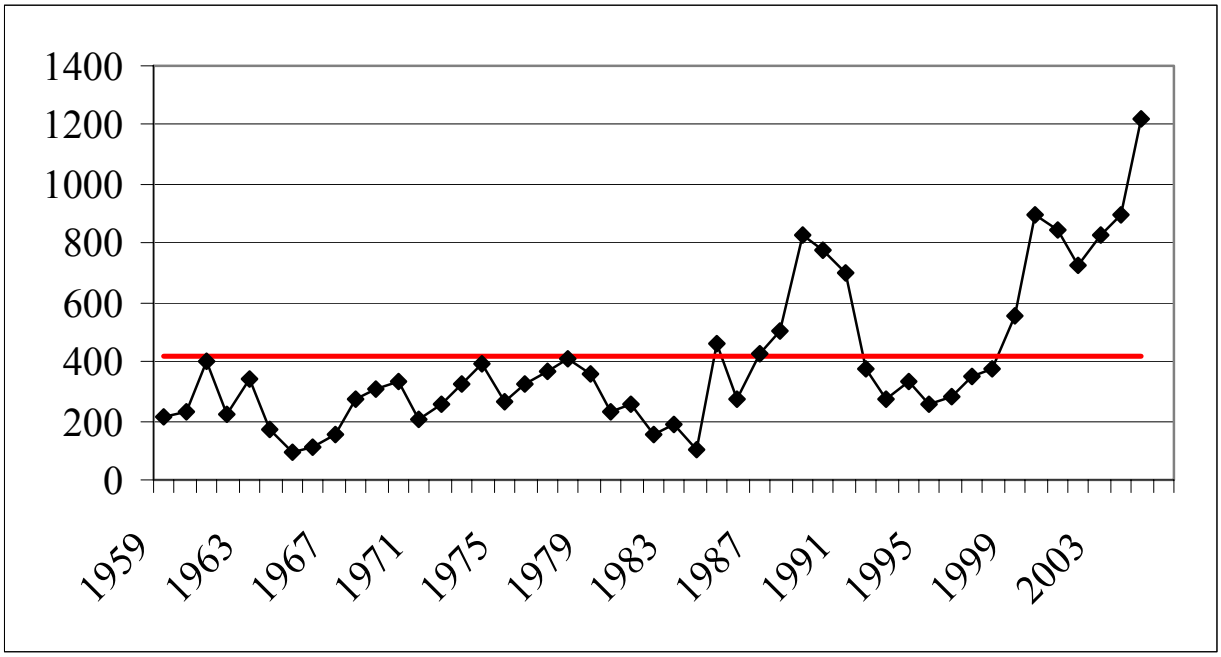

Figure 2. Maximum total number of males counted and 40-year average maximum total males counted on leks in Rich County, 1959-2005.

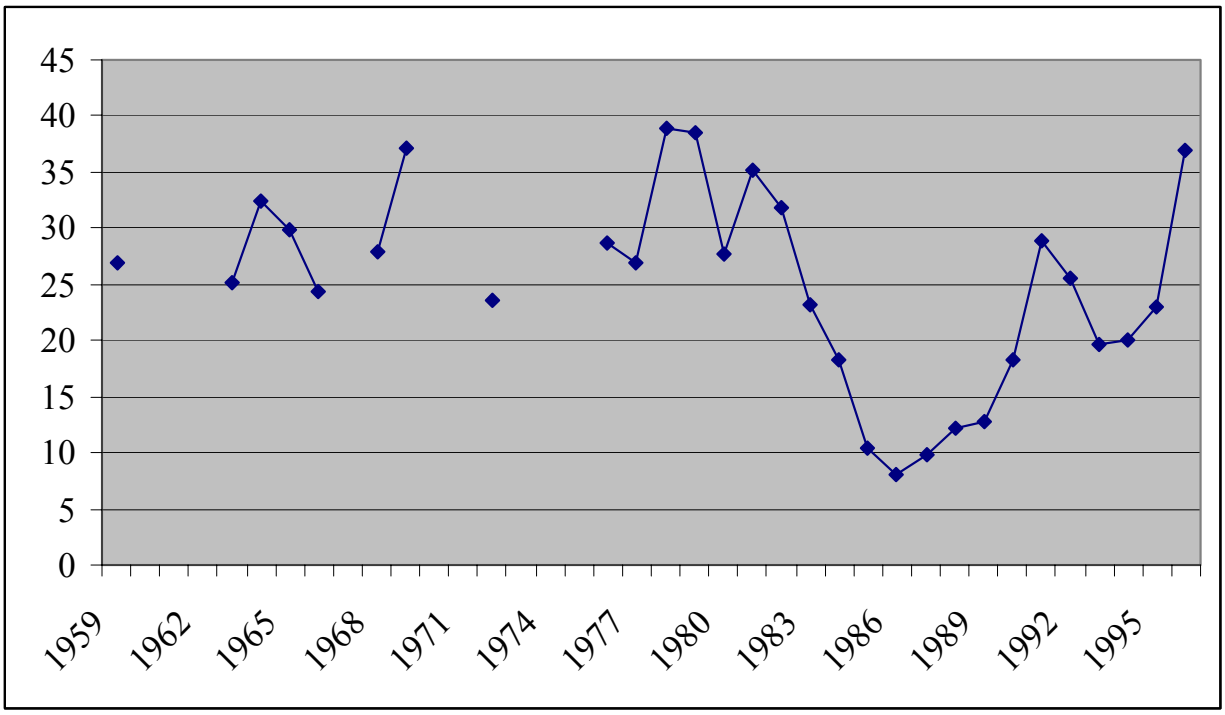

Figure 3. The number of males per lek in Rich County, 1959-2005. Only years when >10 leks were counted were included.

Local Ecology & Life History

Several studies have been conducted on sage-grouse and their habitats in Rich County. Here we provide a brief summary of some of the research conducted on sage-grouse and their habitats in Rich County. Another useful summary of Rich County investigations can be found in Danvir (2002). For complete study methods, results, and management implications please refer directly to Homer (1991) and Hunnicutt (1992).

In 1991, Collin Homer modeled sage-grouse winter habitat in Dry Hollow, Dog Hollow, and Otter Creek in the Central and Crawford Subunits in Rich County. Homer (1991) investigated site-specific habitat selection of radio-collared sage-grouse and tested the effectiveness of using remote sensing data to map large scale sage-grouse habitat. Homer (1991) found that sage-grouse in his study used winter habitat dominated by Wyoming big sagebrush (*Artemesia tridentata wyominensis*) with 20.4-29.6% canopy cover of shrubs. Sage-grouse in Homer's study also appeared to avoid north facing slopes.

In 1992, Mary Hunnicutt expanded on Homer's work, evaluating the use of remote sensing to characterize sage-grouse habitat in the Southern and Crawford Subunits in Rich County and parts of Wyoming adjacent to the Crawford Subunit. After mapping seasonal habitats within her large study plots, Hunnicutt (1992) assessed habitat characteristics for sites used by 127 radio-collared sage-grouse. She found that sites used by nesting hens had low forb/grass cover (0-9%) and heavy shrub cover (30-39%); sites used during early brood rearing were characterized by a higher shrub cover (40-49%) than is typically reported for that time of year. Hunnicutt attributed this discrepancy to differences in the way shrub cover was measured. She measured shrub cover using the remote sensing data rather than at the individual bird location. Hunnicutt (1992) also found that broods used areas with lower grass and forb cover early in the summer and shifted to sites with greater herbaceous cover and lower shrub cover during the later part of the summer (July-August). During late summer, all radio-collared birds in her study used meadow habitats. Hunnicutt (1992) also evaluated habitat diversity, concluding that sage-grouse broods used habitat mosaics that exhibited a higher degree of diversity than did males and adult hens (without broods) during the same season.

In his summary of ecology and life history information for sage-grouse in Rich County from 1985-2001, Danvir (2002) compiled information on sage-grouse behavioral ecology, habitat, use and movement patterns. Danvir (2002) also described the effects of time-controlled grazing management on sage-grouse habitats on Deseret Land and Livestock (DLL) in the Southern Subunit. Danvir (2002) provided a summary of his findings and we have provided that here:

"Winter ecology: Grouse winter flock sizes averaged 8.3 and 63.7 birds/flock for male and mixed sex flocks, respectively. Grouse dispersed 0.2-65 km (mean 11.8 km) to spring breeding areas. 87% of winter observations occurred on slopes < 5%. Homer (1993) used GIS techniques to classify winter grouse habitat, and found Rich county sage grouse generally selected shrubs of medium height (40-60 cm) and medium cover (20-30%). However, grouse used shorter sagebrush *(Artemisia spp.)* on flats and ridge-tops when snow was < 30 cm deep, and taller sagebrush in draws when snow depths exceeded 30 cm. Brush height was correlated with snow depth at winter flock locations (r2=0.47). Grouse preferred brush cover protruding 25 cm above snow. At snow depths ≥ 30 cm, sage grouse, mule deer *(Odocoileus hemionus)* and whitetail

jackrabbits *(Lepus townsendii)* concentrated in < 5% of the winter range, in patches of Wyoming and Basin big sagebrush. These brush patches are considered critically important for survival of these species in deep snow winters. Grouse populations declined (as did mule deer and whitetail jackrabbits) following two deep snow winters. Grouse population change (male lek attendance, Nt/Nt-1) correlated negatively with mean winter snow depth (r2=0.50). Percent grouse population change also correlated negatively with the number of wintering golden *(Aquila chrysaetos)* and bald eagles *(Haliaeetus leucocephalus)* observed on Audubon Christmas Bird counts (r2=0.31). It appeared grouse were more visible, more frequently flushed by predators and suffered greater mortality rates when deep snow covered the Wyoming sagebrush. 65% of grouse examined post-mortem were predated by raptors November–May (primarily golden eagles) and 18% died following collisions with fences. Estimated annual survival rate of radio-tagged grouse was 47%. Increasing coyote abundance during the study period coincided with reduced observations of red fox *(Vulpes fulva)*, whitetail jackrabbits, Uinta ground squirrels *(Citellus armatus)* and with golden eagle nesting success. Golden eagle nesting success was negatively correlated with, and appeared dependent on the abundance of jackrabbits and ground squirrels (r2=0.81 and 0.67, respectively). Coyotes may have aided grouse survival by reducing prey abundance and eagle production.

Breeding ecology: We observed little inter-lek movement of tagged male sage grouse. Leks occasionally moved 0.1-1 km between years. Some leks became inactive during population lows, then reappeared. The date of peak male attendance on leks was correlated with the melting of the winter snow pack (r2=0.43). Peak male attendance occurred later than peak hen attendance in years when yearling males were abundant. Peak hen attendance generally occurred about 1 April, the date of peak hen attendance was also positively correlated with melting of the winter snow pack (r2=0.71). Wyoming sagebrush vigor declined in areas receiving winter browsing by elk *(Cervus elaphus)* and pronghorn *(Antilocapra americana)*, but improved in areas where grasses were purposely overgrazed by cattle.

Summer ecology: 82% of hens nested within 4 km of the capture lek. Mean distance traveled from capture lek to nest was 2.8 km, the mean distance between study leks was 3.1 km. Mean distance between subsequent nests for hens monitored > one year was 0.5 km. Radio-tagged hens generally remained within five km of nesting areas throughout the summer. Males moved an average of 8.3 km from leks to summer use areas (range 3-13 km). Male flocks used sparse lowland and mountain sagebrush in summer. Hens without broods used dense lowland sagebrush. Broods used meadows, spring burns and plantings containing broad-leafed forbs. Grouse were often observed along edges of forb-rich meadows, burns, plantings and roadsides. Use of lowland sagebrush was greatest April-June; use of meadows and mountain sagebrush increased July-August. Grouse use of meadows varied between years, and was correlated with annual April-September precipitation (r2=0.56). In dry summers, grouse concentrated in meadows, on north slopes and at higher elevations. In contrast, grouse were widely dispersed among habitat types and throughout the study area in wet summers. Lek counts increased following wetter summers, but failed to increase following dry summers. 83% of 36 hens nested in Wyoming sagebrush stands, in patches > 100m in diameter. Hunnicutt (1992) used GIS techniques to classify summer grouse habitat use. Hens selected dense brush cover (> 17%) with sparse herbaceous cover (< 8%) for nesting. Hens with young broods (June) preferred dense brush with > 8% herbaceous cover; older broods (July-September) preferred sparse brush with dense herbaceous cover. Combined nesting success of 36 hens was 30.6%. Nesting success and

chick: hen ratios were greater in diverse habitats than in species-poor sage-crested wheatgrass (S-CW) habitats. Mean brood sizes increased as forb availability increased due to burning and planting. Artificial nests were used to compare nesting success with vegetative characteristics. 86% of artificial nest predation was by mammalian predators. Nest predation increased as shrub height, herbaceous and horizontal cover increased [likely because additional cover supported mammalian nest predators]. Arthropod biomass was highest in habitats having greatest herbaceous cover. Lowest arthropod abundance occurred in dense, Wyoming sagebrush with sparse herbaceous cover. Billaux (1996) measured foraging rates of hand-reared sage grouse chicks in various habitats. Foraging rates were significantly correlated with forb abundance across habitat types (r2=0.69). Chicks selected both native and introduced forbs when available, avoided grasses, and always ate some shrubs. Percent forb cover was consistently lower in S-CW than in any other habitat, and appears to explain the low chick: hen ratios observed in S-CW habitats. Wilson (2000) studied grouse use of various vegetation treatments and controls on DLL. Grouse, and broods in particular, readily used portions of burns and plantings having broad-leafed forbs and within 60 m of brush patches.

Habitat management: Time-controlled grazing practices at DLL since 1979 have increased herbaceous cover on rangelands, and slowed the rate of sagebrush increase. Grazing exclosure data suggest: a) grass production was strongly dependent on prior-year precipitation (r 2=0.84) and b) excluding livestock increased shrub production, reduced forb production and failed to increase plant species diversity. Hot, August wildfire burns in Wyoming sage wintering areas appeared detrimental, while cool-season controlled burns in summering areas appeared beneficial to grouse. Mechanical brush thinning and planting desirable forbs may be effective ways to improve grouse reproductive/summer nutrition, without severely reducing winter and nesting habitat. DLL lek counts increased significantly as forb abundance was increased on 5 % of the DLL sage grouse summer range. Results of this study suggest livestock grazing and brush management techniques can be used to enhance sagebrush habitats for sage grouse if used wisely."

Local Habitat

The extent of seasonal habitat types in Rich County was mapped by the UDWR in 1999. Figure 4 and Figure 5 illustrate where nesting, brood-rearing, and winter habitats have been identified in Rich County. As the maps illustrate, nearly the entire county has been designated as brood rearing and winter habitat and there is nearly 100% overlap of these seasonal habitat types. We feel that there is a need to revisit this mapping to better identify seasonal habitat types and use areas in Rich County to facilitate better management of sage-grouse and their habitats.

The UDWR Big Game Range Trend project has been monitoring sites throughout Rich County to track changes in vegetation composition, structure, and diversity. Although these sites were placed in areas used by big game, where they overlap with sage-grouse seasonal habitat types (Figure 6), they can provide information about vegetation and habitat conditions in those areas in a general sense. Data collected at these sites are summarized and available at: http://www.wildlife.utah.gov/range/.

Habitat Improvements & Completed Conservation Actions

The UDWR, BLM, and private landowners have implemented several habitat improvement projects in the Resource Area targeted at restoring or enhancing sagebrush ecosystems and sage-grouse habitat. Recently, in 2004, approximately 4,100 acres of habitat in the Resource Area were treated and 7,000 acres were treated in 2005. Treatments were primarily aimed at reducing sagebrush canopy and enhancing native grass/forb cover in the understory. Additional habitat improvement projects are planned for 2006. The location of some habitat improvement projects is given in Figure 7. Table 3 lists the acreage and general location of habitat improvement projects implemented between 1957 and 2005.

Table 3. Acreage of some habitat improvement projects implemented in from 1957-2006 by landowner.

Landowner	1957	1958	1960	1961	1962	1963	1964	1965	1966	1967	1968	1980	1981	1982	Unknown
BLM		573.9	2321.6		2323.7	288.3	660.7	3673.9	3420.6	1678.0	1827.2	8635.2	9984.8	1475.2	10495.5
Private		16.4	71.6	1012.4	226.3	5.5	92.7	160.7	66.4	170.4	55.6	1295.4	476.1	46.1	10173.6
SITLA	1084.8	2321.6	311.9				4.2	27.6		29.6	10.8	0.5	477.1		1084.8
USFS															0.2
State Wildlife															494.0

Years 1982-2005 are still being compiled and will appear in the Final document.

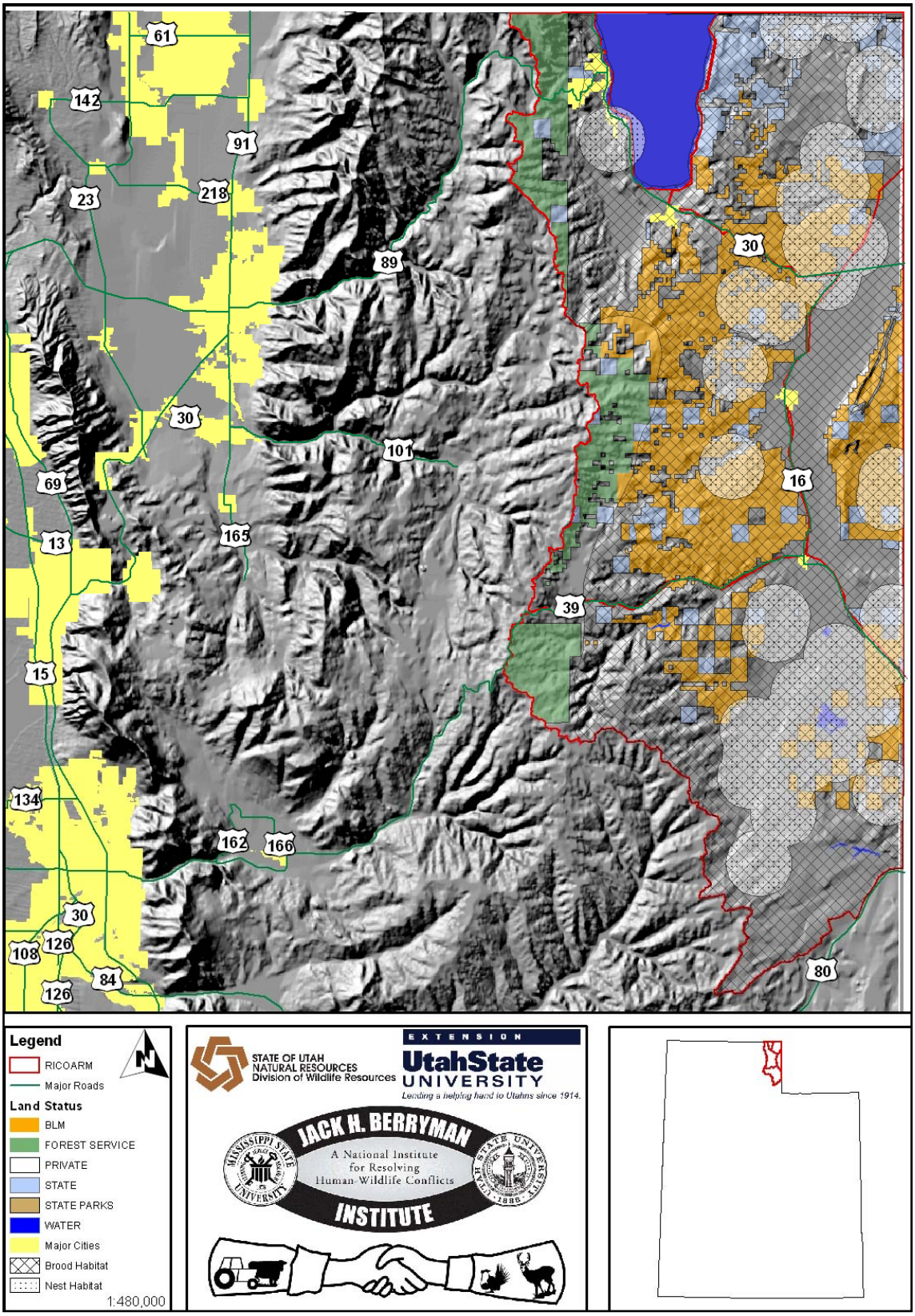

Figure 4. Location of sage-grouse nesting and brood-rearing habitat in Rich County, as identified by the UDWR, 1999.

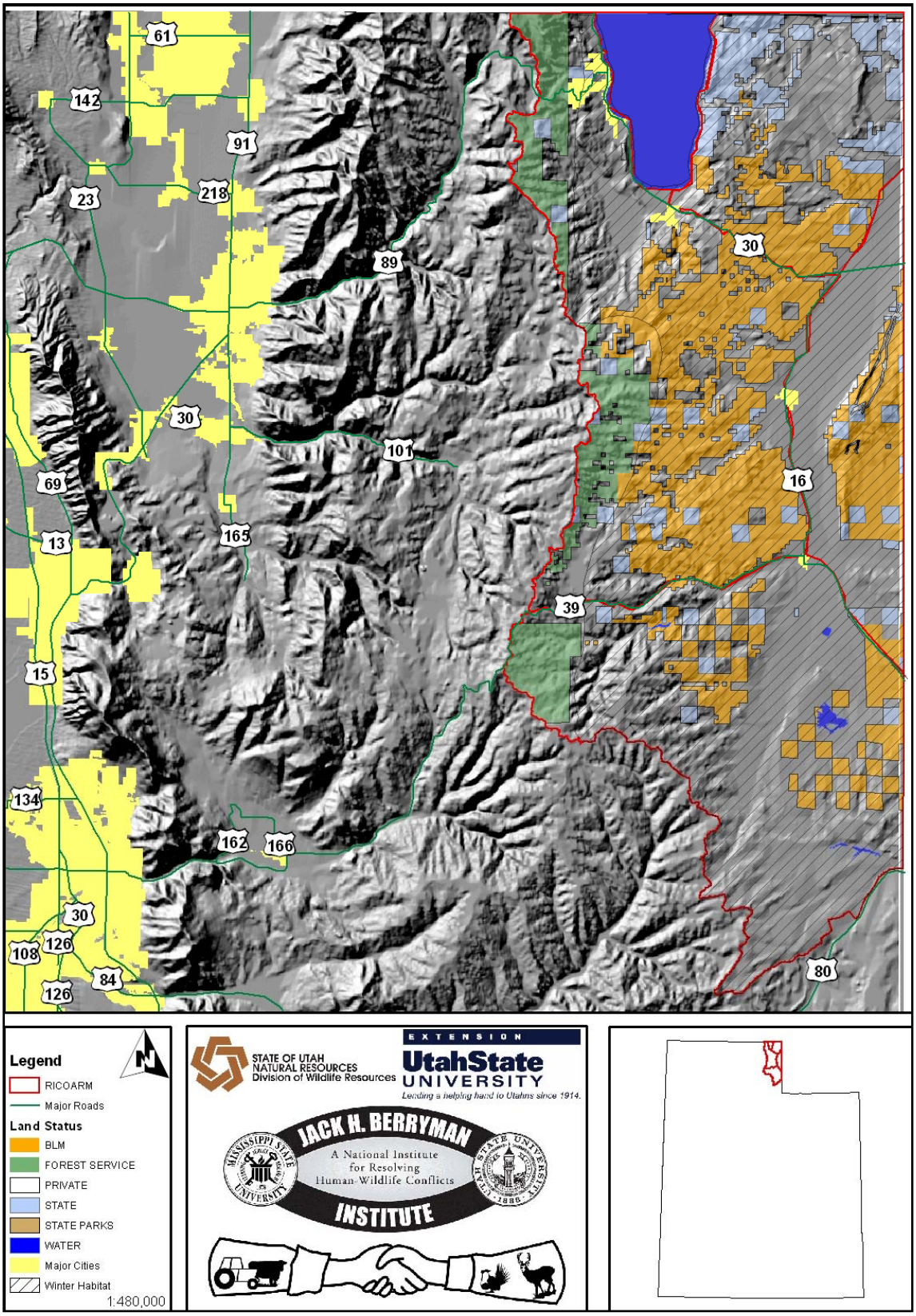

Figure 5. Location of sage-grouse winter habitat in Rich County, as identified by the UDWR, 1999.

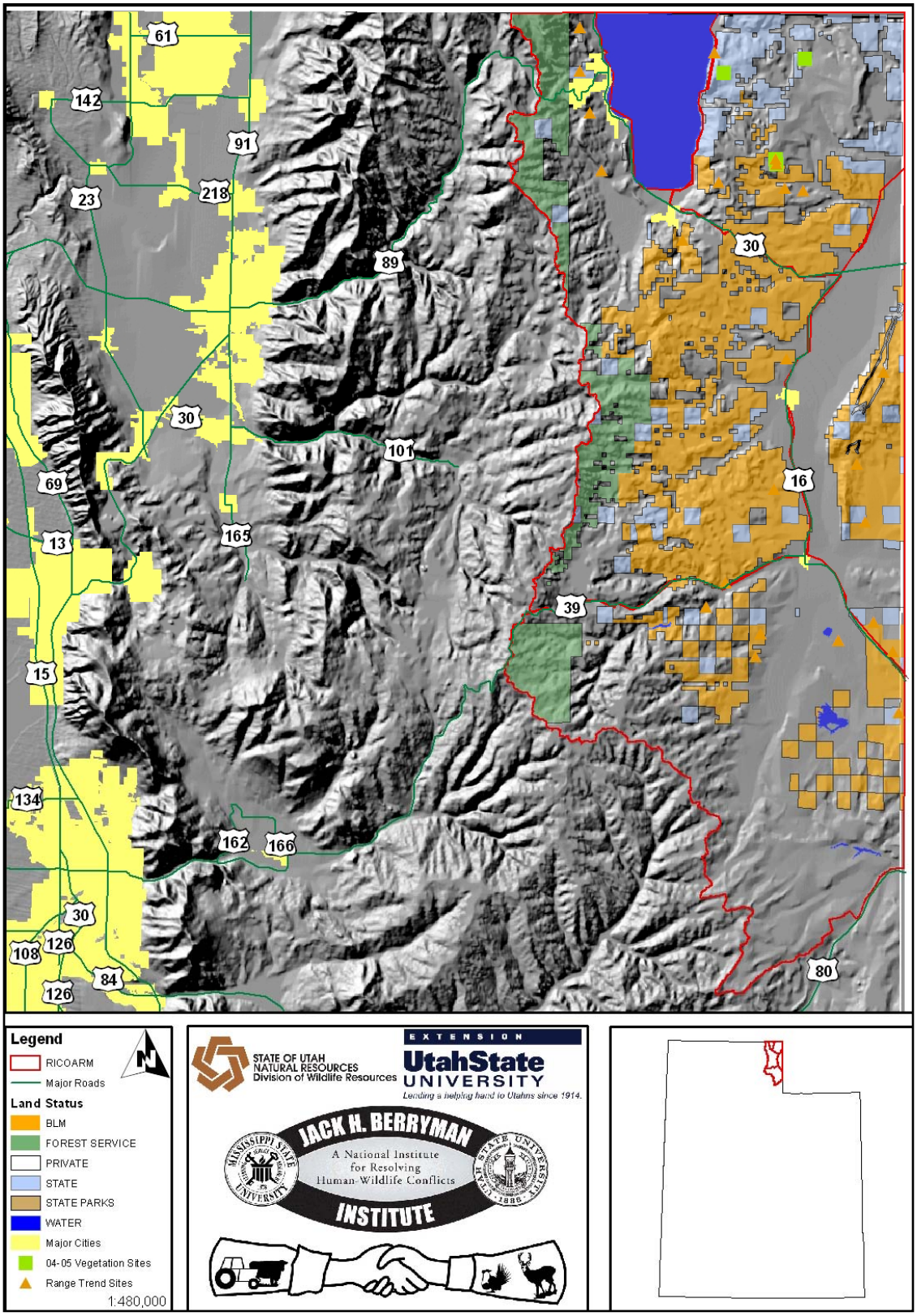

Figure 6. Location of Utah Big Game Range Trend Sites that fall within sage-grouse seasonal habitat identified by the UDWR, 1999.

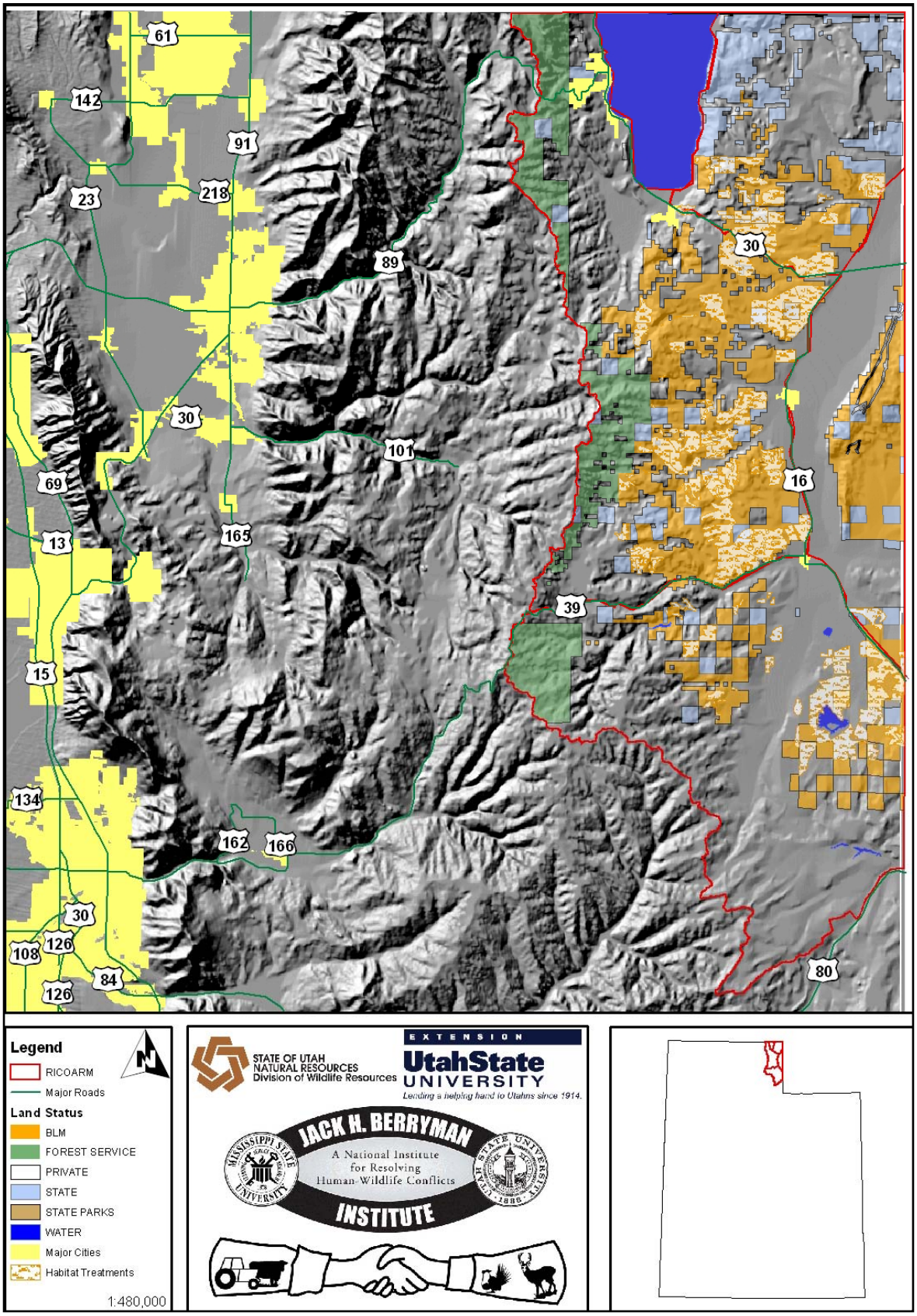

Figure 7. Location of some habitat improvement projects in Rich County.

IV. Threat Analysis

In this section, we summarize and describe the potential threats to sage-grouse populations in Rich County. Where possible, we describe actual, know impacts to sage-grouse and their habitats, however, due to a lack of empirical information regarding many of the threats described, we are only able to present general information and make educated extrapolations to the local area.

A. Development and Human Infrastructure

In this section, we summarize the potential effects of development and human infrastructure including 1) homes and cabins; 2) powerlines, fences, and other tall structures; 3) renewable and non-renewable energy; and 4) roads, on sage-grouse populations in Rich County. These impacts were considered together because they are associated with similar stresses (loss of habitat quality and quantity, habitat fragmentation, direct disturbance, increased predator pressure). There is little empirical evidence available regarding the direct or indirect impacts of most of the threats reviewed in this section, especially that specific to Rich County.

Home & Cabin Development

Home and cabin development impacts sage-grouse populations through direct loss of habitat, habitat fragmentation, increases in domestic predators (i.e dogs and cats), and can lead to increases in other threats including powerlines, fencing, roads, and incompatible OHV recreation.

Today, nearly 2,000 people call Rich County home (Thatcher 1994). Most residents live in and around Bear Lake in the towns of Laketown and Garden City. Many people also live in the County Seat, Randolph. Correspondingly, most growth and construction of homes and cabins has occurred in and around Bear Lake. Between 1994 and 2006, 458 dwelling units were constructed in Garden City while only 45 dwelling units were constructed in other parts of Rich County during the same time period (BEBR 2006).

Powerlines, Fences, & Other Tall Structures

Sage-grouse are potentially subject to increased mortality and disturbance resulting from man-made structures including fences, powerlines, and other tall structures (wind turbines, communication towers), though this threat is poorly understood. Sage-grouse may fly into powerlines, fences, and other tall structures which can result in death or may injure them to the point where they can not effectively avoid predators. Sage-grouse mortalities due to collision with powerlines, fences, and other tall structures have been observed in Colorado, Utah, and other areas (Gunnison Sage-grouse Rangewide Steering Committee 2005). Construction of any structure can result in some habitat loss and fragmentation. Fragmentation may increase vulnerability to predation.

Fences have increased in number over the years as allotments have been split and cross-fenced, as rural properties are developed, and new county roads are put in. Danvir (2002) reported finding the remains of 19 unmarked sage-grouse from 1984-2000 that died due to collision with

a fence line. Powerlines have also increased in number and length (Figure 8).

Renewable & Non-renewable Energy Development

Oil and gas is not a primary industry in Rich County. Few oil and gas wells have been spudded (drilling initiated) in Rich County since 1991 (Figure 9). Development of oil and gas resources in Rich County is not likely to be a significant threat to sage-grouse populations.

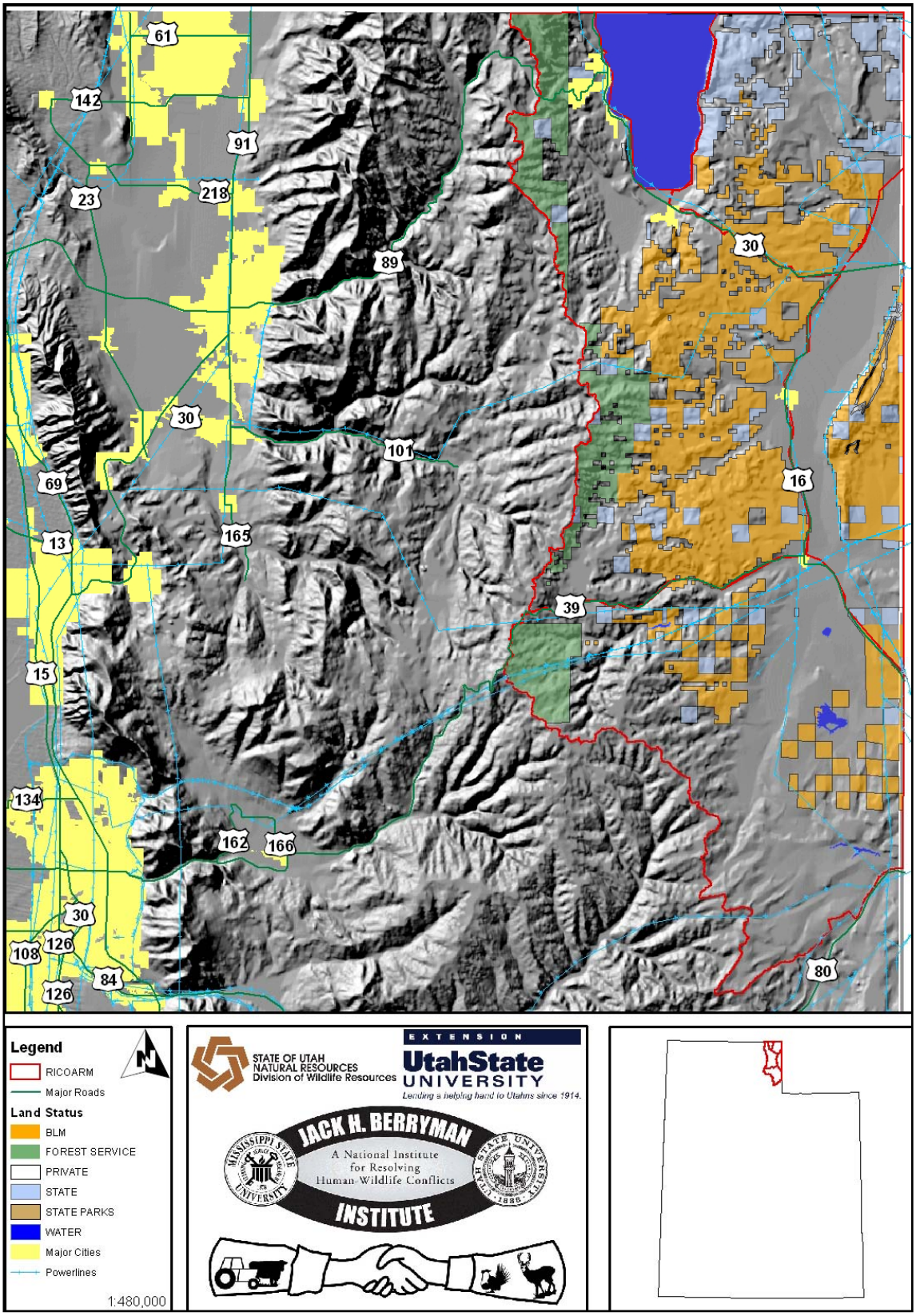

Figure 8. Location of powerlines in the Rich County. Data from Connelly et al. (2004), obtained from http://sagemap.wr.usgs.gov/index.asp.

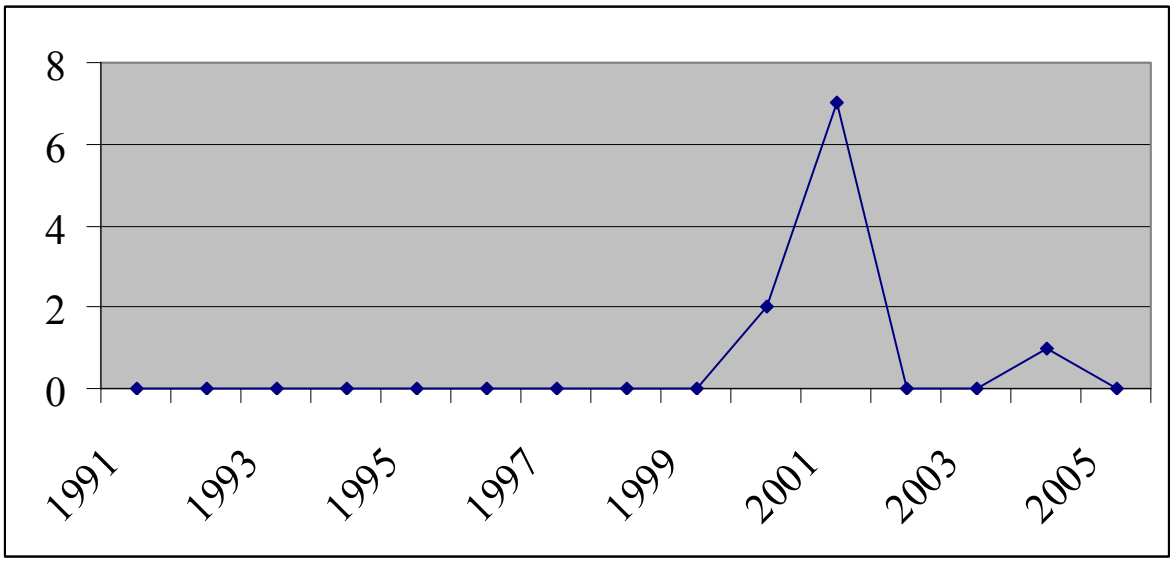

Figure 9. Number of oil and gas wells spudded in Rich County, 1991-2005 (data from Utah Division of Oil, Gas, and Mining).

Oil and gas facilities generally have a small footprint, usually a few acres or less. Each pad will often contain tanks and other equipment for a period of years. When the well is depleted, all facilities are removed and the pad is reclaimed. Some researchers believe facilities suppress sage-grouse use of habitat for some distance beyond the actual footprint of the facility (Robel et al. 2004). Compressor stations, active wells and drilling rigs produce relatively loud and sustained noise that can purportedly interfere with sage-grouse, particularly during the breeding season.

The location of drill sites is depicted in Figure 10. Although drill sights only represent places where oil or gas depositions were sought, many sites were fruitful and pads now exist in those areas. Figure 10 is provided to illustrate generally where oil and gas impacts are located in Rich County.

Effective reclamation of oil and gas pads and other facilities, including the re-establishment of big sagebrush in some instances, is important for maintenance of sage-grouse habitat in these development areas. This can be challenging in drier portions of Rich County. Reclaimed pad sites have been used as leks sites in some areas (B. Maxfield, UDWR, personal communication).

Roads

Collisions with motor vehicles, either while flying or while walking on or across roadways are also potential causes of direct mortality or severe injury for sage-grouse. Road construction can cause an increase in dust on plants, spread of invasive/alien species, and increased access for predators and incompatible recreation activities (Gunnison Sage-grouse Rangewide Steering Committee 2005). Some new roads have been built in Rich County; however, most development is centered around Bear Lake and road construction and expansion impacts in sage-grouse use areas are limited.

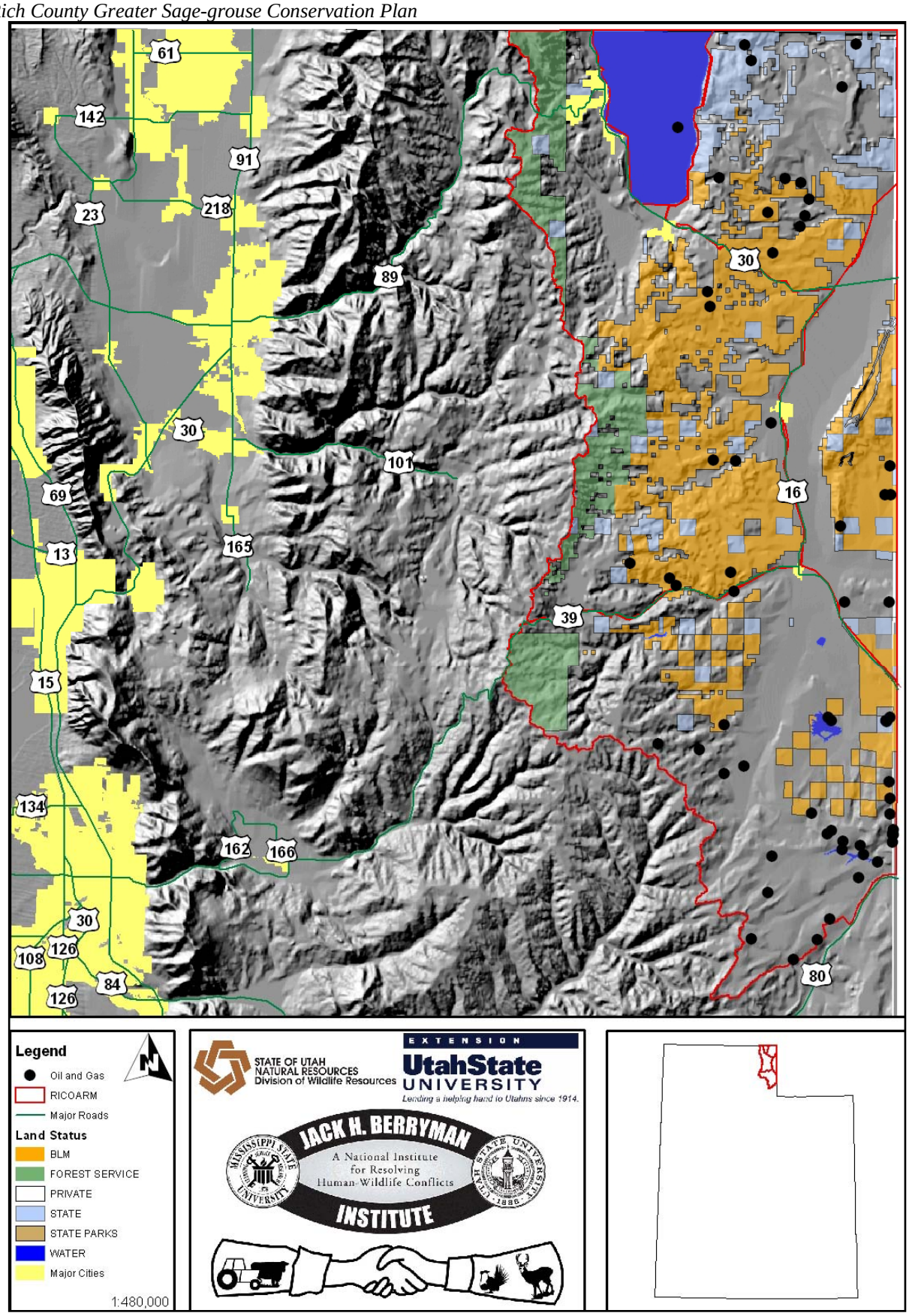

Figure 10. Location of drill sites in Rich County. Data obtained from http://www.ogm.utah.gov/oilgas/MAP_SEARCH/map_search.htm

B. Drought and Weather

Long periods of below average precipitation, above average summer temperatures, above average snowfall or below average winter temperatures can have adverse effects on sage-grouse reproductive success and survival. In fact, prolonged drought during the 1930s and in the later part of the 20th century coincided with declines with sage-grouse populations throughout their range (Patterson 1952, Fischer 1994, Hanf et al. 1994). Extreme climatic conditions that occur during important life cycle sequences have the potential to adversely affect food quality and/or abundance and hiding cover (Hanf et al. 1994, Fischer 1996).

Sage-grouse can be very sensitive to fluctuations in annual moisture (Patterson 1952, Fischer 1994, Hanf et al. 1994). Sage-grouse summer diet, especially for chicks, is heavily dependent on insects and succulent plant growth. Sage-grouse population declines in some areas have been linked to years of low precipitation, most likely due to low nest success and/or poor chick survival (Hanf et al. 1994; Fischer et al. 1996a).

Rich County experienced drought conditions from 2000-2004 and is currently considered to be emerging from drought conditions (Figure 11). It is unclear what the exact direct and indirect effects of drought conditions were on sage-grouse and their habitats in Rich County. It is likely that drought conditions temporarily reduced the amount of forbs and insects available to sage-grouse broods and adults during summer months; however, reduced snowpack likely left greater amounts of sagebrush available to birds during winter. As was illustrated in Figures 2 and 3, sage-grouse lek counts increased during this period, despite potentially detrimental weather conditions.

Severe winter conditions can be a factor in reducing grouse survival but there is no conclusive evidence to support this claim (Wallestad 1975; Beck 1977; Robertson 1991). Winter snow accumulations force birds to move to areas blown free of snow or areas with sagebrush which extends above the snow (Eng and Schladweiler 1972; Wallestad 1975; Beck 1977; Hupp and Braun 1989; Robertson 1991).

The winter of 1983-84 was particularly severe, bringing extreme cold and heavy snow to Utah (and many parts of the western United States) for an extended period. It is believed that sage-grouse populations declined dramatically during this winter. A far less severe, but still harsh, winter occurred in 1992-93. Radio-telemetry and lek count data from the Southern Subunit suggest that sage-grouse populations declined following the winters of 1983-84 and 1992-93 when snow depth was substantial (Danvir 2002). Telemetry data indicated predation by golden eagles (*Aquila chrysaetos*) also occurred during these winters (as grouse were concentrated near remaining patches of basin big sagebrush protruding above snow). Male grouse lek attendance was negatively correlated with mean winter snow depth and number of wintering eagles in the Southern Subunit, Rich County, 1985-2001 (Danvir 2002).

Poor weather conditions in the spring and summer are also suspected of influencing sage-grouse production (Connelly et al. 2000). Good winters followed by relatively wet springs can increase production (Wallestad 1975, Autenrieth 1981) by promoting good insect and forb production. In contrast, severe spring weather (cold temperature combined with rain and wind) that coincides with hatching can decrease production (Wallestad 1975). Summer precipitation (April–

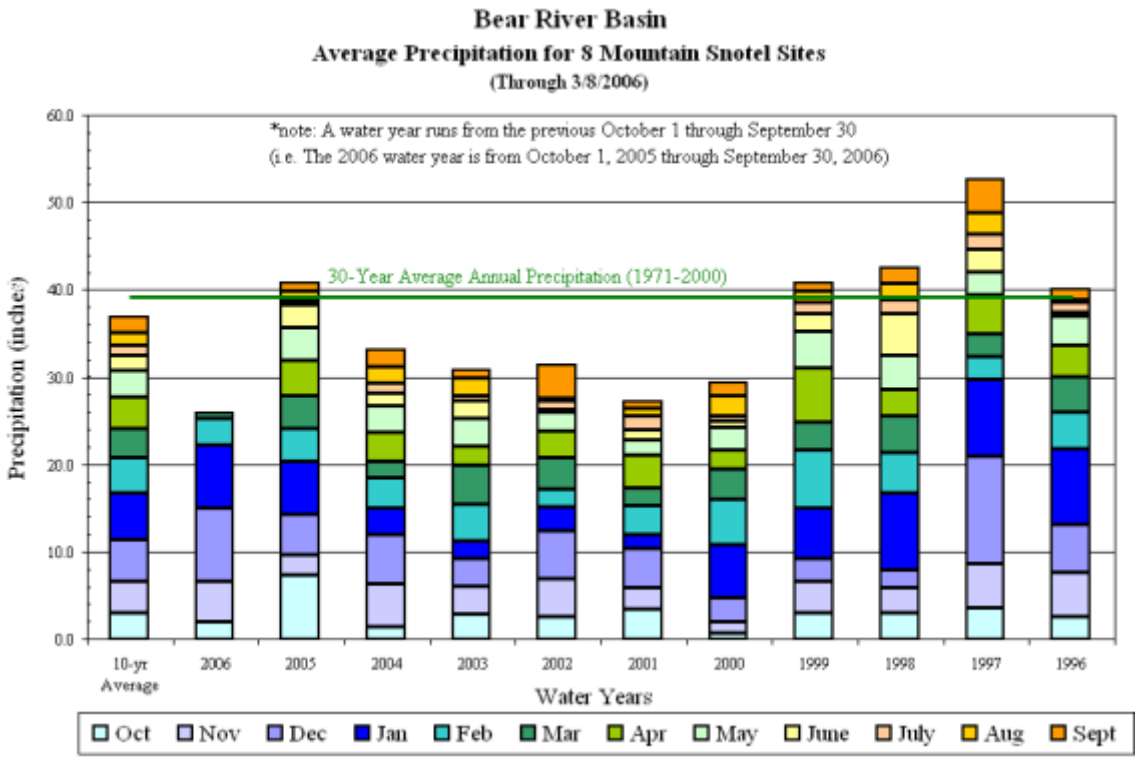

Figure 11. Precipitation in the Bear River Basin, which includes Rich County, from 1996-2006 (through September 30, 2006). From 2000-2004 precipitation fell below the 30-year average, considered drought conditions. Graph obtained from Utah Division of Water Resources.

September) appeared to influence both sage-grouse habitat use and demographics in the Southern Subunit, Rich County. Sage-grouse use of lowland meadows in the southern subunit increased in drier summers, and was negatively correlated with summer precipitation (Danvir 2002). Data suggested populations were negatively affected by dry summers, as lek counts in the Southern Subunit tended to increase following wetter summers while remaining stable or declining following drier summers (Danvir 2002).

C. Hunting

Connelly et al (2000) maintain that most grouse populations can sustain controlled hunting seasons, but caution that grouse have the lowest reproductive potential of the upland game birds, that small populations (<100 male grouse counted during spring lek counts) are highly vulnerable, and that harvest rates should not exceed 10% of the fall population. Connelly et al (2003) found that unhunted populations recovered faster than populations receiving light to moderate hunting pressure. They recommend that grouse hunting seasons be conservative and account for population trend and habitat quality (Connelly 2003).

Sage-grouse have been hunted legally in Utah since 1951. From 1951-1962, harvest was limited by issuing permits. Statewide harvest peaked in the late 1970s and early 1980s with the highest harvest at 28,280 sage-grouse in 1979 and the lowest harvest (1,303) occurring in 1967. Harvest for 2000 was estimated at 1,498 sage-grouse, down 77% from the 1999 estimate. The number of sage-grouse harvested per hunter has shown an overall decrease from 1967-2000 with the lowest rate of 0.31 sage-grouse/hunter attained during the 1997 hunting season. The number of sage-grouse harvested per hunter-day has also shown a decline from 1967-1999 (UDWR 2002).

The UDWR reduced the number of sage-grouse hunting units in 2000 due to declining populations. In 2000, 4 areas in Utah were open for sage-grouse hunting, including all of Rich County. Beginning in fall 2000, a permit was required to hunt sage-grouse in Utah. This requirement may have decreased the hunter participation in the sage-grouse hunt; subsequently reducing the overall harvest. Since 2000, Rich County has seen an overall decrease in the number of sage-grouse hunters and in the number of birds harvested (Table 4). Illegal harvest, or poaching, of sage-grouse likely does occur in Rich County.

Table 4. Sage-grouse harvest information for Rich County, 2000-2003.

Year	Hunters Afield*	Hunter-days Afield	Sage-grouse Harvested	Sage-grouse per Hunter-day
2000	461	937	485	0.52
2001	349	786	310	0.39
2002	106	287	85	0.30
2003	155	383	207	0.54
2004	165	248	141	0.57
2005	240	340	260	0.76

* Harvest information obtained from UDWR hunter questionnaires and telephone surveys.

D. Fire

Across the Intermountain west, fire suppression is believed to have caused sagebrush stands to increase in canopy cover and density with a resulting reduction or loss of herbaceous understory species in many areas. Sagebrush stands have become more even-aged and less productive across large areas of sage-grouse habitat. Fires that do start tend to burn greater acreage and at higher intensity due to the increased amount of fuel available to the fire. BLM fire data shows a rise in fire starts and acreage burned within the last 20 years (BLM 2005b).

The effects of any particular fire event depend on several characteristics of the local area including dominate sagebrush species, aridity, soils, topography, and disturbance (Bunting et al. 1987, Miller and Eddleman 2000). In general sagebrush species are fire adapted and will recolonize and are after a burn. Other threats such as invasive/alien species (e.g. cheat grass, *Bromus tectorum*), livestock grazing, and agricultural cultivation, are now present in sagebrush biomes and also contributes to the frequency, intensity, and duration of fire disturbances.

Fire, in general, is not detrimental to sage-grouse. In fact, sage-grouse have been observed to use burned areas so long as suitable cover and food are present during the time of use (Slater 2003). However, 2 altered fire regimes have emerged as being potentially incompatible with habitat management for sage-grouse populations. In the first, invasion of cheat grass has increased the frequency of fire disturbances, potentially changing sagebrush-steppe plant communities into grasslands (Miller and Eddleman 2000, Connelly et al. 2000). In the second, the occurrence of fire suppression has prevented the regular set-back of succession and promoted the advancement of pinyon-juniper stands (Burkhardt and Tisdale 1969, Young and Evans 1981, Miller and Rose 1995, Miller et al. 2000). In these areas, there is the potential for sagebrush seed sources to be lost, reducing the likelihood that sagebrush could become reestablished after an eventual fire disturbance.

In Rich County, fire planning and management fall under the purview of land management agencies like the BLM and USFS and local governments. In their 2005 Fire Management Plan Environmental Assessment (EA), the BLM notes that the goals of fire management include improving firefighter and public safety, reducing fuel loads, and maintaining the ecological functions of landscapes. The BLM EA provides for the conservation of BLM sensitive species and their habitats during wildland fire suppression, prescribed fire, and non-fire fuel treatment activities (BLM 2005b). The USFS Wasatch-Cache National Forest operates according to the National Fire Plan. According to their 10-year Comprehensive Strategy (USFS 2001), the USFS fire management goals are to improve prevention and suppression, reduce hazardous fuels, restore fire adapted ecosystems, and promote community assistance. The strategy calls for the use of prescribed fire, wildfires, mechanical fuels reduction, and other available techniques to achieve these goals.

Cheatgrass and pinyon-junpier encroachment appear to be limited to small, isolated areas in Rich County. Fire management by the BLM and the USFS is done in close cooperation with the UDWR who often provides a seed mix for post-burn rehabilitation. Fire planning is done carefully and cautiously in Rich County.

E. Livestock Grazing

Livestock grazing is an important use of sage-grouse habitat in the Rich County and throughout the range of sage-grouse in the West. According to the Utah Agricultural Statistics (USDA's NASS 2005), Rich County produced $983,000,000 in cash receipts for all livestock in 2005. The impacts of livestock grazing on sage-grouse are not clear, yet they are often contentious and controversial, perhaps more so than any other issue. Published literature and opinions run the gamut from having no effect or beneficial influence on one side to a totally incompatible, harmful practice that should be eliminated (Connelly et al. 2004). Because of controversy and also because Rowland (2004) recently published a throughout review on the subject, we have chosen to follow the lead of the Gunnison Sage-grouse Rangewide Steering Committee (2005) and simply provide several quotes from her (Rowland's) publication. In addition, the potential impacts of livestock grazing on sage-grouse are covered extensively in Connelly et al. (2004).

Impacts to Sage-grouse Habitat

Rowland (2004:17-19) summarized studies that suggest livestock grazing has a negative impact on sage-grouse habitat:

"Beck and Mitchell (2000) summarized potential effects of livestock grazing on sage-grouse habitats, and cited only four references that provide empirical evidence of direct negative effects of livestock grazing on sage-grouse, as follows. Of 161 nests examined in Utah, two were trampled by livestock (one sheep, one cattle) and five were deserted due to disturbance by livestock (Rasmussen and Griner 1938). In Nevada, sage-grouse habitat in wet meadows was degraded through overgrazing by domestic livestock and altered system hydrology (Oakleaf 1971, Klebenow 1985; as reported by Beck and Mitchell 2000). Klebenow (1982) examined sage-grouse habitat use in relation to grazing at the Sheldon NWR in Nevada, where sheep and cattle had grazed for >130 yr. Dominant sagebrush species at the refuge were low sagebrush, mountain big sagebrush, and Wyoming big sagebrush. Grasses included Sandberg and Cusick's bluegrass (*Poa secunda* and *P. cusickii*, respectively) in wet meadows, and Sandberg bluegrass and mat muhly (*Muhlenbergia richardsonis*) in dry meadows. A rest-rotation system was implemented for cattle grazing in 1980 over the majority of the refuge, where season-long grazing had occurred historically; a smaller portion had previously been managed under deferred rotation. Meadows heavily grazed by livestock (e.g., with few forbs and grasses and dense shrubs present) were avoided by sage-grouse, with the exception of use for free water when available (Klebenow 1982). (No explicit definitions were provided for light versus moderate or heavy grazing.)"

Rowland (2004:17-19) also noted cases where livestock grazing was reported to have had a positive effect:

"Some positive effects of livestock grazing were noted. When cattle were introduced into a meadow with residual grass, sage-grouse initially preferred the grazed openings, which had an effective cover height (sensu Robel et al. 1970) of 5 to 15 cm, compared to 30 to 50 cm in the lightly grazed surrounding areas. Grouse avoided dense, ungrazed basin wild rye meadows but were observed in adjacent wild rye that was grazed. One 40-ha meadow that was lightly grazed by cattle (41 yearling heifers, 60 days in June- August) was used throughout the summer by

sage-grouse and had more sage-grouse (100) than any other meadow on the refuge. Effective cover height in the meadow did not decrease below 5 cm during the summer."

Impacts on Sage-grouse Behavior and Demographics

Studies that focused on sage-grouse behavior and demographic parameter response to grazing reported mixed impacts (Rowland 2004:17-19): "Danvir (2002) reported two instances of nest abandonment related to livestock grazing in northern Utah during 7 yr of observations; one was caused by cattle, the other by sheep. Sage-grouse behavior on leks did not appear to be altered by the presence of cattle grazing (Danvir 2002). Sheep grazing in Idaho did not appear to disrupt use of leks by sage-grouse (Hulet 1983). Autenrieth (1981), however, cautioned against grazing sheep in sage-grouse winter habitat. He also suggested that livestock use of meadows occupied by sage-grouse, as well as livestock drives in sage-grouse habitat, could be detrimental to sage-grouse. In Wyoming, nesting densities of sage-grouse were considerably lower (10 nests/100 ha) in areas heavily grazed by domestic sheep compared to adjacent sites with moderate grazing (28 nests/100 ha) (Patterson 1952). Nest desertion caused by migrant bands of sheep also was documented (Patterson 1952). Heath et al. (1998) compared sage-grouse nesting and breeding success at three ranches with different grazing operations and levels of predator control in Wyoming. They found that, despite heavier livestock use (removal of >50% of annual herbaceous production, and grazing by both sheep and cattle) and long-term predator control on one ranch, nesting and breeding success of sage-grouse did not differ substantially among the three sites. Chick survival to 21 days was, however, greater on the ranch with lighter grazing, suggesting that predator control did not fully compensate for the greater reductions in herbaceous production (Heath et al. 1998). Further, hens were documented leaving the more heavily grazed ranch to nest elsewhere but returning to that ranch to rear broods (Heath et al. 1998). In a similar study, Holloran (1999) examined sage-grouse habitat use and productivity in relation to grazing management strategies at four ranches in southeastern Wyoming. He found no differences in nest success, brood survival, or numbers of chicks fledged among the ranches. Some differences in habitat use by sage-grouse were found among the ranches; however, these could not be ascribed to differences in grazing pressure, but were ascribed to differences in soil types and precipitation patterns (Holloran 1999). Above-average precipitation during the study, however, may have obscured any potential differences in habitat suitability for sage-grouse among sites. Neither of these studies employed control sites or replication."

Conclusions

Livestock grazing is an important use of sagebrush rangelands in Rich County. Although some incompatible grazing likely occurs within Rich County, the majority of livestock operations appear to be coexisting with sage-grouse and sage-grouse populations are stable to increasing. Studies conducted on Deseret Land and Livestock in the Southern Subunit, described earlier in the Plan, have concluded that excluding livestock can increase shrub production, reduce forb production, and fail to increase species diversity; however time-controlled grazing appears to have increased herbaceous cover and slowed the rate of sagebrush encroachment. There is no empirical information on the effects of livestock grazing on sagebrush habitats in other subunits and this likely warrants additional investigation. In addition, the direct effects of livestock grazing on sage-grouse movement, habitat use, and behavior have not been studied in Rich County; this information would likely contribute to better management of livestock and sage-

grouse habitats.

F. OHV Recreation

The effects of off highway vehicle (OHV) recreation and other forms of recreation (snowmobiles, birdwatching, etc.) on sage-grouse behavior and populations are poorly understood. Impacts of recreational activities are likely to be of 2 forms: disturbance of individuals and alteration of habitat.

Recreational activities, specifically OHV recreation, likely has the potential to impact individual birds or flocks of birds by flushing them from breeding grounds, nests, roost sites, or foraging areas, depending on the season in question. Noise associated with OHV recreation is likely the primary cause of disturbance to individual or flock behavior. Disturbance during nesting season may result in nest abandonment or failure. Disturbance during any time of year may increase the vulnerability of sage-grouse to predators. OHV recreation, and other forms of recreation, may also trample plants, disturb soils, and otherwise alter and degrade habitat. In many instances, specific areas are designated for use of OHVs. When confined to specific use areas, impacts are likely to be reduced.

OHV recreation is relatively common in Rich County and although specific impacts to sage-grouse populations are unknown from studies, they are thought to be minimal.

G. Invasive/Noxious Weeds

The Utah Department of Agriculture (Section 4-17-2) defines noxius weeds as "…any plant the commissioner determines to be especially injurious to public health, crops, livestock, land, or other property." Under the Utah Noxious Weed Act (4-17-10) county weed departments are charged to "…develop, implement, and pursue an effective program for the control and containment of noxious weeds on all lands under their control or jurisdiction, including highways, roadways, rights-of-way, easements, game management areas, and state parks and recreation areas."

Russian knapweed (*Centaurea repens*), dyers woad (*Isatis tinctoria* L), and several other species of thistle, grasses, and knapweed are listed on the Utah Noxious Weed List (Section 4-17-3, Utah Noxious Weed Act). Although cheat grass is not listed there nor is it included in individual county lists for Rich County, this invasive plant species is known to be established in some parts of the county.

Invasive species effect the species composition, nutrient cycling, and physical structure of sagebrush systems. Invasive species also impact the function of sagebrush systems, especially their ability to recover from fire. These impacts often culminate in an alteration of wildlife species diversity and abundance in effected systems.

Cheat grass is an annual grass native to Russian and parts of northern Europe. When it invades sagebrush communities, cheatgrass is known to increase fire frequency and has the potential to convert sagebrush communities to annual grass rangelands. Cheat grass has also been reported to encourage establishment of other invasive species (Grahame and Sisk 2002).

Noxious weeds have been recognized within Rich County as a serious problem by County Weed Control Board, BLM, and USFS. County weed control departments maintain records of the location, extent, and severity of weed establishment and actively work to control the spread and establishment of weeds in their respective counties. In January 1996, the BLM published Partners Against Weeds, (PAW) an action plan for the Weed Management program in the Bureau. The PAW plan lists 7 goals, the first being to develop a prevention and early detection program. The PAW recommends developing and enforcing a policy to "ensure seeds, seed mixtures, hays, grains and straws are free of weed seed" as a prevention and detection strategy. Utah's BLM Resource Advisory Council (RAC) developed a guideline requiring certified weed free forage to be used on BLM lands by anyone having the need to take forage with them when using BLM public lands. The guidelines were approved by both the Utah State Director and the Secretary of the Interior in 1997. Beginning November 1998, users of BLM administered land in Utah will be required to use only certified noxious weedfree hay, straw or mulch. Approved products for livestock feed on public lands include pellets, hay cubes, processed grains and certified hay, straw or mulch normally available at some feed stores and producers in Utah. The USFS is also committed to a campaign against the spread of invasive species. Working with agency and local government partners the USFS aims to create Cooperative Weed Management Area (CWMA) Participative Agreements for all USFS lands.

H. Parasitism & Disease

Several bacterial and parasitic diseases may effect sage-grouse to varying degrees. Sage-grouse have long co-existed with a range of pathogens and many produce no, or few ill effects in individuals and populations. Large-scale (i.e. rangewide or state-wide) impacts to sage-grouse have not been reported. Below, we discuss a few of the pathogens that appear to be most likely to impact sage-grouse populations (Connelly et al. 2004).

West Nile Virus

West Nile virus (WNV) is an arbovirus, or arthropod-borne virus, of the flavivirus family which also includes Dengue and Yellow Fever. WNV is one of many mosquito-borne viral infections. West Nile Virus is primarily transmitted by mosquitoes of the *Culex* family during normal blood-feeding. Some species in this family are feed primarily on birds and birds act as reservoirs or amplifying hosts of the virus. Although many species of birds are known to contract WNV, species in the Corvid family (crows, ravens, and jays) are more susceptible to the disease and are therefore useful geographic detectors of WNV. Mammals, including humans and horses, are considered incidental hosts and are therefore viral 'dead ends.' Humans are most likely to acquire WNV from an infected mosquito. Other mammals, such as horses, do not maintain a high enough level of the virus in the blood stream to transmit the virus to humans.

WNV was first detected in the Western Hemisphere in 1999 and has since rapidly spread across the North American continent into all 48 continental states, seven Canadian provinces, and throughout Mexico. In addition, WNV activity has been detected in Puerto Rico, the Dominican Republic, Jamaica, Guadeloupe and El Salvador.

In 2003, several cases of WNV were confirmed in sage-grouse in Wyoming (19 brids), Montana (3 birds), and Alberta, Canada (5 birds). In that same year, WNV was detected in chickens in Price, Utah and in mosquito pools in the Uinta Basin. In 2004, sage-grouse in Wyoming, Montana, Colorado, and California tested positive for the virus. In 2005, the virus was confirmed in a dead sage-grouse in northeastern Utah and also in a prairie falcon in Carbon County, Utah. A limited percentage of sage-grouse appear to be capable of developing immunity to the virus (Cornish, unpublished data) and infection appears to be almost always fatal within 24-48 hours.

Macro-parasites

Coccidiosis—Coccidiosis is an intestinal disease caused by one or more species of the protozoan genus Emieria (Jolly 1982): *E. angusta, E. centrocerci, and E. pattersoni*. Infection results in diarrhea caused by damage to the mucosal lining of the digestive tract. The disease is transmitted through consumption of contaminated feces. Coccidiosis is the most well know of all diseases known to infect sage-grouse (Connelly et al. 2004). In Wyoming, Colorado, and Idaho from 1932-1953 this disease resulted in significant losses of young sage-grouse (Honess and Post 1968); however no cases have been documented since the 1960s (Connelly et al. 2004). Cases were typically reported in areas where large numbers of birds are concentrated. The concentration led to contamination of and spread via water and food sources. Connelly et al. (2004) speculated that this disease lacks prevalence in recent years because sage-grouse density

has decreased. No cases of Coccidiosis are known from Rich County; however this does not imply that the condition does not exist or have the potential to exist. Specifically, drought conditions that result in a decrease in water sources may potentially increase sage-grouse concentrations in localized areas, thereby increasing the potential for impacts from this infection.

Tapeworms—Sage-grouse are the only known host of the cestode tapeworm *Raillietina centrocerci* (Honess 1982). There is little consensus on the impact *Raillietina centrocerci* have on sage-grouse populations. The Canadian Sage Grouse Recovery Strategy indicates that this infection may be a largely overlooked cause of mortality; however, Honess (1982) suggested that there was a synergy between host and parasite with little negative impacts to sage-grouse. The parasite does not affect the quality of sage-grouse meat. There are no documented cases of *Raillietina centrocerci* in Rich County; however, this does not imply that this infection does not impact sage-grouse therein.

Filarid Worms—A filarial nematode, *Ornithofilaria tuvensis*, which utilizes the connective tissue between skin and breast muscle in sage-grouse, appears to prevent flight in infected birds (Hepworth 1962). This infection is rare but appears to have significant impacts. This infection is not known to occur in Rich County; however it may yet exist, undetected.

Avian Malaria—Avian malaria, caused by the protozoan *Plasmodium pediocetti*, is known to infect wild sage-grouse but is considered rare. Although this infection does not have a profound impact on sage-grouse populations, it does cause birds to reduce activity during morning hours and may impact courtship and breeding of strutting males (Boyce 1990, Johnson and Boyce 1990). This disease is transmitted by biting flies (Friend and Franson 1999).

Conclusions

We currently consider WNV to be the disease/parasite with greatest potential to impact sage-grouse populations in Rich County. As previously mentioned, in 2005 a dead sage-grouse was found in northeastern Utah that was infected with WNV. Parts of Colorado and Wyoming adjacent to Rich County have also detected infected birds. There is potential for disease persistence from transmission between these areas.

As previously mentioned, other diseases discussed in this section may have an effect on sage-grouse but have not been documented in Rich County and, therefore, do not pose as great a potential threat.

I. Predation

Sage-grouse occupy an important place in the food web in sagebrush environments and are preyed upon by a wide variety of terrestrial and avian predators. Numerous predators have been documented preying upon differing ages of sage grouse and/or their nests. Documented nest predators include weasel, badger, elk, coyote, common raven, American crow, red fox, striped skunk, black-billed magpie and various species of snakes (Batterson and Morse 1948, Patterson 1952, Nelson 1955, Autenrieth 1981, Hanf et al. 1994, Young 1994, DeLong et al. 1995, Sveum 1995). Numerous species have also been documented killing and/or consuming adult sage-grouse and include Cooper's, ferruginous, red-tailed and Swainson's hawks, Northern goshawks, coyote, red fox, and bobcat (Girard 1937, Rasmussen and Griner 1938, Batterson and Morse 1948, Nelson 1955, Rogers 1964, Beck 1977, Dunkle 1977, Autenrieth 1981). Numerous predator species, many of which are listed above, have been documented to kill juvenile sage-grouse. Because of the small size of young sage-grouse, additional predators have been documented and include American kestrels, merlin, Northern harrier, common raven, and weasel (Girard 1937, Patterson 1952, Nelson 1955, Rogers 1964, Autenrieth 1981).

Predation is the end result for the vast majority of sage-grouse throughout their range, both historically and presently (Bergerud 1988). Schroeder and Baydack (2001:26) suggest that predation has the potential to affect the annual life cycle of sage-grouse in 3 primary ways: "1) success of nests, 2) survival of juveniles during the first few weeks after hatch, and 3) annual survival of breeding-age birds." Peterson and Silvy (1996) conclude that the relative importance of predation on the viability of sage-grouse populations is relatively unknown and needs study.

Nest success varies by year, area, population density, and/or management strategy (Connelly et al. 1998, Schroeder et al. 1999). Connelly et al. (2000) suggested that several studies on nest success have illustrated success >40% and that nest predation does not appear to be a problem across the range of the grouse. In contrast, Gregg (1991) and Gregg et al. (1994) suggested that nest predation may be limiting grouse numbers in Oregon. Red foxes and common ravens have been implicated in affecting nest success and the annual survival of breeding age birds in the Strawberry valley area of Utah (Bunnell et al. 2000). Researchers suggest that the advancing population of a nonnative predator, red fox, is responsible for preying upon a large portion of the population in that area (Flinders 1999). In artificial nest studies conducted in Strawberry Valley, ravens depredated 98% of artificial nests within 48 hours of their placement; remote cameras were used to verify the identity of artificial nest predators (Baxter and Flinders, unpublished).

The following sections on the history of predator management and effects of predator management on sage-grouse populations were written, in conjunction with the CRM SAGR Subcommittee, for the Plan by representatives from USDA-WS. Wildlife Services has been managing predator populations and collecting data on predator population trends in the state for several decades. They also have an extensive body of personal knowledge about predator population management and the impacts of various management practices.

History of Predator Management in Utah

The following sections on the history of predator management and effects of predator management on sage-grouse populations were written for the Plan by representatives from

USDA-WS. Wildlife Services has been managing predator populations and collecting data on predator population trends in the state for several decades. They also have an extensive body of personal knowledge about predator population management and the impacts of various management practices.

Understanding the impact of predation on sage-grouse is difficult, as the primary effects (the number of sage-grouse killed by predators) is affected by habitat variables, variables associated with the predator population and variables within the sage-grouse population itself. Secondary effects of predation exist and are indicated when habitat choices are dictated by the risk of predation. What we currently know about habitat needs of sage-grouse is developed from studies of core sage grouse range. However, if predation or the risk of predation is effecting habitat selection, then otherwise good habitat is made unavailable to grouse. To better understand the role predation management may have played historically, it is important to examine records of the past.

Predator management in Utah began in the late 1800's with territorial bounties followed by a federal appropriation in 1917. The original purpose for the federal program was the suppression of rabies. The program has gone through several changes with both State and Federal agencies involved. The US Biological Survey managed predator control in early years and developed the structure that was later used by the USFWS which is to have men in designated Wildlife Services districts (districts) that were supervised. From 1936 to 1986 the USFWS managed the program as Animal Damage Control. In 1986 it was moved to the United States Department of Agriculture under the Animal and Plant Health Inspection Service and in 1996 was renamed as Wildlife Services (again) (USDA-WS).

Correlations exist between livestock inventories and the intensity of predator management efforts. Domestic sheep numbers are on record [Utah Agricultural Statistics] at a high of 2.7 million in 1931. Breeding sheep inventories as of January 1, 2003 were reported at 290,000 head, or 10.7% of the maximum number. Sheep numbers varied quite a lot from year to year in some cases and from decade to decade since the early 1900's. Toxicants were used extensively in the early years when sheep numbers were high. Additionally, predator management in the early years involved many trappers, setting and tending steel traps statewide. As many as 132 men were hired (1936) to set traps and apply baits. Figure 12 shows the recorded take of coyotes from the predator control program between 1917 and 2004. These data do not include poisoned coyotes which were not found (but estimated as 7-10 coyotes for each one found).

Strychnine and thallium treated single lethal dose (SLD) baits were the main toxicants used between 1920 and 1950. Compound 1080 was developed about 1945, first as a rodenticide and later as a predicide in large bait stations. USDA-WS records indicate that 1443 bait stations were applied in 1969, covering 54% of the townships in the State. Bait placement from 1950 to 1972 were large bait stations while SLD baits were used prior to that. From about 1950 to 1972, Compound 1080 became the main force in controlling coyotes in all districts of Utah by the government and by private individuals. The low government take of coyotes during this period indicates that coyote populations were suppressed by bait station use. Toxicants were banned in federal programs in 1972, and current policies allow only two very selective toxicants for limited use.

Early predation control also extended to ravens, crows, eagles and magpies. Records indicate that single baits were applied around "draw station" to target birds. Records also note that UDWR personnel targeted areas for bird suppression which were not treated by the federal program.

It is difficult to assess the poison years in terms of population suppression of species such as ravens, coyotes, and even red foxes. Individual species records are presented below:

Red Fox—While some early records of red foxes exist, red foxes are believed to have been virtually absent on the landscape before the 1970's. Red fox do not exist in government records before 1972, and have increased since then. Red foxes may have been successfully suppressed by rabies or by bait station use, or both. Figure 13 shows red fox take from 1972-2004.

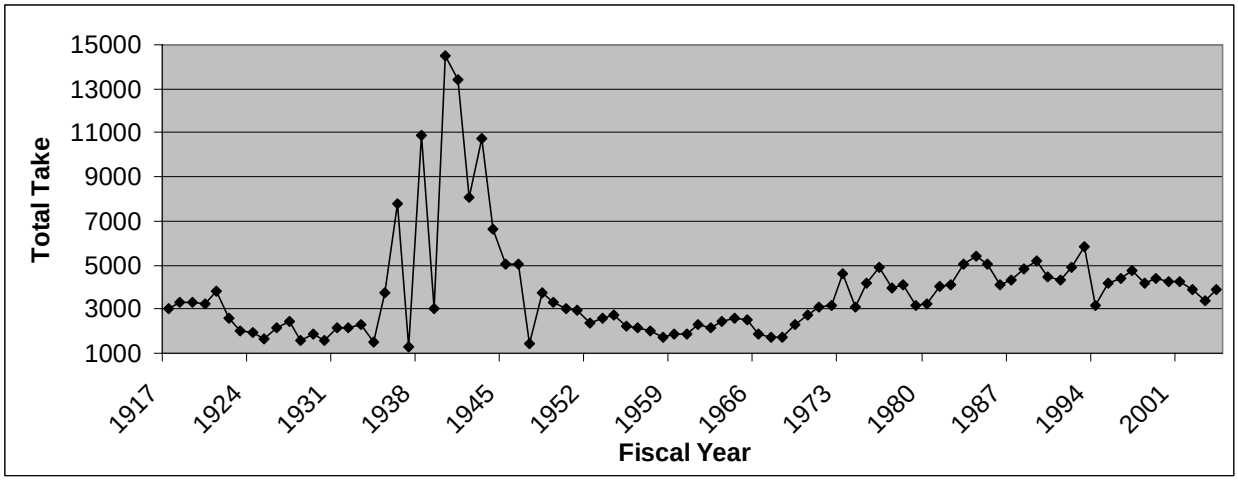

Figure 12. USDA-WS reported coyote take in Utah, 1917-2004. Data reported by USDA-WS.

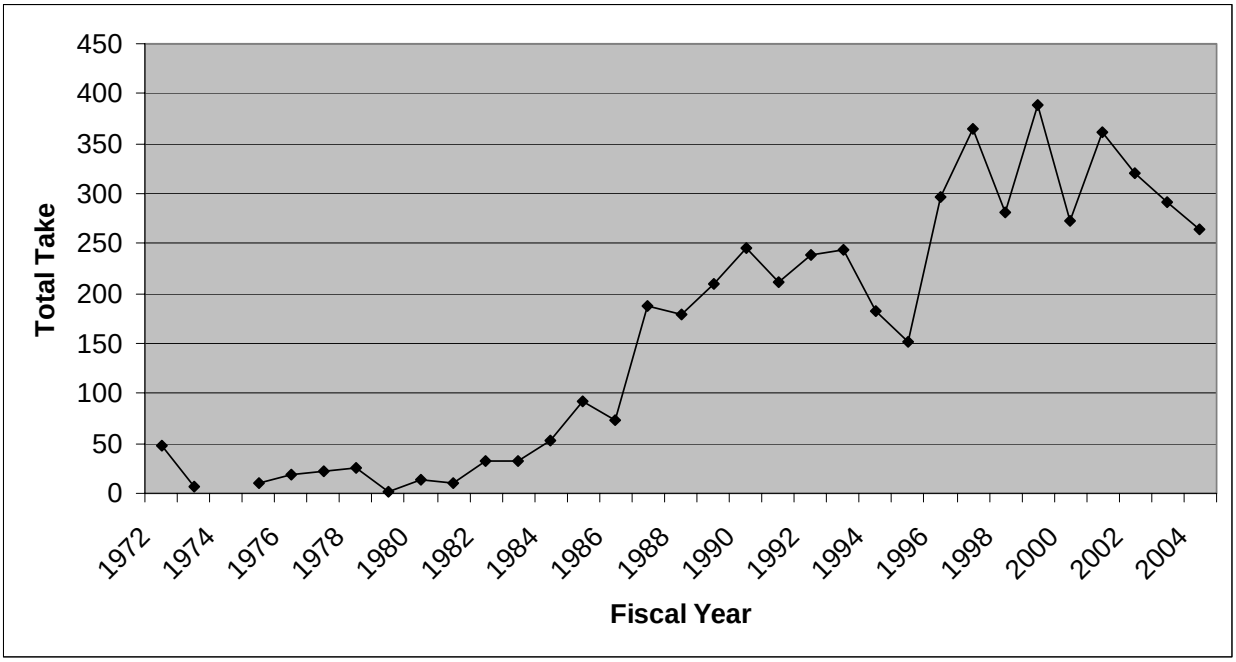

Figure 13. USDA-WS reported fox take in Utah, 1972-2004. Data reported by USDA-WS.

It is interesting to observe that the statewide increase in red fox abundance has occurred during the lowest period of coyote control. Sargeant (1984, 1987) theorizes that protection for coyotes would allow coyote populations to increase, thus suppressing red fox populations. This has not happened on a landscape basis in Utah.

An argument may be made that red fox in Utah are an invasive species, based on historical data. Red foxes were historically divided into two species, *Vulpes vulpes* in the Old World and *V. fulva* in the New World, but today they are considered to be one species in the U.S. (*V. vulpes*). Churcher (1959) reviewed 12 subspecies of red foxes in North America with 9 subspecies currently recognized in Canada. Churcher (1959) suggested that the red fox was introduced from Europe to the southern colonies around 1790.

Following the introductions there was confusion as to which populations were expanding. Audubon and Bachman (cited in Churcher 1959) believed that Pennsylvania was the southern limit of the red fox's range in 1750 and documented a range extension southwards to Georgia by 1850. Leopold (1933) reported the expansion of red fox in Wisconson, which was displacing the grey fox and Godin (1977) reported *V. fulva* had established itself by 1850 and was displacing the gray fox to some degree along the southeastern seaboard. Godin also speculated that the introduced foxes might have interbred with a scarce population of indigenous red foxes, but historical accounts do not support this. Churcher (1959) concluded from the available evidence that the red fox was native to North America north of 40-45 degree N but was scarce or absent in the hardwood forests where gray foxes were common. Churcher (1973) suggested that the "original" habitat was the northern mixed hardwood and softwood forest zones; he also observed that the red fox might also have been found in the hardwoods to the south and the tundra to the north. Gilmore (1946) believed that red foxes were absent from Pennsylvania during aboriginal times and concluded that they did not range into the mideastern United States. Rhoads (1903 cited in Churcher 1959) stated that "in earlier colonial times the red fox was unknown in the austral zone [southern states].

Archaeological evidence from Ontario, Canada (Peterson et al. 1953) has shown that the red fox was present in the Midland area prior to introductions during the decade 1639-49 and that it was present earlier in the Oxford and Middlesex counties of southern Ontario, Canada. Sites farther south did not have red foxes (Gilmore 1946).

Once the red fox began to spread south and west from northeastern U.S. after its introduction from Europe, it expanded its range to include the prairies of the mid west and continued to expand west to Colorado and Utah. It has reached the Utah-Nevada line and seems likely to invade Nevada as well.

Striped Skunk—Historically, what may be significant is the relatively few skunks found in Utah. Figure 14 shows skunk take by USDA-WS in Utah from 1917-2004. Periodic rabies eruptions suppressed skunk populations in the early years of the century. As an example, in 1918 with 51 full time personnel setting traps, only 10 skunks were removed statewide. In the 1920's, following years of SLD bait placements, skunk take in the program increased to above 100 annually, but then declined to none in 1933, 12 in 1934, 35 in 1935 and up to 98 in 1936. The cycle of skunk removal probably reflects the population level effect of rabies in skunks. The last skunk rabies incident in USDA-WS records occurred in 1972 in Davis County, with a county-

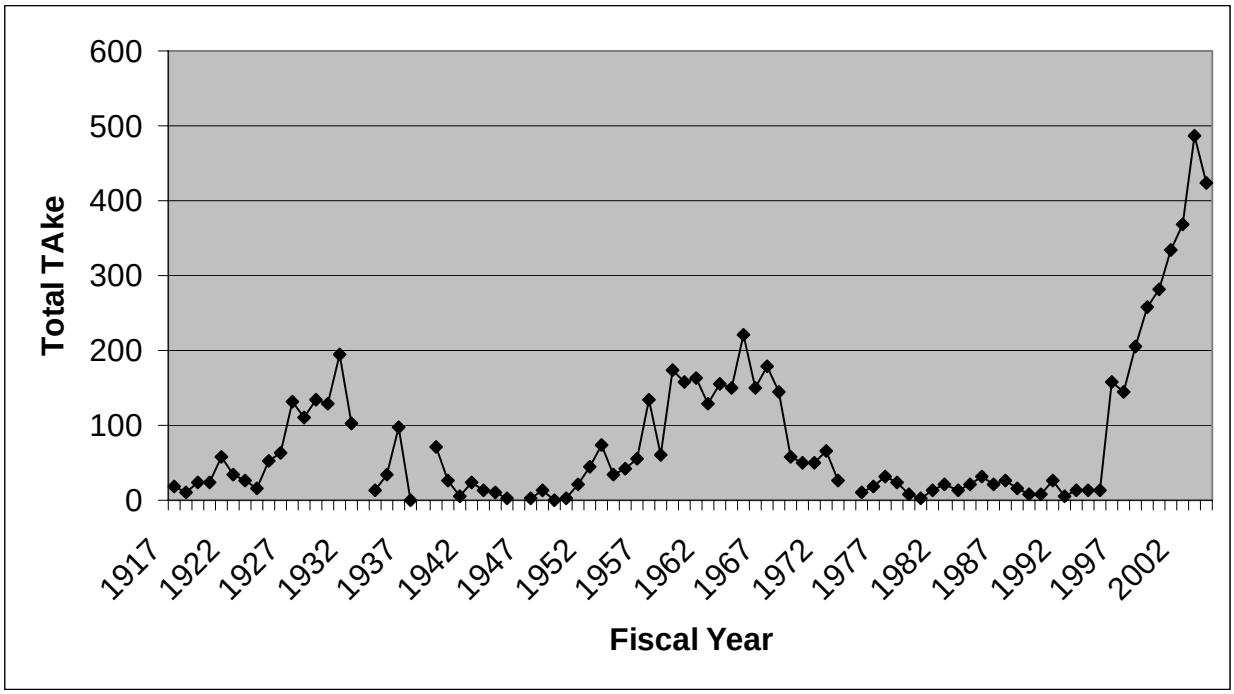

Figure 14. USDA-WS reported skunk take in Utah, 1917-2004. Data reported by USDA-WS.

wide control program initiated as a result.

Raven and Magpie—Breeding bird survey results indicate a 300% increase in raven numbers from the 1968 to the present. While most biologists believe the increase is due to more favorable conditions and anthropogenic food sources the increase in populations also follows the reduction in use of poisons which likely kept their numbers low.

Magpies were targeted along with ravens at draw stations with smaller baits placed especially for birds. USDA-WS records show that UDWR personnel placed baits to target birds in areas where federal poison programs were not active.

Coyote—Intensive coyote control prior to 1972 suppressed coyote populations. Since that time, the design of the predation management program has been to reduce coyote damage while not impacting populations. Analyses by Connolly and Longhurst (1975) and Pitt et al. (2002) indicate that the current level of exploitation does not impact coyote populations. It seems likely that coyote populations have never been higher than in modern times.

Impacts of Predation on Sage-grouse

Given that predators and nest predators are abundant and many are present in all time high numbers, impacts to sage-grouse may take one of two forms. Sage-grouse may be killed directly by predators (primary effects), and most mortality of sage-grouse is predation. Direct predation has negative population effects when it exceeds recruitment.

Secondary effects of predation include biological effects which are the result of behavioral

changes in sage-grouse. These behavioral changes result from the risk of predation and may take the form of lower fecundity, longer dispersals, use of suboptimal habitat, nest abandonment and a number of other behaviors which may affect populations.

Autenrieth (1981) suggested that nest predation was likely the most important population constraint on sage grouse, predation on adult birds does occur and may be significant in some cases. Presnall and Wood (1953) reported tracking a coyote approximately 5 miles to its den in northern Colorado, and finding evidence along the way that the coyote had killed 3 adult sage-grouse and destroyed a sage-grouse nest. Examination of the stomach contents from an adult female coyote removed the next day showed parts of an adult sage-grouse, plus 6 newly-hatched sage-grousechicks. The area around the den site was littered with sage-grouse bones and feathers. No other prey animal remains were found around the den, and it appeared that the pups had been raised largely upon sage-grouse. Till (1992) documented sage-grouse remains at 4 of the 30 coyote den sites examined during his study in south central Wyoming, but provided no indication of the relative abundance or distribution of sage-grouse in his study area. In northern Utah, researchers from Brigham Young University (BYU) confirmed predation, primarily by red fox and coyote, as the cause of death for 13 of 21 radio-instrumented sage-grouse in the first year in their study area (Bunnell and Flinders 1999). Two additional instrumented birds could not be found but were suspected to have been killed by predators, suggesting a 71% predation loss of instrumented birds. Additionally, 11 other sage-grouse were found dead in their study area, and all but 1 of these birds were killed by mammalian predators. USDA-WS is not aware of controlled studies conducted to determine if coyote and red fox control would actually result in significant benefits to grouse populations. However, the above studies indicate there may be some benefit to the removal of these predators in some situations

In addition to primary predation effects secondary predation impacts likely exist in a number of populations. The risk of coyote predation may cause habitat abandonment or, through habitat choices, reduce fitness and make grouse more susceptible to other mortality. Coyote damage management may be indicated for populations not performing to habitat potential.

Meso-predator Release—As red fox have been implicated as primary predators of sage-grouse in many areas, the notion of some natural control of red fox by coyotes has been suggested. The idea that coyote removal may benefit red fox, and thus be a detriment to sage-grouse, has been offered by some as a need to limit coyote removal. The potential for an indirect effect on sage-grouse of coyote removal would take the form of a "meso-predator release", which is the increase in smaller mammalian carnivore species after larger carnivores have been reduced or eliminated. The "meso-predator release" theory allows that smaller predators are allowed to increase due to either a lack of predation or release from competition or both. Gehrt and Clark (2003) present an opposing view of "meso-predator release" and point out several weaknesses in the circumstantial evidence that has been used to suggest that meso-predator release occurs.

Sargeant, et. al. (1984) reported on the effects of red fox predation on breeding ducks. Their data were collected when coyote populations were presumably suppressed by widespread use of predicide, and he notes that at the time (1968-73), "[c]oyote populations in most of the midcontinent area appear to be suppressed by man." The authors noted an inverse relationship between red fox and coyote populations and speculated that "...protection of coyotes will result in expansion of local or regional populations that in turn will cause reductions in fox

populations." They inferred that this will reduce predation on upland nesting ducks. Sargeant et al. (1987) reported on spatial relationships between coyotes and red foxes and showed that home ranges of fox families did not overlap the core centers of coyote home ranges on a North Dakota study site. Although none of their radio collared foxes were killed by coyotes in their study, they hypothesized that red foxes tended to avoid coyote territories, presumably because of the fear of being killed by coyotes. Thus, they inferred that a red fox population would increase if the coyote population is reduced, because the removal of territorial coyotes would create vacant coyote territories that could then become occupied by red foxes.

However, the presence of coyotes does not completely displace red foxes. Voigt and Earle (1983) verified that red fox travel through coyote areas during dispersal, but did not establish there. They also reported that "...individual foxes and coyotes can occur in close proximity to each other along territory borders and when coyotes travel into fox areas." They also noted that "fox-coyote range overlap near borders was similar to fox-fox range overlap near borders and that coyotes do not "completely displace foxes over areas." Gese et al. (1996) reported that coyotes tolerated red foxes when encountered about half of the time in Yellowstone National Park, although they also at times were aggressive toward and would sometimes kill foxes.

There are other studies that suggest coyote territories would not remain vacant for very long after the coyotes are removed. Gese (1998) noted that adjacent coyote packs adjusted territorial boundaries following social disruption in a neighboring pack, thus allowing for complete occupancy of the area despite removal of breeding coyotes. Blejwas et al. (2002) noted that a replacement pair of coyotes occupied a territory in approximately 43 days following the removal of the territorial pair. Williams et al. (2003) noted that temporal genetic variation in coyote populations experiencing high turnover (due to control) indicated that "...localized removal did not negatively impact population size..." When we consider the level of coyote removals that USDA-WS coyote damage management activities (only 2-4% of the estimated population), it is most likely that coyote populations are probably not impacted enough, even at the individual territorial level, to create the vacant territories that would theoretically allow red fox populations to increase substantially at the local level based on the North Dakota studies discussed above. Therefore, we believe it would be unlikely for USDA-WS's coyote removal actions to lead to indirect increases in predation effects on grouse populations. To the contrary, where populations are not performing to the full potential of the habitat, predation management may be necessary as part of an applied management plan for sage-grouse.

Predation Defense Mechanisms—Sage-grouse have adapted to live, and have evolved with, many of these predators. Sage-grouse and other ground nesting birds have developed effective strategies for hiding from predators when they occupy habitat of sufficient quality. Schroeder et al. (1999) briefly describe some of those adaptations. The actual timing of the strutting display and/or the formation of leks may have evolved due to predation selective pressures (Patterson 1952, Hartzler 1972, Bergerud 1988, Phillips 1990). Sage-grouse also respond to predation by either crouching in dense vegetation or flying away from an attacking predator (Hartzler 1972, Ellis 1984). Female Greater Sage-grouse have also been documented defending their nests from ground squirrels (Schroeder 1997). Girard (1937) observed females attacking predators in the defense of their brood. In an attempt to lead potential predators away from nests and/or young chicks, females have been documented performing distraction displays. The distraction display includes dragging wings on the ground while moving erratically (Peterson 1980). In addition, a

female will occasionally re-nest if her first nest is destroyed by predators early in the incubation period (Patterson 1952, Eng 1963, Connelly et al. 1993, Schroeder 1997), although re-nesting rates for sage-grouse are relatively low (Connelly et al. 1993).

Predator Control and Livestock Populations

Predator control activities began in Utah in 1888 with Territorial Bounty laws which continued into Statehood and through the early 1900's. The inauguration of the government sponsored predator control program began in 1915 with small appropriations of funds used to hire a supervisor and 8 men in designated areas where control was needed to protect livestock and today is managed by USDA-WS.

Utah sheep numbers were at a record high of 2.7 million in 1931. Numbers varied from year to year in some cases and from decade to decade since the early 1900's. Today, approximately 265,000 sheep are grazed in Utah. Although sheep numbers are down, today more cattle ranching operations exist in the state compared to 1931.

Predator control for the protection of cattle replaced some of the reduction in control because of reduced sheep numbers. Improved methods of hunting with aircraft increased efficiency and effectiveness since the early 1970's, but poisons were used extensively in the early years when sheep numbers were high. Congress passed the Animal Damage Control Act of March 2, 1931. Records show that in 1936 up to 132 men were hired for predator control. Poison baits placed by men in the various field districts were more effective at controlling predator populations over a larger area than are currently worked today. A documented figure of 16,719 predators was taken in 1939 by government trappers and that figure doesn't reflect all of those which were poisoned. This amount was a record catch for any one fiscal year and shows more predators were taken in early years than records of today. The number of predators taken during this era not only exceeds the modern "take," but likely represented a larger percentage of the population of the day. Modern records (since 1972) show that on average USDA-WS in Utah averages about 5,000 coyotes per year by using 25 field men and several fixed wing aircraft along with contracted helicopter work. Another 5,000 coyotes (on average) are taken by private hunters and trappers annually in Utah.

The coyote population in Utah today is near 100,000 based on studies by USDA-WS research personnel (Connolly, USDA-WS, unpublished data, 1996). Predator damage management today focuses on individuals causing damage as opposed to population reduction (or eradication in the case of the wolf) in the past. Current control is practiced on less of the land mass, with more restrictions and for the protection of fewer livestock than at any time in Utah history. Correspondingly, there are probably more coyotes alive today than at any time in Utah history.

Strychnine and thallium were the main poisons used in the early 1900's until the advent of compound 1080 in about 1945. Compound 1080 was first effectively used on rodents and later on predators. From about 1950 to 1972, 1080 became the main method in controlling coyotes in all districts of Utah by the government and by private individuals. It is impossible to know precisely the effects it had on the coyote population as population census were not conducted and the main objective of control was eradication.

It is reasonable to believe that Compound 1080 reduced coyote numbers considerably in large tracks of land that are no longer worked because current land use practices prohibit coyote control. Strychnine baits used for coyote control before 1972 (in conjunction with Compound 1080) likely controlled ravens and raptors which fed on the baits. Compound 1080 is highly selective to canines but was overused by most of the applicators because there were no dosage restrictions or regulations in place.

It is difficult to assess the extent of population suppression for ravens, coyotes and even red foxes during the poison years. Some red foxes were found in Utah in low numbers and at high elevations early in the Territorial history. However, most biologists believe the red fox in Utah today is an invasive species which arrived in the 1970's. Ravens have increased in numbers from the 1970's likely because of more favorable conditions including human food sources (landfills, etc.). The increase in the raven population also follows the reduction in use of poisons that could have kept their numbers low. Early records show raven predation on lambs in the 1950's and concern to control them.

The effects of reduced coyote control on sage-grouse are not well understood. The decline of sage-grouse occurred at the same time as coyote populations expanded. It could be concluded that the poison ban allowed coyotes, raptors, and ravens all to expand in population numbers and range. Protections were placed at this time on ravens and magpies in the form of removing bounties and adding laws that prohibited shooting and nest destruction. The reduction in sheep numbers added to the favorable habitats for predators and raptors by the increases in prey base and improved meadows and riparian areas. Red foxes arrived at this time and expanded in numbers because of the more favorable environments as previously discussed.

Incidentally, sage-grouse could have also benefited from the high numbers of sheep concentrated in winter areas. Proper sheep grazing in the winter has the effect of rejuvenating sagebrush. As sheep numbers declined, sagebrush became decadent to some degree. Although natural cycles may have once occurred in sage-grouse populations, changes in the environment since the 1970's have caused a long term decline. Once a decline in sage-grouse numbers occurred, then the increase in predator numbers, especially red fox and ravens, would be more detrimental to the grouse.

Conclusions

No empirical evidence is available specifically related to the effects of predation on sage-grouse in Rich County. Many sage-grouse predators are known to occur in Rich County and USDA-WS does conduct predator control in the area related to livestock operations which is likely to influence predator-prey dynamics involving sage-grouse. However, sage-grouse numbers in Rich County are increasing or stable and, given current circumstances and management actions, predation by native predators is not considered a serious threat to sage-grouse populations in the area. Predation by non-native predators, including domestic animals and red foxes, is an issue of greater concern. Non-native red fox populations have decimated relatively isolated populations of sage-grouse in nearby Strawberry Valley (Bunnell et al. 2000) and there is some concern that increasing populations of red foxes in Rich County could eventually have a negative impact on sage-grouse populations.

J. Vegetation Management

Vegetation management conducted in the past was a reflection of the priorities of the time and also on the mandates and policies of the federal government, when vegetation management was done on federal land. Much of the land in Rich County is under private management, an important consideration when evaluating past and current conditions. In the past, many vegetation treatments were conducted to increase forage for livestock.

Recently, vegetation management has increasingly focused on restoring health to sagebrush rangelands. Management is increasingly done in a proactive manner. For example, seeing controlled burns to prevent the establishment of non-native plants, setting back succession in sagebrush stands to create a mosaic of sagebrush cover classes across the landscape, and adjusting grazing practices to retain tall grasses for nesting cover. Habitat management also involves restorative treatments designed to remove cheatgrass and other invasive/noxious weeds, removal of pinyon-juniper stands, and restore native species.

Several treatment types are used to manipulate sagebrush communities. Connelly et al. (2004:7-46 to 7-50) describes the mechanical, chemical, and biological techniques available and discusses their successes and challenges.

Given the current climate of vegetation management (i.e. restore/maintain plant/wildlife community health), vegetation management is not likely to be an important negative impact to sage-grouse populations in Rich County. As discussed in an earlier section of this Plan, several habitat management projects have been implemented and are proposed for 2006 designed to improve sage-grouse habitat. Further, the formation of the Rich County CRM has provided an outlet for increased education about proper management techniques, a forum for sharing ideas and resources, and for coordination of activities across jurisdictional and landownership boundaries. Finally, the Utah Partners for Conservation and Development (UPCD), a collection of resource management agencies, NGO, and private individuals recently established a Regional Team that encompasses Rich County. The purpose of the Northern Utah UPCD Regional Team is to increase communication, coordination, and sharing of resources and information with regards to habitat and watershed improvements in northern Utah. Increased focus and coordination is likely to only improve project planning, implementation, and outcomes.

Some of the work done on Deseret Land and Livestock, described earlier in the Plan, has provided evidence that vegetation treatments that reduced shrub cover and increased herbaceous cover, without reducing nesting or winter habitat, coincide with and may have contributed to increased sage-grouse numbers in the southern subunit of Rich County (Danvir 2002, Danvir et al. *in press*). In addition to habitat treatments described by Danvir (2002), several thousand acres have been treated in Rich County by private landowners and public agencies with the intent of improving sage-grouse habitat (Table 3). For most of these projects, we are not aware of post-treatment data that indicates the treatments resulted in conditions preferred by sage-grouse; however, that does not mean that those conditions do not exist or that the treatments were unsuccessful. Overall, we feel there is a great need to better monitor vegetation treatments in Rich County to expand our understanding of the effects of vegetation management on sage-grouse populations and habitats.

V. Conservation Strategy

One of the main purposes of this Plan is to provide a framework of strategies and associated actions that can be implemented to abate threats, address information gaps, and guide monitoring efforts. Strategies and actions listed below (the order is irrelevant) were developed by CRM SAGR Subcommittee partners. Several other documents and publications provide recommendations and guidelines for management of sage-grouse populations and their habitats, many of which were reviewed in the Introduction of this Plan. Strategies developed by the CRM SAGR Subcommittee are designed to be specific to the local area while taking into consideration the guidelines provided at a rangewide level.

Implementation of strategies and actions is strictly voluntary on the part of CRM SAGR Subcommittee partners. However, despite this, we have designated for each strategy the public and private partners who might be involved in implementation. Designation does not imply responsibility or commitment of resources of any sort to implementing, initiating, or completing any actions; however, it provides a framework of resources and expertise.

To help prioritize implementation of the Plan, efficiently use resources, and develop and secure funding, we have also identified which threats each strategy addresses. In addition, we list the aspects of sage-grouse ecology likely to be impacted by each strategy.

A. Strategies and Actions

1. **Strategy**: By 2016 increase amount of breeding habitat in "good" condition the northern two-thirds of the County.
   1.1. **Action**: Work with public and private partners to implement rest-rotation/time controlled grazing management strategies, where appropriate.
   1.2. **Action**: Implement appropriate treatments and seeding in CRP fields and stands dominated by crested wheatgrass.
   1.3. **Action**: Work with NRCS and private partners to implement Farm Bill programs beneficial to sage-grouse.
   1.4. **Action**: Work with public and private partners to research/monitor effects of treatments on sage-grouse populations and habitat.

   Partners: NCRS, BLM, UDWR, CRM, USFS, private partners, USFWS.
   Threats Addressed: Vegetation management.
   Aspects of Sage-grouse Ecology Addressed: Breeding habitat quality, connectivity of seasonal habitat types.

2. **Strategy:** Minimize impacts of agricultural conversion on sage-grouse.
   2.1. **Action:** Maintain the CRP program and improve its benefit to wildlife by altering seed mixes to include a greater proportion of ecologically appropriate species.
   2.2. **Action:** Maintain or reestablish sagebrush patches of sufficient size and appropriate shape to support sage-grouse between agricultural fields.
   2.3. **Action:** Work with NRCS and others to maintain the CRP program and enroll important sage-grouse habitats currently in grain production.
   2.4. **Action:** Encourage use of sage-grouse friendly seed mixes, including bunchgrasses, forbs and big sagebrush, in CRP and other grassland plantings.

2.5. **Action:** Rehabilitate old low diversity, CRP fields with ecologically appropriate seed mixes including bunchgrasses, forbs, and big sagebrush.
2.6. **Action:** Encourage interest and enrollment of key sage-grouse habitats in the Grassland Reserve Program or other relevant Farm Bill programs.
2.7. **Action**: Work with NRCS and private partners to identify areas important to sage-grouse that should be given higher priority for CRP.
2.8. **Action**: Work with public and private partners to implement sage-grouse appropriate management of CRP.

Partners: NRCS, CRM, private partners, UACD, UFBF.
Threats Addressed: Invasive/noxious weeds, vegetation treatments.
Aspects of Sage-grouse Ecology Addressed: Seasonal habitat quality, connectivity of seasonal habitat types.

3. **Strategy**: Maintain and/or increase amount of winter habitat in "good" condition in the Southern Subunit through the use of appropriate treatments and/or land management strategies.
   3.1. **Action**: Work with public and private partners to manage livestock grazing to increase quality and condition of sagebrush stands, where appropriate.
   3.2. **Action**: Work with public and private partners to avoid sagebrush-reducing grazing in areas important for winter use, where feasible.
   3.3. **Action**: Plant sagebrush seedlings into crested wheatgrass stands, where appropriate and feasible.

   Partners: UDWR, BLM, private partners, NRCS, SITLA, UACD, USFWS.
   Threats Addressed: Livestock grazing, vegetation treatments, fire.
   Aspects of Sage-grouse Ecology Addressed: Winter habitat quality, population distribution, connectivity of seasonal habitat types, connectivity of populations and subpopulations.

4. **Strategy**: Coordinate fire management practices with public and private partners to prevent loss of crucial sage-grouse habitat and enhance/improve sage-grouse habitat, where appropriate.
   4.1. **Action**: Comment on BLM/USFS fire plans.
   4.2. **Action**: Re-seed sites, post-burn, with ecologically appropriate seed mixture to prevent the establishment of cheat-grass and other invasive/noxious species.
   4.3. **Action**: Use fire management to reduce sagebrush canopy cover and create diverse sagebrush stands in brood-rearing and summer use areas, where appropriate.

   Partners: BLM, USFS, UDWR, SITLA, private partners, NRCS.
   Threats Addressed: Fire, invasive/noxious weeds, vegetation management, pinyon/junpier encroachment.
   Aspects of Sage-grouse Ecology Addressed: Seasonal habitat quality, connectivity of seasonal habitat types.

5. **Strategy:** Maintain and where possible, improve grass/forb component in the understory in nesting and brood-rearing areas.
   5.1. **Action**: Reclaim and/or reseed areas disturbed by treatments when necessary, using seed mixtures with appropriate grasses and desirable forbs.
   5.2. **Action**: Restore understory vegetation in areas lacking desirable quality and quantity of

herbaceous vegetation where economically feasible.

5.3. **Action**: Work with public and private partners to implement rest-rotation/time controlled grazing management strategies, where appropriate.

5.4. **Action**: Conduct vegetation treatments to improve forb diversity (e.g., harrowing, aerating, chaining) and reclaim or reseed disturbed area, if needed.

5.5. **Action**: Develop management techniques to increase forb diversity and density in sagebrush steppe, within limits of ecological sites and annual variations.

5.6. **Action**: Avoid land use practices that reduce soil moisture, increase erosion, cause invasion of exotic plants, and reduce abundance and diversity of forbs.

5.7. **Action**: Avoid developing springs for livestock in crucial sage-grouse nesting and brood-rearing areas.

Partners: UDWR, CRM, USFS, NRCS, BLM, private partners, USFWS.
Threats Addressed: Vegetation management, livestock grazing, invasive/noxious weeds.
Aspects of Sage-grouse Ecology Addressed: Breeding habitat quality, summer/late brood-rearing habitat quality, connectivity of seasonal habitat types, population distribution.

6. **Strategy**: Increase information dissemination and education opportunities for public and private partners regarding sage-grouse ecology and habitat needs.

6.1. **Action**: Develop educational materials (brochures, presentations, etc.) about sage-grouse ecology, habitat needs, and habitat management strategies.

6.2. **Action**: Share information and educational materials with CRM and other partners through use of printed materials, field tours, websites, reports, and other opportunities.

6.3. **Action**: Support involvement of public and private partners in sage-grouse monitoring (lek counts, brood counts, etc.) and management.

Partners: USU Extension, CRM, NRCS, USU College of Natural Resources, BLM, UDWR, USFS, SITLA, private partners.
Threats Addressed: All
Aspects of Sage-grouse Ecology Addressed: All

7. **Strategy**: By 2016, increase percentage of riparian areas in Rich Co. that are functioning properly and provide suitable for sage-grouse brood-rearing habitat.

7.1. **Action**: Work with public and private partners to implement appropriate grazing management practices in riparian areas.

7.2. **Action**: Work with public and private partners to implement appropriate management to reduce amount of noxious/invasive weeds in riparian areas.

7.3. **Action:** Modify or adapt pipelines or developed springs to create small wet areas.

7.4. **Action:** Protect existing wet meadows and riparian areas, with a focus on those areas in crucial sage-grouse brood-rearing habitats.

7.5. **Action:** Manage vegetation and artificial structures to increase water-holding capability of areas.

7.6. **Action:** Install catchment structures to slow run-off, hold water, and eventually raise water tables.

Partners: BLM, NRCS, County Weed Board, USFS, private partners, UDWR.
Threats Addressed: Livestock grazing, vegetation management, drought/weather.
Aspects of Sage-grouse Ecology Addressed: Summer/late brood-rearing habitat quality, connectivity of seasonal habitat types.

8. **Strategy**: Increase practice of time-controlled, seasonally appropriate, rest-rotation grazing.
   8.1. **Action**: Encourage small operators to combine herds and allotments to provide rest-rotation with minimal fencing.
   8.2. **Action**: Facilitate cooperation and communication between private livestock operators.
   8.3. **Action**: Provide educational opportunities for private operators about benefits of time-controlled grazing.
   8.4. **Action**: Provide incentives (habitat project approval from CRM, UDWR, BLM, etc.) for cooperation between private partners.
   8.5. **Action**: Avoid dividing allotments into pastures, where possible.
   Partners: CRM, NRCS, DLL, USU Extension, private partners, County Commission, BLM, USFS
   Threats Addressed: Livestock grazing, fences.
   Aspects of Sage-grouse Ecology Addressed: Seasonal habitat quality, population distribution, connectivity of seasonal habitat types.

9. **Strategy:** Minimize the impact of excessive predation.
   9.1. **Action:** Modify power lines and wood fence posts (to remove raptor perches) in important sage-grouse areas, where feasible and where predator concerns have been identified.
   9.2. **Action:** Remove trees, remove/modify raptor perches, and maintain quality sagebrush habitat, where predation concerns on sage-grouse have been identified.
   9.3. **Action:** Begin site-specific predation management considering all predator species (especially common ravens and red fox) where necessary and appropriate.
   Partners: USDA-WS, UDWR, CRM, BLM, USFS, private partners.
   Threats Addressed: Powerlines, fences, and other tall structures, roads, predators.
   Aspects of Sage-grouse Ecology Addressed: Population size, population distribution.

10. **Strategy:** Improve knowledge of disease in sage-grouse populations.
    10.1. **Action:** Collect grouse parasite and disease organism samples while handling birds for other research.
    10.2. **Action:** Monitor radio collared and other grouse for West Nile Virus and other disease outbreaks.
    Partners: USU, UDWR, BLM, USFS, private partners, CRM.
    Threats Addressed: Parasites/disease.
    Aspects of Sage-grouse Ecology Addressed: Population size, connectivity of populations/subpopulations.

11. **Strategy:** Minimize impacts of utilities lines in sage-grouse habitat.
    11.1. **Action:** Avoid new construction during important periods and re-route lines where technically and economically feasible to avoid impacts. If new power lines must be installed, route them along existing roads if possible.
    11.2. **Action:** Schedule maintenance to minimize important periods, however, maintenance in emergency situations will be unrestricted.
    11.3. **Action:** Install raptor deterrents when applicable.
    Partners: BLM, USFS, UDWR, CRM, private partners.
    Threats Addressed: Powerlines, fences, and other tall structures, roads.
    Aspects of Sage-grouse Ecology Addressed: Population size, connectivity of seasonal

habitats, connectivity of populations and subpopulations.

12. **Strategy:** Minimize impacts of exotic, invasive, and undesirable plant species.
    12.1. **Action:** Identify areas where undesirable vegetation is encroaching on sage-grouse habitat.
    12.2. **Action:** Treat areas where undesirable vegetation has become or is at risk of becoming a factor in sage-grouse habitat loss or fragmentation.
    12.3. **Action:** Work with existing weed management programs to incorporate sage-grouse habitat needs.
    12.4. **Action:** Identify large areas of introduced plant species that are not meeting sage-grouse habitat needs and reseed with native species where appropriate.
    12.5. **Action:** Identify areas where pinyon or juniper trees are encroaching on good quality sagebrush habitat and treat as needed.
    12.6. **Action:** Manage fire, transportation, and vegetation treatments to minimize undesirable vegetation where possible.

    Partners: UDWR, NRCS, County Weed Board, USU Extension, BLM, USFS, private partners.
    Threats Addressed: Invasive/noxious weeds, pinyon/juniper encroachment, fire, roads, vegetation treatments.
    Aspects of Sage-grouse Ecology Addressed: Seasonal habitat quality

13. **Strategy:** Minimize the amount of quality sage-grouse habitat eliminated by residential and commercial land development consistent with private property rights.
    13.1. **Action:** Participate with County land use decision makers in identifying key sage-grouse habitats.
    13.2. **Action:** Maintain sagebrush environments of sufficient size and shape around developments in sage grouse habitat.
    13.3. **Action:** Encourage the voluntary use of conservation easements and other land protection vehicles with willing sellers in sage grouse habitats.
    13.4. **Action:** Educate rural residents about the importance of good grazing management in keeping small tracts weed free and capable of providing wildlife habitat.

    Partners: UDWR, CRM, Rich County Commission, Rich County Planning Department, USU Extension.
    Threats Addressed: Home/cabin development, roads, powerlines and other tall structures.
    Aspects of Sage-grouse Ecology Addressed: Connectivity of seasonal habitats, seasonal habitat quality.

14. **Strategy**: By 2016, increase population and habitat monitoring efforts in Rich County.
    14.1. **Action**: Encourage public and private partners to use techniques from Connelly et al. (2003b) "Monitoring of Greater Sage-grouse Habitats and Populations".
    14.2. **Action**: UDWR biologists will coordinate with private partners to identify sage-grouse lek sites and count birds on private lands.
    14.3. **Action**: UDWR to enlist and coordinate private volunteers and/or other agency biologists search for new leks and conduct lek counts on active leks.
    14.4. **Action**: Provide, when possible, reimbursement for volunteers for mileage, etc.
    14.5. **Action**: Test dead sage-grouse for West Nile Virus and any other parasites/pathogens of importance.

Partners: UDWR, CRM, USU, USU Extension, BLM, USFS, UFBF, private partners.
Threats Addressed: Parasites and disease
Aspects of Sage-grouse Ecology Addressed: Population size, population distribution

15. **Strategy**: Minimize impacts of oil and gas development on sage-grouse and their habitat.
    - 15.1. **Action**: Coordinate and communicate with BLM to ensure that adequate information/data is available for decision making process.
    - 15.2. **Action**: Support recommendations that provide for temporal avoidance, minimization of tall structures, and avoid crucial habitat or use areas, where possible.
    - 15.3. **Action:** Reduce fragmentation of sage-grouse habitat by oil and gas development activities.
    - 15.4. **Action:** Minimize disturbance to sage-grouse associated with oil and gas development.
    - 15.5. **Action:** Reduce cumulative impacts of oil and gas development.
    - 15.6. **Action:** Use directional drilling where feasible to minimize surface disturbance, particularly where will density exceeds 1:160 acres.
    - 15.7. **Action:** Minimize pad size and other facilities to the extent possible, consistent with safety.
    - 15.8. **Action:** Plan and construct roads to minimize duplication.
    - 15.9. **Action:** Cluster development of roads, pipelines, electric lines and other facilities.
    - 15.10. **Action:** Use existing, combined corridors where possible.
    - 15.11. **Action:** Use early and effective reclamation techniques, including interim reclamation, to speed return of disturbed areas to use by sage-grouse.
    - 15.12. **Action:** Reduce long-term footprint of facilities to the smallest possible.
    - 15.13. **Action:** Avoid aggressive, non-native grasses (e.g. intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, smooth brome, etc) in reclamation seed mixes.
    - 15.14. **Action:** Eliminate noxious weed infestations associated with oil and gas development disturbances.
    - 15.15. **Action:** Minimize width of field surface roads.
    - 15.16. **Action:** Avoid ridge top placement of pads and other facilities.
    - 15.17. **Action:** Use low profile above ground equipment, especially where well density exceeds 1:160 acres.
    - 15.18. **Action:** Avoid breeding/nesting season (March 1 – June 30) construction and drilling when possible in sage-grouse habitat.
    - 15.19. **Action:** Limit breeding season (March 1 – May 1) activities near sage-grouse leks to portions of the day after 9:00 a.m. and before 4:00 p.m.
    - 15.20. **Action:** Reduce daily visits to well pads and road travel to the extent possible in sage-grouse habitat.
    - 15.21. **Action:** Utilize well telemetry to reduce daily visits to wells, particularly where well density exceeds 1:160 acres.
    - 15.22. **Action:** Locate compressor stations off ridge tops and at least 2,500 feet from active sage-grouse leks, unless topography allows for closer placement.
    - 15.23. **Action:** Avoid locating facilities within a minimum of ¼ mile of active sage-grouse leks, unless topography allows for closer placement.
    - 15.24. **Action:** Plan for and evaluate impacts to sage-grouse of entire field development rather than individual wells.
    - 15.25. **Action:** Study, and attempt to quantify, impacts to sage-grouse from oil and gas

development.

15.26. **Action:** Evaluate need for near-site and/or off-site mitigation to maintain sage grouse populations during oil and gas development and production, especially where well density exceeds 1:160 acres.

15.27. **Action:** Implement near-site and/or off-site mitigation as necessary to maintain sage-grouse populations.

15.28. **Action:** Share sage-grouse data with industry to allow for planning to reduce and/or mitigate for impacts.

15.29. **Action**: Update setbacks, mitigation requirements, and spatial and temporal avoidance recommendations as new information becomes available.

Partners: UDWR, USFS, BLM, private partners.

Threats Addressed: Renewable and nonrenewable energy development, roads, powerlines and other tall structures, seasonal habitat quality, connectivity of seasonal habitats, connectivity of populations and subpopulations.

Aspects of Sage-grouse Ecology Addressed: Seasonal habitat quality, invasive/noxious weeds, connectivity of seasonal habitat types, connectivity of populations and subpopulations.

16. **Strategy:** Minimize impacts of utilities lines in sage-grouse habitat.

16.1. **Action:** Avoid new construction during important periods and re-route lines where technically and economically feasible to avoid impacts.

16.2. **Action:** Schedule maintenance to minimize important periods, however, maintenance in emergency situations will be unrestricted.

16.3. **Action:** Install raptor deterrents when applicable.

Partners: BLM, USFS, USFWS, UDWR, private partners.

Threats Addressed: Powerlines and other tall structures, fire, invasive/noxious weeds, roads, vegetation management, predation.

Aspects of Sage-grouse Ecology Addressed: Connectivity of seasonal habitats, seasonal habitat quality, connectivity of populations and subpopulations, population size.

17. **Strategy**: Monitor and manage lek viewing opportunities to make sure they do not become harmful to sage-grouse populations.

17.1. **Action**: Occasionally conduct lek viewing tours to facilitate access to leks.

17.2. **Action**: Provide educational materials to local birding groups on appropriate lek viewing behavior.

17.3. **Action**: Discourage viewing of sensitive lek areas through access restrictions, increased law enforcement patrols, and effective use of trespass laws.

Partners: UDWR, BLM, USU Extension, private partners.

Threats Addressed: None.

Aspects of Sage-grouse Ecology Addressed: Population size, population distribution, breeding habitat quality.

18. **Strategy**: Initiate and/or maintain monitoring and research efforts to address information gaps identified in this Plan and in future adaptive planning efforts.

18.1. **Action**: Explore funding opportunities to further scientific research into information gaps identified in this Plan and in future adaptive planning efforts, as needed.

18.2. **Action**: Participate in the Northern Region UPCD Regional Team to develop

cooperative relationships with those partners.

18.3. **Action**: Develop research and/or monitoring protocols to address information gaps identified in this plan and in future adaptive planning efforts.

18.4. **Action**: Cooperate with USU and other academic institutions to establish graduate student projects designed to investigate information gaps identified in this Plan and in future adaptive planning efforts.

Partners: CRM, UPCD, NRCS, BLM, USFWS, UDWR, USU, USFS, private partners.
Threats Addressed: All
Aspects of Sage-grouse Ecology Addressed: All

B. Priority Evaluation

In order to help prioritize strategies, actions, and most effectively allocate resources, we have assigned a rank of "low", "medium", "high", or "very high" to each threat with regards to its contribution to reduction in population health or habitat condition (Table 5). Again, given the stipulations regarding a lack of empirical, locally-based information in many cases, these rankings are based on the best information available to us and our implicit, experiential knowledge of Rich County. Ranking definitions are based on The Nature Conservancy's Conservation Action Planning process (TNC 2005). Rankings are provided to help highlight potential priorities for subsequent strategies and actions.

Partners in the CRM SAGR Subcommittee and others can use the rankings in Table 5, combined with the strategies and actions listed above to prioritize implementation and direct resources to efficiently and effectively abate threats and maintain and improve sage-grouse populations and their habitats in Rich County.

Table 5. Relative importance/contribution of individual threats to reducing or degrading aspects of sage-grouse populations in Rich County. Threats are described in the "Threat Analysis" section of this Plan. Rankings are as follows: L=low; M=medium; H=high; and VH=very high. Ranks are defined according to TNC (2005).

Threat	Reduced Population Size	Population Distribution	Reduced Breeding Habitat Quality	Reduced Summer/Late Brood-rearing Habitat Quality	Reduced Winter Habitat Quality	Reduced Connectivity of Seasonal Habitat Types	Reduced Connectivity of Populations & Sub-populations
Home & Cabin Development	M	M	M	M	L	M	M
Powerlines, Fences, & Other Tall Structures	H	L	M	L	L	M	M
Renewable & Non-renewable Energy Development	M	M	H	H	M	L	L
Roads	H	L	M	L	L	M	M
Drought & Weather	H	H	M	H	L	H	H
Hunting Pressure	L	M	-	-	-	-	H
Incompatible Fire Management Practices	H	H	H	H	H	H	H
Incompatible Livestock Grazing	H	H	H	H	M	H	H
Incompatible OHV Recreation	H	M	M	M	M	H	H
Invasive/Noxious Weeds	M	H	M	L	L	M	M
Parasites & Disease	M	M	-	-	-	-	H
Predation	M	M	L	-	-	-	M
Vegetation Management							
Pinyon-Juniper Encroachment							

IV. Literature Cited

Aldridge, C. L. 1998. Status of the sage grouse (*Centrocercus urophasianus urophasianus*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, and Alberta Conservation Association. Wildlife Status Report 13. Edmonton, Alberta.

Anderson, D. R. 2001. The need to get the basics right in wildlife field studies. Wildlife Society Bulletin 29:1294-1297.

Apa, A. D. 1998. Habitat use and movements of sympatric sage and Columbian sharp-tailed grouse in southeastern Idaho. Dissertation, University of Idaho, Moscow.

Armentrout, D. J., F. Hall, M. Dobel, and the Northeastern California Sage-grouse Working Group. 2004. Draft conservation strategy for sage-grouse (Centrocercus urophasianus) within the Buffalo-Skedaddle population management unit. Bureau of Land Management, Eagle Lake Office, Susanville, California.

Autenrieth, R. E. 1981. Sage grouse management in Idaho. Idaho Department of Fish and Game Wildlife Bulletin Number 9. Boise, Idaho.

Autenrieth, R. E., W. Molini, and C. E. Braun. 1982. Sage grouse management practices. Western States Sage Grouse Committee, Technical Bulletin 1, Twin Falls, Idaho, USA.

Barnett, J. K., and J. A. Crawford. 1994. Pre-laying nutrition of Sage grouse hens in Oregon. Journal of Range Management 47:114-118.

Batterson, W. M. and W. B. Morse. 1948. Oregon Sage Grouse. Oregon Fauna Service, Oregon Game Commission, Portland, Oregon.

Bureau of Economic and Business Research (BEBR). 2005. BEBR construction information database. URL: http://www-new.business.utah.edu/display.php?pageId=1137. University of Utah, Salt Lake City, Utah, USA.

Beck, T. D. 1977. Sage grouse flock characteristics and habitat selection during winter. Journal of Wildlife Management 41:18-26.

Beck, T. D. I., and C. E. Braun. 1980. The strutting ground count: variation, traditionalism, management needs. Proceedings of the Annual Conference of the Western Association of Fish and Wildlife Agencies 60:558-566.

Beck, J. L., and D. L. Mitchell. 2000. Influences of livestock grazing on Sage Grouse habitat. Wildlife Society Bulletin 28:993-1002.

Beck, J. L., D. L. Mitchell, and B. D. Maxfield. 2003. Changes in the distribution and status of sage-grouse in Utah. Western North American Naturalist 63:203–214.

Bergerud, A. T. 1988. Population ecology of North American grouse. Pages 578-648 in A. T. Bergerud and M. W. Gratson, editors. Adaptive strategies and population ecology of

northern grouse. University of Minnesota Press, Minneapolis.

Blejwas, K. M., B. N. Sacks, M. M. Jaeger, and D. R. McCullough. 2002. The effectiveness of selective removal of breeding coyotes in reducing sheep predation. Journal of Wildlife Management 66:451-462.

Billaux, A. 1996. Foraging ecology of sage grouse chicks in relation to vegetation. M.S. Thesis, Utah State University, Logan, USA.

Boyce, M. S. 1990. The red queen visits sage grouse leks. American Zoologist 30:263-270.

Braun, C. E. 1995. Distribution and status of Sage Grouse in Colorado. Prairie Naturalist 27: 1-9.

Bunnell, K. D. and J. T. Flinders. 1999. Restoration of sage grouse in Strawberry Valley, Utah 1998-99 report. Unpublished report to: Utah Reclamation Mitigation and Conservation Commission. Brigham Young University, Provo, Utah.

Bunnell, K. D., D. J. Bambrough, and J. T. Flinders. 2000. Revised progress report: Strawberry Valley Sage grouse recovery project. Brigham Young University, Provo, Utah.

Bunting, S. C., B. M. Kilgore, and C. L. Bushey. 1987. Guidelines for prescribed burning sagebrush-grass rangelands in the northern Great Basin. General Technical Report INT-231.

Bureau of Land Management (BLM). 2005a. National Sage-grouse habitat conservation strategy. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

Bureau of Land Management (BLM). 2005b. Salt Lake Fire Management Plan Environmental Assessment, UT-020-2004-0091. U.S. Department of the Interior, Bureau of Land Management, Salt Lake City, Utah, USA.

Burkhardt, J. W., and E. W. Tisdale. 1969. Nature and successional status of western juniper vegetation in Idaho. Journal of Range Management 22:264-270.

Cannon, R.W., and F. L. Knopf. 1981. Lek numbers as a trend index to prairie grouse populations. Journal of Wildlife Management 45:776-778.

Churcher, Charles S. 1959. The specific status of the New World red fox. Journal of Mammalogy. 40: 513-520.

Churcher, C.S. 1973. Red fox. Canadian Wildlife Service Hinterland Who's Who, Cat.CW69-4/5. 4pp.

Clifford, H. 2002. Chick-a-boom at the lek. High Country News.

Coggins, K. A. 1998. Sage grouse habitat use during the breeding season on Hart Mountain National Antelope Refuge. Thesis. Oregon State University, Corvallis.

Connelly, J. W., W. J. Arthur, and O. D. Markham. 1981. Sage grouse leks on recently disturbed sites. Journal of Range Management. 34:153-154.

Connelly, J. W. 1982. An ecological study of Sage grouse in southeastern Idaho. Dissertation, Washington State University, Pullman.

Connelly, J. W., H. W. Browers, and R. J. Gates. 1988. Seasonal movements of Sage grouse in southeastern Idaho. Journal of Wildlife Management 52:116-122.

Connelly, J. W., W. L. Wakkinen, A. D. Apa, and K. P. Reese. 1991. Sage grouse use of nest sites in southeastern Idaho. Journal of Wildlife Management 55:521-524.

Connelly, J. W., R. A. Fischer, A. D. Apa, K. P. Reese, and W. L. Wakkinen. 1993. Renesting of Sage grouse in southeastern Idaho. Condor 951041-1043.

Connelly, J. W., K. P. Reese, and W. L. Wakkinen, M. D. Robertson, and R. A. Fischer. 1994. Sage grouse ecology report. Idaho Department of Fish and Game Job completion Report. W-160-R-19. Subproject 9. Boise, Idaho.

Connelly, J. W., and C. E. Braun. 1997. Long-term changes in Sage grouse (*Centrocercus urophasianus*) populations in western North America. Wildlife Biology 3:229-234.

Connelly, J. W., Gratson, M. W., and Reese, K. P. 1998. Sharp-tailed grouse. The birds of North America, No. 354. The birds of North America, Inc., Philadelphia, Pennsylvania.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin. 28:967-985.

Connelly, J. W., K. P. Reese, E. O. Garton, and M. L. Commons-Kemner. 2003a. Response of greater sage-grouse *Centrocercus urophasianus* populations to different levels of exploitation in Idaho, USA. Wildlife Biology 9:335-340.

Connelly, J. W., K. P. Reese, and M. A. Schroeder. 2003b. Monitoring of greater sage-grouse habitats and populations. University of Idaho, College of Natural Resources Experiment Station Bulletin 80, Moscow, Idaho. 50pp.

Connelly, J. W., S. T. Knick, M. A. Schroeder, S. J. Stiver. 2004. Conservation Assessment for Greater Sage-grouse and Sagebrush Habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, Wyoming.

Connolly, G. E. and W. M. Longhurst. 1975. The effects of control on coyote populations: a simulation model. Division of Agricultural Sciences, University of California Bulletin 1872:1-37.

Dalke, P. D., D. B. Pyrah, D. C. Stanton, J. E. Crawford, and E. F. Schlatterer. 1963. Ecology, productivity, and management of sage grouse in Idaho. Journal of Wildlife Management 27:810-841.

Danvir, R. E., W. J. Hopkin, G. E. Simonds, B. Teichert, S. L. Kearl, J. F. Kimball Jr., R. M. Welch, A. Aoude, J. Haskell, *in press*. Sagebrush, sage-grouse, and ranching: A holistic approach. Wildlife Management Institute

Danvir, R. E. 2002. Sage Grouse ecology and management in northern Utah sagebrush-steppe. A Deseret Land and Livestock Wildlife Research Report. Deseret Land and Livestock Ranch and the Utah Foundation for Quality Resource Management, Woodruff, Utah. 39 + appendices.

Danvir, R. E. and S. L. Kearl. 1996. A holistic approach to managing wildlife and big game movements with livestock: the Lost Creek Foundation *in* K. E. Evans, comp. Sharing common ground on western rangelands: proceedings of a livestock/big game symposium. February 26-28, Sparks, NV, USA. US Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT, USA. General Technical Report INT-GTR-343.

Daubenmire, R. 1970. Steppe vegetation of Washington. Washington Agricultural Experiment Station Technical Bulletin. 62. Washington State University, Pullman, Washington.

DeLong, A. K., J. A. Crawford, and D. C. DeLong, Jr. 1995. Relationships between vegetational structure and predation of artificial Sage grouse nests. Journal of Wildlife Management 59:88-92.

Drut, M. S., J. A. Crawford, and M. A. Gregg. 1994*a*. Brood habitat use by Sage Grouse in Oregon. Great Basin Naturalist 54:170-176.

Drut, M. S., W. H. Pyle, and J. A. Crawford. 1994*b*. Technical note: diets and food selection of Sage grouse chicks in Oregon. Journal of Range Management 47:90-93.

Dunkle, S. W. 1977. Swainson's Hawks on the Laramie plains, Wyoming. Auk 94: 65–71.

Dunn, P. O., and C. E. Braun. 1986. Summer habitat use by adult female and juvenile Sage grouse. Journal of Wildlife Management 50:228-235.

Edelmann, F. B., M. J. Ulliman, M. J. Wisdom, K. P. Reese, and J. W. Connelly. 1998. Assessing habitat quality using population fitness parameters: a remote sensing/GIS-based habitat-explicit population model for Sage grouse (*Centrocercus urophasianus*). Technical Report 25. Idaho Forest, Wildlife and Range Experiment Station, Moscow, Idaho.

Ellis, KL 1984. Behavior of a lekking sage grouse in response to a perched golden eagle. West. Birds 15:37-38.

Eng, R. L. 1963. Observations on the breeding biology of male Sage Grouse. Journal of Wildlife Management 27:841-846.

Eng, R. L., and P. Schladweiler. 1972. Sage grouse winter movements and habitat use in central Montana. Journal of Wildlife Management 36:141-146.

Fischer, R. A., A. D. Apa, W. L. Wakkinen, K. P. Reese, and J. W. Connelly. 1993. Nesting-area fidelity of Sage grouse in southeastern Idaho. Condor 95:1038-1041.

Fischer, R. A. 1994. The effects of prescribed fire on the ecology of migratory Sage grouse in southeastern Idaho. Dissertation. University of Idaho, Moscow.

Fischer, R. A. 1996. An investigation on fire effects within xeric Sage grouse brood habitat. Journal of Range Management 49:194-198.

Flinders, J. T. 1999. Restoration of sage grouse in Strawberry Valley, Utah, 1998-99 report. Utah Reclamation Mitigation and Conservation Commission, Progress Report. Brigham Young University, Provo, Utah.

Friend, M., and J. C. Franson, editors. 1999. Field manual of wildlife diseases: general field procedures and diseases in birds. U.S. Geological Survey Biological Resources Division, Information and Technology Report 1999-001.

Gates, R. J. 1983. Sage grouse, lagomorph, and pronghorn use of a sagebrush grassland burn site on the Idaho National Engineering Laboratory. Thesis, Montana State University, Bozeman, Montana.

Gates, R. J. 1985. Observations of the formation of a Sage grouse lek. Wilson Bulletin 97:219-211.

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996. Social and nutritional factors influencing the dispersal of resident coyotes. Animal Behaviour 52:1025-1043

Gese, E. M. and R. L. Ruff. 1998. Howling by coyotes (Canis latrans): variation among social classes, seasons, and pack sizes. Canadian Journal of Zoology 76:1037-1043.

Gehrt, S. D., and W. R. Clark. 2003. Raccoons, coyotes, and reflections on the mesopredator release hypothesis. Wildlife Society Bulletin 31:836-842.

Gill, R. B. 1965. Distribution and abundance of a population of Sage grouse in North Park, Colorado. Thesis, Colorado State University, Fort Collins.

Gilmore, R. M. 1946. Mammals in archeological collections from southwestern Pennsylvania. Journal of Mammalogy 27:227–234

Girard, G. L. 1937. Life history, habits, and food of the sage grouse, *Centrocercus urophasianus* Bonaparte. Publication 3. University of Wyoming, Laramie, Wyoming.

Godin, A. J. 1977. Wild mammals of New England. The Johns Hopkins University Press, Baltimore, MD. 304 p.

Grahame, J. D., and T. D. Sisk, editors. 2002. Exotic and invasive species on the Colorado Plateau, http://cpluhna.nau.edu/Biota/invasive_exotics.htm *In* Canyons, cultures and

environmental change: an introduction to the land-use history of the Colorado Plateau. [03/16/04] http://www.cpluhna.nau.edu/.

Gray, G. M. 1967. An ecological study of Sage grouse broods with reference to nesting, movements, food habits and sagebrush strip spraying in the Medicine Lodge drainage, Clark County, Idaho. Thesis, University of Idaho, Moscow, Idaho.

Gregg, M. A. 1991. Use and selection of nesting habitat by Sage grouse in Oregon. Thesis, Oregon State University, Corvallis, Oregon.

Gregg, M. A., J. A. Crawford, M. S. Drut, and A. K. DeLong. 1994. Vegetational cover and predation of sage grouse nests in Oregon. Journal of Wildlife Management 58:162-166.

Griner, L. A. 1939. A study of Sage grouse (*Centrocercus urophasianus*), with special reference to life history, habitat requirements, and numbers and distribution. Thesis, Utah State Agricultural College, Logan, Utah, USA.

Gunnison Sage-grouse Rangewide Steering Committee. 2005. Gunnison Sage-grouse Rangewide Conservation Plan. Colorado Division of Wildlife, Denver, Colorado, USA.

Haines, A. L. 1965. Osborne Russell's Journal of a Trapper. University of Nebraska Press, Lincoln, Nebraska, USA.

Hanf, J. M, P. A. Schmidt, and E. B. Groschen. 1994. Sage grouse in the high desert of central Oregon: results of a study, 1988-1993. U. S. Department of Interior, Bureau of Land Management Series P-SG-01, Prineville, Oregon, USA.

Hartzler, J. E. 1972. An analysis of Sage Grouse lek behavior. Unpublished Ph.D. dissertation. University of Montana, Missoula, Montana, USA.

Heath, B. J., R. Straw, S. H. Anderson, J. Lawson, and M. Holloran. 1998. Sage-Grouse productivity, survival, and seasonal habitat use among three ranches with different livestock grazing, predator control, and harvest management practices. Federal Aid Job Completion Report. Wyoming Game and Fish Department, Cheyenne, Wyoming. 66 pages.

Hepworth, W.G. 1962. Diagnosis of diseases in mammals and birds. P-R Project FW-3-R-8, Job IW, Wyoming Game and Fish Commission, Cheyenne, Wyoming.

Holloran, M. J. 1999. Sage Grouse (*Centrocercus urophasianus*) seasonal habitat use near Casper, Wyoming. M.S. thesis. University of Wyoming, Laramie, Wyoming. 128 pages.

Homer, C. G. 1991. Modeling sage grouse winter habitat with Landsat Thematic Mapper data in a Geographic Information System. M.S. Thesis, Utah State University Logan, Utah, USA

Homer, C. G., T. C. Edwards, Jr., R. D. Ramsey and K. P. Price. 1993. Use of remote sensing methods in modeling sage grouse winter habitat. Journal of Wildlife Management 57:78-

84.

Honess, R. G., and G. Post. 1968. Sage grouse coccidiosis. Pages 4-22 *in* Part 1: History of an epizootic in Sage Grouse. University of Wyoming Agricultural Experiment Station, Science Monograph 14, Laramie, Wyoming, USA.

Honess, R. G. 1982. Cestodes of Grouse. Pages 161-164 in E. T. Thorne, N. Kingston, W. R. Jolley, and R. C. Bergstrom, editors. Diseases of Wildlife in Wyoming, Second Edition. Wyoming Game and Fish Department, Cheyenne, Wyoming.

Hulet, B. V. 1983. Selected responses of Sage Grouse to prescribed fire, predation, and grazing by domestic sheep in southeastern Idaho. M.S. thesis. Brigham Young University, Provo, Utah. 64 pages.

Hunnicutt, M. 1992. Use of Landsat imagery and geographical information systems in the assessment of rangeland cover and wildlife habitat. M.S. Thesis, Utah State University, Logan, U.S.A.

Hupp, J. W., and C. E. Braun. 1989. Topographic distribution of Sage grouse foraging in winter. Journal of Wildlife Management 53:823-829.

Jenni, D. A., and J. E. Hartzler. 1978. Attendance at a sage grouse lek: implications for spring censuses. Journal of Wildlife Management 42:46-52.

Johnson, G. D., and M. S. Boyce. 1990. Feeding trials with insects in the diet of Sage Grouse chicks. Journal of Wildlife Management 54:89-91.

Jolley, W. R. 1982. Protozoa. Pages 107154 in E. T. Thorne, N. Kingston, W. R. Jolley, and R. C. Bergstrom, editors. Diseases of Wildlife in Wyoming, Second Edition. Wyoming Game and Fish Department, Cheyenne, Wyoming, USA.

Klebenow, D. A. 1969. Sage grouse nesting and brood habitat in Idaho. Journal of Wildlife Management 33:649-662.

Klebenow, D. A. 1982. Livestock grazing interactions with Sage Grouse. Pages 113-123 *in* J. M. Peek and P. D. Dalke, editors. Wildlife-livestock relationships symposium: Proceedings 10. University of Idaho, College of Forestry, Wildlife, and Range, Moscow, Idaho.

Klebenow, D. A. 1985. Habitat management for Sage Grouse in Nevada. World Pheasant Association Journal 10:34-46.

Klott, J. H., and F. G. Lindzey. 1989. Comparison of sage and sharp-tailed grouse leks in south central Wyoming. Great Basin Naturalist 49:275-278.

Leopold, A. 1933. Game Management. Scribner. Reprinted by University of Wisconsin Press. 1986.

Lincoln County Sage Grouse Technical Review Team. 2004. Lincoln County sage grouse conservation plan. Lincoln County Coordinated Resource Management Steering Committee and the Nevada Division of Wildlife Resources. May 20, 2004. 73pp.

Martin, N. S. 1970. Sagebrush control related to habitat and Sage grouse occurrence. Journal of Wildlife Management 34:313-320.

Meyers, O. B. 1992. Sage grouse habitat enhancement: effects of sagebrush fertilization. Dissertation, Colorado State University, Fort Collins.

Miller, R. F., and J. A. Rose. 1995. Historic expansion of *Juniperus occidentalis* (western juniper) in southeastern Oregon. The Great Basin Naturalist 55:37-45.

Miller, R. F., and L. L. Eddleman. 2000. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State University Agricultural Experiment Station Technical Bulletin 151. Corvallis, Oregon, USA.

Miller, R. F., T. J. Svejcar, and J. A. Rose. 2000. Impacts of western juniper on plant community composition and structure. Journal of Range Management 53:574-585.

National Agriculture Statistics Service, Utah Field Office. 2005. URL: http://www.nass.usda.gov/Statistics_by_State/Utah/index.asp. Salt Lake City, Utah, USA. Accessed August 1, 2006.

Nelson, O. C. 1955. A field study of Sage Grouse in southeastern Oregon with special reference to reproduction and survival. Thesis, Oregon State College, Corvallis, Oregon.

Northwest Colorado Greater Sage-Grouse Working Group (GSGWG). 2004. Draft Northwest Colorado Greater Sage-grouse conservation plan. Colorado Division of Wildlife, Denver, Colorado. June 24, 2004.

Oakleaf, R. J. 1971. The relationship of Sage Grouse to upland meadows in Nevada. M.S. thesis. University of Nevada, Reno, Nevada. 64 pages.

Patterson, R. L. 1952. The Sage grouse in Wyoming. Sage Books, Inc. Denver, Colorado.

Peterson, RL et. al. 1953. Early Records of Red and the Gray Fox in Ontario. Journal of Mammalogy 34: 126-127.

Petersen, B. E. 1980. Breeding and nesting ecology of female sage grouse in North Park, Colorado. Thesis. Colorado State University, Fort Collins, Colorado.

Peterson, M., and N. Silvy. 1996. Reproductive stages limiting productivity of the endangered Attwater's prairie chicken. Conservation Biology 10:1264-1276

Phillips, J. B. 1990. Lek behaviour in birds: do displaying males reduce nest predation? Animal Behaviour 39:555-565.

Pitt , W. C., F. F. Knowlton, and P. W. Box. 2001. A new approach to understanding canid populations using an individual-based computer model: Preliminary results. Endangered Species Update 18:103-106.

Presnall, C. C. and A. Wood. 1953. Coyote predation on sage grouse. Journal of Mammalogy 34:127.

Pyle, W. H., and J. A. Crawford. 1996. Availability of foods of Sage grouse chicks following prescribed fire in sagebrush-bitterbrush. Journal of Range Management 49:320-324.

Rasmussen, D. I., and L. A. Griner. 1938. Life history and management studies of the Sage Grouse in Utah, with special reference to nesting and feeding habits. Transactions of the North American Wildlife Conference 3:852-864.

Remington, T. E., and C.E. Braun. 1985. Sage grouse food selection in winter, North Park, Colorado. Journal of Wildlife Management 49:1055-1061.

Rhoads, S. N. 1903. The mammals of Pennsylvania and New Jersey. Privately published, Philadelphia, Pennsylvania.

Rich County Coordinated Resource Management System (CRM). 2005. Draft System Manual. Rich County, Utah, USA.

Robel, R. J., J. N. Briggs, A. D. Dayton, and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. Journal of Range Management 23:295-297.

Robel, R.J., J. A. Harrison, C. A. Hagen, J. C. Pitman, and R. R. Reker. 2004. Effect of energy development and human activity on the use of sand sagebrush habitat by lesser prairie-chickens in southwestern Kansas. Transactions of the 69th North American Wildlife and Natural Resources Conferences.

Robertson, M. D. 1991. Winter ecology of migratory Sage grouse and associated effects of prescribed fire in southeastern Idaho. Thesis, University of Idaho, Moscow.

Rogers, G. E. 1964. Sage Grouse investigations in Colorado. Technical Publication No. 16. Colorado Game, Fish and Parks Department, Denver, Colorado.

Rowland, M. 2004. Effects of management practices on grassland birds: greater sage-grouse. Northern Prairie Wildlife Research Center, Jamestown, North Dakota, USA.

Sargeant, A. B., S. H. Allen, and R. T. Eberhardt. 1984. Red fox predation on breeding ducks in midcontinent North America. Wildlife Monographs. 89.

Sargeant, A. B., S. H. Allen, and J. O. Hastings. 1987. Spatial relations between sympatric coyotes and red foxes in North Dakota. Journal of Wildlife Management 51:285-293.

Savage, D. E. 1969. Relation of Sage grouse to upland meadows in Nevada. Nevada Fish and

Game Commission, Job Completion Report, Project W-39-R-9, Job 12. Reno.

Schroeder, M. A. 1997. Unusually high reproductive effort by Sage grouse in a fragmented habitat in north-central Washington. Condor 99:933-941.

Schroeder, M. A., J. R. Young, and C. E. Braun. 1999. Sage grouse (*Centrocercus urophasianus*). In A. Poole and F. Gill, editors. The Birds of North America, No. 425. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Schroeder, M. A., and R. K. Baydack. 2001. Predation and the management of prairie grouse. Wildlife Society Bulletin 29:24-32.

Shields, W. F. 1968. The Woodruff bison kill. University of Utah Anthropological Papers 99:45-53.

Slater, S. J. 2003. Sage-grouse (*Centrocercus urophasianus*) use of different-aged burns and the effects of coyote control in southwestern Wyoming. Thesis, University of Wyoming, Laramie, Wyoming.

Sveum C. M. 1995. Habitat selection by Sage Grouse hens during the breeding season in south-central Washington. Thesis, Oregon State University, Corvallis, Oregon.

Sveum, C. M., W. D. Edge, and J. A. Crawford. 1998. Nesting habitat selection by Sage grouse in south-central Washington. Journal of Range Management 51:265-269.

Swenson, J. E., C. A. Simmons, and C. D. Eustace. 1987. Decrease of Sage grouse *Centrocercus urophasianus* after ploughing sagebrush steppe. Biological Conservation 41:125-132.

Thatcher, L. 1994. Bear Lake, Rich County *in* A. K. Powell, *ed*. Utah History Encyclopedia. University Press, University of Utah, Salt Lake City, Utah, USA.

The Nature Conservancy (TNC). 2005. Conservation Action Planning: User Manual V 4.b. The Nature Conservancy, Arlington, Virginia.

Till, J. A. 1992. Behavioral effects of removal of coyote pups from dens. Proceedings of the Vertebreate Pest Conference 15:396-399.

Trueblood, R. W. 1954. The effect of grass reseeding in sagebrush lands on Sage grouse populations. Thesis, Utah State Agricultural College, Logan.

United States Department of Agriculture National Agriculture Statistics Service (USDA NASS). 2005. URL: http://www.nass.usda.gov/

United States Forest Service (USFS). 2001. A collaborative approach for reducing wildland fire risks to communities and the environment. USDA Forest Service. URL: http://www.fireplan.gov/resources/reference_library.html

Utah Division of Oil, Gas, and Mining (OGM). 2006. Drilling activity database. URL: http://www.ogm.utah.gov/oilgas/STATISTICS/drilling/1SPUD.htm

Utah Division of Water Resources. 2006. Precipitation Data. URL: http://www.water.utah.gov/DroughtConditions/

Utah Division of Wildlife Resources (UDWR). 2002. Strategic Management Plan for Sage-grouse. Utah Department of Natural Resources, Division of Wildlife Resources, Salt Lake City, Utah. Publication 02-20.

Utah Division of Wildlife Resources (UDWR). 2006. Utah Sensitive Species List. Utah Department of Natural Resources, Division of Wildlife Resources. Salt Lake City, Utah. May 12, 2006. 141 pp.

Vale, T. R. 1975. Presettlement vegetation in the sage-brushgrass area of the intermountain west. Journal of Range Management. 28:32-36.

Vavra, M., W. A. Laycock, and R. D. Pieper. 1994. Ecological Implications of Livestock Herbivory in the West. Society for Range Management, Denver, Colorado.

Voigt, D. R., and B. D. Earle. 1983. Avoidance of coyotes by red fox families. Journal of Wildlife Management 47:852-857.

Wakkinen, W. L. 1990. Nest site characteristics and spring-summer movements of migratory Sage grouse in southeastern Idaho. Thesis. University of Idaho, Moscow.

Wakkinen, W. L., K. P. Reese, and J. W. Connelly. 1992. Sage grouse nest locations in relation to leks. Journal of Wildlife Management 56:381-383.

Wallestad, R. O. 1971. Summer movements and habitat use by Sage grouse broods in Summer movements and habitat use by Sage grouse broods in central Montana. Journal of Wildlife Management 35:129-136.

Wallestad, R. 1975. Male Sage grouse responses to sagebrush treatment. Journal of Wildlife Management 39:482-484.

Wallestad, R., and D. Pyrah. 1974. Movement and nesting of Sage grouse hens in central Montana. Journal of Wildlife Management 38:630-633.

Wallestad, R. O. and P. Schladwiller. 1974. Breeding season movements and habitat selection of male Sage grouse. Journal of Wildlife Management 38:634-637.

Welch, B. L., J. C. Pedersen, and R. L. Rodriquez. 1988. Selection of big sagebrush by Sage grouse. Great Basin Naturalist 48:274-279.

Williams, C. L., Blejwas, K., Johnston, J. J., Jaeger, M. M. 2003. Wildlife Society Bulletin 31:925-932.

Wilson, G. 2000. Sage grouse use of burns and range seedings in Rich County, Utah. Utah Division of Wildlife Resources Research Report, Salt Lake City, Utah, USA.

Wisdom, M. J., R. S. Holthausen, B. C. Wales, C. D. Hargis, V. A. Saab, D. C. Lee, W. J. Hann, T. D. Rich, M. M. Rowland, W. J. Murphy, and M. R. Eames. 2000. Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: broad-scale trends and management implications. U.S. Department of Agriculture Forest Service General Technical Report PNW-GTR-485. Vol. 1-3. Pacific Northwest Research Station, Portland, Oregon.

Young, J. R., C. E. Braun, S. J. Oyler-McCance, J. W. Hupp, and T. W. Quinn. 2000. A new species of Sage grouse (Phasianidae: *Centrocercus*) from southwestern Colorado. Wilson Bulletin 112:445-453.

Young, J. R. 1994. The influence of sexual selection on phenotypic and genetic divergence among sage grouse populations. Dissertation, Purdue University, West Lafayette, Indiana, USA.

Young, J. A., R. A. Evans, and P. T. Tueller. 1976. Great Basin plant communities—pristine and grazed. Pages 186–216 *in* Holocene environmental change in the Great Basin. R. Elston, editor. Nevada Archeological Survey Research Paper Number 5.

Young, J. A., and R. A. Evans. 1981. Demography and fire history of a western juniper stand. Journal of Range Management 34:501-506.

Zablan, M. A. 1993. Evaluation of Sage grouse banding program in North Park, Colorado. Thesis, Colorado State University, Fort Collins.