ELKO COUNTY SAGEBRUSH ECOSYSTEM CONSERVATION STRATEGY

Prepared by:

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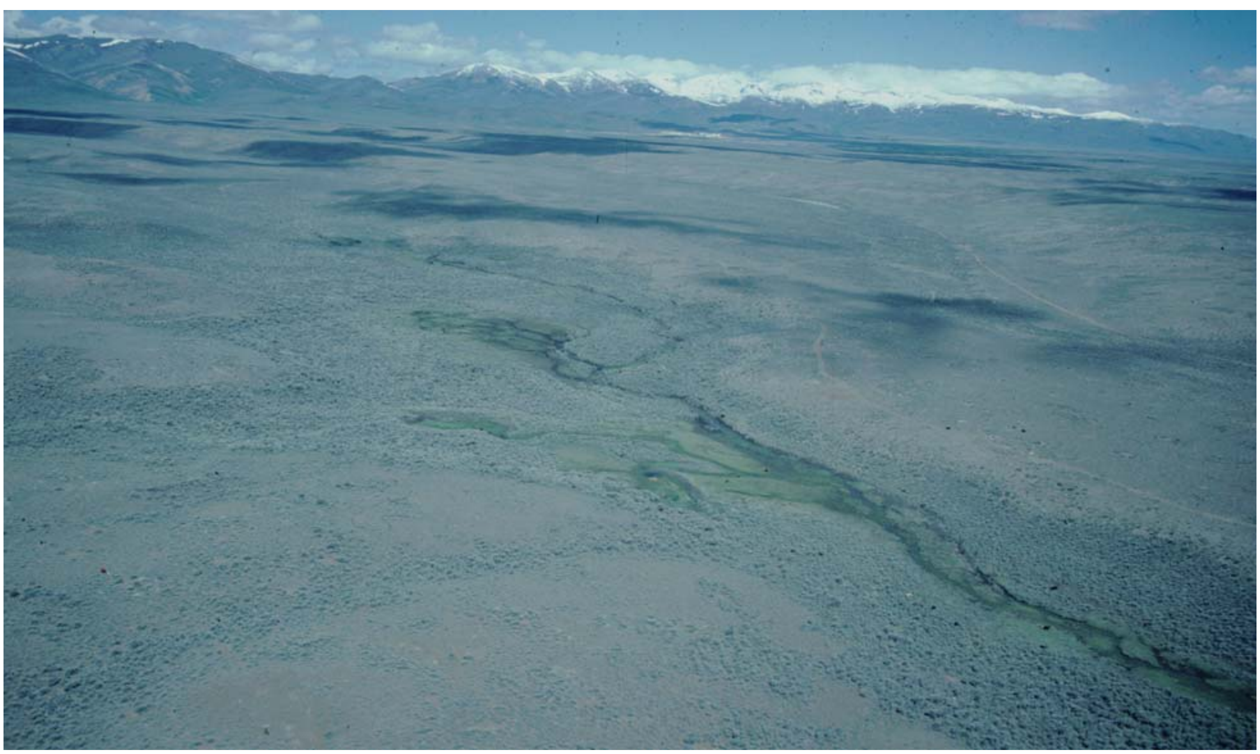

March 2004

NORTHEASTERN NEVADA STEWARDSHIP GROUP, INC.

Mission Statement

Whereas:
As the Northeastern Nevada Stewardship Group, Inc., we appreciate:
Opportunities which allow us to live and work in Northeast Nevada;
Natural resources which enable local prosperity;
Productive ecosystems which provide healthy environments and quality lifestyles;
Our western heritage, culture, and customs.

Therefore:
In order to ensure a better future for our families, community, and future generations,
To build trust amongst our diverse citizenry, and to
Ensure sustainable resource use,
We join together as full partners to
Provide a collaborative forum for all willing participants.
We are dedicated to dynamic, science-based resolution of
Important issues related to resource stewardship and
Informed management of our public lands with
Positive socioeconomic outcomes.

SIGNATURE PAGE

The Strategy presented herein is a process for assessing the 19 watersheds within the planning area. As such, there is no commitment by any agency or individual signatory below to any expenditure of funds or personnel resources to the process. By their signatures, these individuals and/or the agency represented by the signatory, are agreeing to proceed with the process and are indicating a general approval of the Strategy. Their signature should not be interpreted to mean that each signatory is in total agreement with all of the wording or all of the components of this Strategy. Each agency can only participate to the extent allowable by law, regulation, or policy.

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President, Northeastern Nevada Stewardship Group

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Helen Hankins
Field Manager, Elko Field Office, Bureau of Land Management

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PREFACE

The Northeastern Nevada Stewardship Group, Inc. (NNSG) was established in the fall of 1998 as a result of frustration with the confrontational manner in which natural resource and land use issues were being addressed in the region. Seeking an alternative means of conflict resolution, a collaborative training session was conducted. Following the training, the group met again and decided that sufficient interest and support existed to form a community-based organization operating under the concept of collaboration. The NNSG was thus formed, and the first task undertaken was to develop a mission statement that met the needs and expressed the values of the diverse membership (see preceding page).

The NNSG is open to all individuals, organizations, interest groups, businesses, corporations, and governmental agencies. The NNSG has no jurisdictional authority, yet is empowered by the process of collaboration and by its membership. It is noteworthy that the NNSG did not form as a result of the potential petition to list the Sage-Grouse as threatened or endangered under the Endangered Species Act (ESA) of 1973, as amended. Rather, the NNSG formed as a group and developed their mission prior to seeking an issue to pursue (i.e., the mission statement was not born of any specific issue, but recognized the need to develop a format to address all issues). As such, the NNSG has incorporated community values into the development of this strategy, a strategy developed to provide for the natural resources within the county, as well as to provide for the well being of the people, continuance of the land uses, and maintenance of the cultures of Elko County.

By 1999, the potential for a petition to list Sage-Grouse as threatened or endangered under the ESA was the issue "du jour." Because this issue had the potential to affect land users of every persuasion; and therefore, the potential to bring diverse viewpoints to the table to resolve the issue, Sage-Grouse conservation was selected as the issue for NNSG to implement the collaborative process. This was a new issue and hard-line positions had not yet developed. The potential for a successful collaborative effort existed and the citizens worked to resolve differences for the common good.

Developing and accepting the strategy are only the first steps in a long journey. The strategy is the road map, but there will be unexpected detours in the road ahead. Only time will tell if the trust that has been built among the members will be sufficient to weather the obstacles ahead. It is important that we remain true to our mission, and so the mission statement is included as the very first page, convenient for continual reference.

The NNSG makes no pretense to having ownership or jurisdiction over any lands or resources. However, as indicated by the development of this document, the NNSG does have a stake in how these lands are managed, and has taken the active role in providing a road map for the management of the lands within Elko County. The NNSG also recognizes the importance of private lands within the regional landscape. Management strategies on private and public lands need to complement each other if either strategy is to be successful. Therefore, in terms of land management actions, the strategy will not distinguish between private land and public land. The distinction will lie in how those strategies can be implemented, funding for the implementation, and the adaptive management process for modifying the strategies based on monitoring.

The strategy that follows is the result of a collaborative effort. The NNSG as a group decided to explore the Sage-Grouse conservation issue and assigned the task to a committee or "pod." The pod then went through a series of steps, including weekly meetings over a six-month period, and monthly meetings (more or less) over a four-year period, to develop the framework and content of the strategy. During this time, Governor Guinn convened a statewide Sage-Grouse Conservation Team. NNSG was invited to participate in this statewide effort. The completion of the NNSG Sagebrush Ecosystem Conservation Strategy was delayed to allow the statewide Sage-Grouse Conservation Strategy to develop. The NNSG agreed to be one of the six local planning groups involved in the statewide effort, but also decided to maintain the original course of the NNSG Sagebrush Ecosystem Conservation Strategy. The primary difference is the focus of the two strategies. The

NNSG strategy is a watershed-based, ecosystem conservation strategy and the State strategy is primarily focused on Sage-Grouse conservation. While the two strategies share common goals and considerable overlap in process, they remain separate approaches. The end result is that the NNSG has incorporated some of the statewide strategy for Sage-Grouse conservation, but will implement Sage-Grouse conservation through watershed/ecosystem management. The actual writing of the strategy was contracted out to a third party to facilitate the writing process, but the process has been at the direction and supervision of the pod. The pod members and contributors to this strategy are listed in **Appendix A**.

During this process, NNSG sponsored a series of workshops and symposia on topics directly related to this effort. Producing a strategy that is science-based requires that the membership be exposed to the existing science and to understand the underlying scientific principles sufficiently to evaluate the various fact and fiction that arises during the process. For many people, reading this document may be their first, or their only, or their major exposure, to Sage-Grouse or sagebrush ecology; therefore, the information from the literature and the science symposia has been included extensively into this document. Although this has added to the length of the document, Section 2 provides the reader with an opportunity to have this information in one location for easy reference. This information has also been the basis for understanding the relationship between Sage-Grouse and its habitat, and therefore, the basis for developing the several of the management strategies.

Of utmost importance is the recognition that this is not an ending point, but a starting point. The concern about Sage-Grouse has led to additional research to explore relationships between habitat and nutrition, habitat and predation, seasonal movements, population genetics, and many other topics. The strategy presented herein includes the concept of adaptive management. This allows for new information and new hypotheses, which develop from controlled research studies or from on-the-ground experience, to be included into the decision-making process. Therefore, this strategy is based on our current understanding of the sagebrush ecosystem, which is admittedly only superficial. However, this basic understanding is sufficient to move forward and to allow us to learn from our mistakes, as well as our successes. With approximately 11 million acres in the planning area, it is impossible with current, or even with wishful funding levels, to affect a large amount of acreage in a short period of time. Therefore, by taking small steps and implementing the monitoring of the key resources and systems, and by implementing the adaptive management process, the on-the-ground work can proceed without fear of making a mistake that will wreak irrevocable damage to the ecosystem. That is not to imply that we won’t make mistakes, but that they will be made at a scale and magnitude that they can be corrected with time.

ACKNOWLEDGEMENTS

The major contributors to this strategy are listed in **Appendix A**; these are the pod members that attended meetings, discussed the issues, and contributed to the solutions. Their perseverance is appreciated. This document is first and foremost, their collective vision.

Mr. J. Kent McAdoo, University of Nevada Cooperative Extension, accepted the task of editing the document before it was presented to the pod for their review. His suggestions greatly improved the document and his contributions to the process are greatly appreciated. Kent was also a “sounding board” for many of the theoretical concepts that are included in this Strategy, and the discussions about these topics were improved by his thoughts.

Mr. Ray Lister, Elko Field Office, Bureau of Land Management (BLM), led the effort to coordinate the GIS mapping and the determination of “restoration” ratings (habitat R values) of the habitat within the planning area. He was assisted in this effort by Mr. Bruce Piper, also of the Elko Field Office, BLM. Ray also provided the summary of BLM activities that currently provide consideration and/or benefits to Sage-Grouse within the Elko Field Office.

Mr. Larry Gilbertson and Mr. Sid Eaton of the Nevada Department of Wildlife (NDOW), provided access to the local NDOW data base regarding Sage-Grouse. This included lek count data, lek locations, and wing data. In addition, they revised the original Sage-Grouse Population Management Unit (PMU) boundaries based on their local knowledge and developed the population estimates for each PMU. They also made the first assignment of risks within the risk matrix. Mr. Steve Foree, NDOW Habitat Biologist contributed in a variety of ways, not the least of which was his questioning of the basis for each part of the strategy. Steve also provided a summary of NDOW’s efforts to enhance Sage-Grouse populations and the monitoring conducted by NDOW.

Mr. Paul Blackburn and Mr. Chuck Petersen, Natural Resource Conservation Service (NRCS) provided guidance on the use of the NRCS soil survey data that was used in the identification of the restoration ratings. Mr. Leland (Lee) Campsey, also of the NRCS, took minutes of the pod meetings and provided important information regarding range issues and grazing. Lee also served as an important link between the NNSG Sage-Grouse Pod and the ranching community through the local Conservation Districts.

Mr. Will Amy and Ms. Portia Jelineck, U.S. Forest Service (USFS) also contributed with their local knowledge of habitat condition and Sage-Grouse seasonal use areas on National Forest lands. They also kept the group advised of actions that had potential to be in conflict with the Forest Plan. Will provided a summary of the USFS actions that benefit Sage-Grouse or Sage-Grouse habitat.

The ranching community was well represented at the meetings and contributed much in the way of local knowledge of Sage-Grouse distribution, as well as providing a historical perspective of Sage-Grouse abundance, landscape changes, and grazing practices. Mr. Fred Zaga and Mr. Harvey Barnes also assisted the pod through their support of the NNSG effort through their membership in other organizations, such as the Nevada Cattlemen’s Association, the Elko County Public Land Use Advisory Council, and the N-1 Grazing Board. Of all the stakeholders in this process, the ranching community has the potential to be most affected. The strategy would be hollow without their input and support.

The mining industry was also well represented on the pod and contributed ideas for the Strategy, funds for symposia, and funds to support the administrative needs of NNSG. There has been willingness by this industry to be part of the solution and it is greatly appreciated.

The Nevada Subcommittee for Public Lands provided the initial grant for writing the Strategy and for acquiring information on the other sagebrush obligate species. We hope they view this as money well spent. Assemblyman John Carpenter also provided support for the group at County Commission meetings and other public meetings. His support and participation is appreciated.

At the beginning of this process, the N-1 Grazing Board provided a grant of $20,000 to allow the NNSG to implement demonstration projects. These projects were a test of some of the ideas included in this Strategy and were important in letting individuals see the opportunity that exists for improving wildlife habitat, livestock forage, and fuels management.

The Elko Field Office, BLM and Mountain City and Ruby Mountain Districts, USFS have also contributed funding for various operational, symposia, and activity costs. The completion of this strategy would not have occurred without their assistance.

Many other individuals have contributed to the thinking that went into this document through questions, suggestions, and comments about Sage-Grouse, range management, predation, and a variety of other topics. Too numerous to mention, or even remember, but they will recognize their contribution as they read the strategy.

There are two men who guided the preparation of this document, yet never attended a meeting. Dr. William H. Marshall, a pioneer in the field of wildlife ecology, stressed the value of habitat in the management of game animals, and the interrelationships of plants and animals as the basis for developing management plans. Mr. Gordon W. Gullion, a former resident of Elko and game biologist with NDOW, and one of the foremost experts of ruffed grouse ecology, stressed the need to learn the conditions under which healthy populations existed prior to settlement. This includes the factors that created suitable habitat conditions, as well as the factors (such as predators), that influenced how a species used or selected habitats. While these conditions cannot often be recreated exactly, they do provide the basis for designing habitat management actions. These two themes were the paradigm for this strategy.

PREAMBLE

The NNSG recognizes that the federal land management agencies have laws, regulations, and policies that direct how they administer the public lands. The Federal Land Policy Management Act (FLPMA) directs the agencies to develop land use plans (LUPs) to guide their on the ground management. In addition, the federal agencies are required by the National Environmental Policy Act (NEPA) to conduct environmental analysis of federal actions or federally funded actions. The federal agencies have also entered into agreements (Memoranda of Understanding, Cooperative Agreements, etc.) that further define roles and responsibilities. One such agreement is the Memorandum of Understanding (MOU) between the federal land management agencies and the Western Association of Fish and Wildlife Agencies (WAFWA). This MOU states that the federal agencies will consider the guidelines for the management and conservation of Sage-Grouse developed by WAFWA in federal land actions.

In addition, the Bureau of Land Management (BLM) Nevada has included Sage-Grouse as a Sensitive Species and has developed guidelines for considering the potential impacts to Sage-Grouse or Sage-Grouse habitat from various program-specific actions (i.e., rights-of-way for utility lines, mining, fences, land exchanges, etc.). These guidelines were risk-based and are incorporated into the decision-making process. The U.S. Forest Service (USFS) has also identified Sage-Grouse as a Sensitive Species, but has not yet developed specific management guidelines; however, Sage-Grouse was previously considered a USFS Management Indicator Species, which provides special consideration of the species in their decision-making process.

The Northeastern Great Basin Resource Advisory Council (RAC) has also developed Standards and Guidelines for Rangeland Health. These standards apply to livestock and wild horse and burro actions as they relate to vegetative conditions, or rangeland health. The USFS also has desired conditions that are developed for each plant community. These conditions address the soil, vegetation, hydrology, and disturbance associated with functioning, not functioning, and threshold conditions. These plant community conditions are the basis for evaluating land uses and planning new actions.

These are just some of the sideboards within which the federal agencies must operate. Therefore, the NNSG Elko County Sagebrush Ecosystem Conservation Strategy can only be adopted by the federal land management agencies to the extent that the actions proposed in the strategy are in conformance with the applicable LUPs, laws, policies, and agreements. However, there are also lands in Elko County that are not administered by the federal agencies; and therefore, it is appropriate to include in this strategy actions that may be conducted on private lands that are beyond the actions appropriate for federally-administered lands. Consequently, the signing of this strategy by authorized officers of the federal agencies does not imply that all actions proposed within this strategy, or subsequent watershed plans, are appropriate for federally-administered lands, but is an acceptance of the strategy in concept.

Actions that are developed and proposed for specific locations on public lands, or actions that are federally funded, will be reviewed for conformance with LUPs, laws, regulations, policies, and agreements. If a specific action is not in conformance with the LUPs, laws, regulations, policies, and agreements, then either the action will be modified to the extent possible to provide conformance, or an amendment to the LUP will be proposed. In addition, all actions that are proposed for public lands or that are federally funded, will be subject to NEPA analysis. Under this process, the special consideration afforded to Sage-Grouse as a BLM Sensitive Species or a USFS Sensitive and/or Management Indicator Species, and any other risk-based guidelines would be incorporated into the analysis.

Furthermore, the NNSG Elko County Sagebrush Ecosystem Conservation Strategy (Strategy) does not supercede any LUPs or seek to interfere or replace existing federal agency management. However, the NNSG is hopeful that some of the solutions to resource issues provided within this strategy, and to be developed in subsequent watershed management plans, can be viewed as consistent with the goals, objectives, and management decisions outlined in the LUPs and will be incorporated into existing LUP implementation strategies or actions. The process outlined in this Strategy may be useful to identify and prioritize needed changes in management to address specific issues.

As part of this effort, the Strategy presented focuses on those aspects of ecosystem management that have not been a priority for the federal agencies and does not address those issues that the federal agencies are currently addressing. In addition, there is overlap in dealing with some issues where the synergy of two or more independent actions can be combined to achieve results not possible by either action alone. For example, the federal land management agencies regulate grazing on public lands in terms of kind of livestock, number of livestock, season of use, and allowable utilization levels. The NNSG does not propose to conduct independent allotment evaluations to determine if the existing grazing systems are achieving the desired results; this is the purview of the federal agencies. However, the NNSG strategy focuses on the functionality of systems (energy, nutrient, and water) within watersheds. The stressors on the systems, including but not limited to livestock grazing, will be evaluated through the watershed assessment process. As a result of the assessment process, the NNSG may determine that some adjustments in grazing may be required to allow a system to function. In such cases, the information will be provided to the appropriate federal land management agencies to be incorporated as part of the allotment monitoring data and as input from an interested party in the allotment evaluation process. Thus, the NNSG will attempt to influence the decision-making process based on the results of the watershed assessment, but it remains up to the federal land management agencies to make the final decision.

The major focus of the NNSG strategy is that of landscape health. This is a synergistic effort in that the Bureau of Land Management's Great Basin Restoration Initiative, the Forest Service's Healthy Forest Initiative, and the North Fork Humboldt Land and Resource Management Plan provide the direction for restoring rangeland and forests to healthy, productive condition. The watershed assessment/planning process is compatible with the goals and objectives of these agency initiatives.

The NNSG has identified several factors that affect Sage-Grouse populations; however the three general conditions that need to be addressed through the watershed assessment/planning process that allow for synergism and include: 1) annual grasslands (primarily cheatgrass); 2) encroachment of pinyon-juniper woodlands from woodland sites to range sites; and 3) the interference of natural disturbance regimes that have allowed for sagebrush-grassland plant communities to become dominated by older sagebrush and to reach extreme fuel loading conditions. Each of these conditions represents a stressor on the sagebrush ecosystem and to the fauna and flora that inhabit this ecosystem. The watershed assessment/planning process will allow for an objective evaluation of the causes of these conditions, as well as other stressors to the watershed, and the appropriate site-specific actions needed to rectify the conditions or to remove the stressors. The end result should be increased health of the range and forest lands.

Sage-Grouse have been the impetus for this conservation effort, but should be viewed as the "means" not the "ends"; by understanding the ecology of this species and the ecology of the sagebrush plant community on which it depends, some of the general concepts for ecosystem management can be developed. The "ends" is to achieve properly functioning ecosystems that allow for sustainability of the resources and the sustainability of the land uses that depend on those resources.

ELKO COUNTY SAGEBRUSH ECOSYSTEM CONSERVATION STRATEGY

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EXECUTIVE SUMMARY

Introduction

The Elko County Sagebrush Ecosystem Conservation Strategy (Strategy) is the result of collaboration among various interest groups, individuals, and agency personnel in response to the potential for listing Sage-Grouse as threatened or endangered under the Endangered Species Act. However, the Northeastern Nevada Stewardship Group (NNSG) quickly realized that the Sage-Grouse was an indicator species of ecosystem health. Because of the variety of plant community types (i.e., habitats) needed by Sage-Grouse for breeding, nesting, brood-rearing, and wintering, "the goal of managing Sage-Grouse habitats for an optimal balance of shrubs, forbs, and grasses at community and landscape scales should be analogous with restoring and /or maintaining form, function, and process in sagebrush-dominated habitats" (Crawford et al. 2004). Consequently, the focus of the effort changed from a single-species conservation plan to an ecosystem conservation strategy. However, the emphasis on Sage-Grouse has not been lost in the process. Throughout the process, sagebrush obligate species, special status species (both plants and animals), and other unique land features (e.g., aspen stands, sub-alpine forests, etc.) will be considered in the management actions developed with the intent on maintaining the diversity of communities on the landscape.

Habitat Conservation Assessment

The Strategy includes an assessment of the planning area that consists of a summary of Sage-Grouse biology and ecology, a description of sagebrush ecology, a list of factors that affect Sage-Grouse and Sage-Grouse habitats, and a historical perspective of the landscape changes and Sage-Grouse populations.

As part of this assessment, the NNSG followed portions of the Nevada Sage-Grouse Conservation Strategy developed by the Governor's Sage-Grouse Conservation Team. Sage-Grouse population management units (PMUs) were identified within the planning area, and each PMU was evaluated for risks to Sage-Grouse using the following factors: Habitat Quantity, Habitat Quality/Nutrition, Habitat Fragmentation, Changing Land Uses, Livestock Grazing, Fire Ecology, Disturbance, Predation, Hunting, Disease, Cycles, and Climate/Weather. Those PMUs with higher total risk values were identified as priority areas for management. The level of risk assessment was general; not specific enough to identify individual project level actions, but detailed enough to identify the general types of issues that need to be addressed.

The condition of the vegetation with respect to Sage-Grouse habitat requirements was also evaluated using soil mapping provided by the Natural Resource Conservation Service (NRCS), various vegetation mapping efforts provided by the Elko Field Office, Bureau of Land Management (BLM), allotment evaluation data from BLM and U.S. Forest Service, Humboldt-Toiyabe National Forest (USFS), and field experience of the members of the team. The evaluation generally followed the protocols developed in Idaho and included five habitat categories:

- R-0: Habitat areas with desired species composition that have sufficient, but not excessive, sagebrush canopy and sufficient grasses and forbs in the understory to provide adequate cover and forage to meet the seasonal needs of Sage-Grouse (4,805,000 acres);
- R-1: Habitat areas which currently lack sufficient sagebrush and are currently dominated by perennial grasses and forbs, yet have the potential to produce sagebrush plant communities with good understory composition of desired grasses and forbs (1,170,000 acres);
- R-2: Existing sagebrush habitat areas with insufficient desired grasses and forbs in the understory to meet seasonal needs of Sage-Grouse (2,018,000 acres);
- R-3: Sagebrush habitat areas where pinyon-juniper encroachment has affected the potential to produce sagebrush plant communities that provide adequate cover and forage to

meet the seasonal needs of Sage-Grouse (354,000 acres); and

- R-4: Habitat areas which have the potential to produce sagebrush plant communities but are currently dominated by annual grasses, annual forbs, or bare ground (251,573 acres).

The remaining 1,626,000 acres of the planning area were identified as non-Sage-Grouse habitats (forests, urban areas, salt-desert shrub, etc.).

This breakdown indicated that although Elko County has considerable acreage of intact Sage-Grouse habitat (R-0 acreage), the potential habitat in which sagebrush can be readily established and sagebrush habitat in poor condition (R-1 and R-2 acreage, respectively), and the areas formerly occupied by sagebrush but now occupied by pinyon-juniper and cheatgrass (R-3 and R-4 acreage, respectively) account for 44 percent of the acreage (3,793,000 acres) that have potential to support Sage-Grouse within the planning area. These habitat condition categories that represent risks to Sage-Grouse also represent acreage that is not functioning in terms of watershed values. Consequently, the issues of habitat quantity and habitat quality were identified as major issues to be addressed.

Conservation Strategy

The NNSG Strategy and the Nevada Sage-Grouse Conservation Strategy (State Strategy) identify some common goals. The first goal of the State Strategy is to:

> Create healthy, self-sustaining Sage-Grouse populations well distributed throughout the species' historic range by maintaining and restoring ecologically diverse, sustainable, and contiguous sagebrush ecosystems and by implementing scientifically-sound management practices.

The goal of the NNSG Strategy is to:

> Manage watersheds, basins, and sub basins in a manner that restores or enhances (as appropriate) the ecological processes necessary to maintain proper functioning ecosystems, inclusive of Sage-Grouse.

The NNSG Strategy also includes goals specific to various resources (e.g., Sage-Grouse, vegetation, special status species, livestock, recreation, mining, and fuels management). However, these goals are general goals that can be refined at the watershed management unit level.

The objectives of the NNSG Strategy are to:

> Implement a watershed analysis process on the watersheds within the planning area by initiating the assessment of three watersheds each year; and

> Develop a watershed plan for each watershed within one and one-half years following the initiation of the process.

The watershed assessment will follow range, watershed, riparian, and Sage-Grouse habitat evaluation processes developed by the BLM, U.S. Geological Survey, NRCS, Agricultural Research Service, USFS, Environmental Protection Agency, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, National Park Service, the Bureau of Indian Affairs, and the Western Association of Fish and Wildlife Agencies.

The watershed management plans will include actions and management strategies that address the specific land health and Sage-Grouse habitat issues identified in the watershed assessment. Once completed, the individual projects, groups of inter-related projects, or the entire watershed plan will be subject to National Environmental Policy Act (NEPA) analysis to determine the impacts of such actions on the critical elements of the human environment, as well as the cumulative impacts of such actions.

The NNSG Strategy identifies several management strategies that are likely to be incorporated into the watershed management plans on a site-specific basis. The management strategies identified to date address some of the major issues that have been identified in the initial PMU risk assessment and watershed review. As other issues are identified in the watershed assessment process, additional management strategies will be developed.

Monitoring at the watershed plan-level, at the individual watershed project-level, and at the on-the-ground resources-level will be part of the watershed management process. For each monitoring level, the responsibility for conducting the monitoring, the variable(s) to be monitored, the frequency at which monitoring is to occur, and the manner in which the monitoring will be reported will be specified. The variables to be monitored will be directly related to the goals and objectives of the watershed plan, the project, and the resources to be affected by the project.

The feedback provided by the monitoring with respect to the objectives will provide the basis for implementing adaptive management strategies. If objectives are being achieved, then the type of action implemented will continue. If objectives are not being achieved, then the hypothesis on which the objective is based, the practice that was implemented, the conditions under which it was implemented, the variables being monitored, and monitoring methodology will all be re-evaluated to determine where changes need to be instituted.

This Strategy is the process for identifying the site-specific issues, developing watershed-specific management/conservation plans, proposing and implementing site-specific actions, determining the appropriate monitoring of these actions, and implementing adaptive management concepts to the entire process.

1 INTRODUCTION

1.1 Background

The potential of a petition to list Sage-Grouse under the Endangered Species Act (ESA) of 1973, as amended, had broad implications for land uses; and therefore, was an appropriate issue with which NNSG to become involved. The initial approach was to develop a Sage-Grouse conservation plan (i.e., a plan to manage appropriate habitats and lands for the benefit of Sage-Grouse). It soon became apparent that such an undertaking was myopic because improving conditions for the benefit of one species often results in worsening conditions for other species. In reality, this approach is analogous to cutting the proverbial pie into more pieces; emphasizing certain lands for one species or group of species at the expense of other species or land uses. This approach also pits “resource protection” against “resource use” by prioritizing one use (i.e., Sage-Grouse or Sage-Grouse habitat) at the expense of another (i.e., livestock grazing, hunting, recreation, etc.). This approach would ultimately bring the group back to the table at some future date to develop a conservation plan for the next species facing extirpation as a result of implementation of the Sage-Grouse conservation plan, or would create controversy and conflict, rather than resolving issues.

The plight of Sage-Grouse is symptomatic, and treating the symptom would not cure the ailment. Sage-Grouse can be viewed as a biotic indicator species, and their range-wide decline is an indication that the ecosystems on which Sage-Grouse depend are not functioning properly. Therefore, on the grand scale, the task is to return functionality to the ecosystems. Consequently, the NNSG decided to expand the scope of the plan to be all encompassing. However, defining an ecosystem was not a simple task, and managing an ecosystem may even be an even more daunting task.

The first step was to realize that the Great Basin ecosystem was not within our capability to manage. The second step was to define the area of interest, Elko County (**Figure 1**). The County is defined by political boundaries, not ecological boundaries; therefore, some overlap with adjacent conservation plans is necessary and desirable. Elko County is located primarily within the Basin and Range Physiographic Province of the Great Basin, and the northern part of the county is within the Columbia Plateau Province. Major Land Resource Areas (MLRAs) as defined by the Natural Resource Conservation Service (NRCS 1987), include the Owyhee High Plateau (MLRA 25), Great Salt Lake Area (MLRA 28), and a portion of the Humboldt Area (MLRA 24) (**Figure 2**). Without a single “ecosystem” with which to work, but realizing that the vegetation communities in the various provinces and MLRAs were similar, the “sagebrush ecosystem” was selected as the ecosystem on which to focus. This included the riparian, woodland, and salt-desert shrub, although the primary focus of this strategy will be the lands currently supporting sagebrush-herb[1] or range sites capable of supporting sagebrush-herb communities.

This is not a strategy to create more sagebrush per se, but is a strategy to improve the functionality of the sagebrush-herb communities. This strategy also recognizes that perennial grasses and forbs are an essential component of the sagebrush community. As such, the maintenance of this herbaceous component is vital to the maintenance of the functionality of the system in terms of energy, nutrient, and water cycling, as well as being integral to the sustainability of the sagebrush-herb community. Thus the absence of sagebrush on a site and the dominance by grass and forbs on the site is a seral stage, or state in the transition from disturbance to sagebrush dominance. This is a necessary step in the development of the sagebrush community. Therefore, one of the essential concepts of this strategy is that periodic disturbance is required to maintain the sagebrush ecosystem. How, when, and where the disturbance should be introduced is to be determined through the watershed assessment.

[1] “Sagebrush-herb community” is a term borrowed from Dr. Alma Winward and is used to designate a community that has shrub (primarily sagebrush), perennial grass, and forb components. The latter two components make up the herbaceous layer, thus the use of the term “herb.” While “sagebrush-herb” is synonymous with “sagebrush-grassland,” sagebrush-herb adds emphasis to the important forb component.

DESIGNED	GB	12/01	FIGURE 1
DRAWN	akt	12/01	
CHECKED			SAGEBRUSH ECOSYSTEM CONSERVATION STRATEGY PLANNING AREA
APPROVED			

No.	DESCRIPTION	BY	DATE

PREPARED BY: SRK Consulting Engineers and Scientists

SCALE: AS SHOWN | REVISION: A
JOB NO. 140701
DWG NAME 140701-102

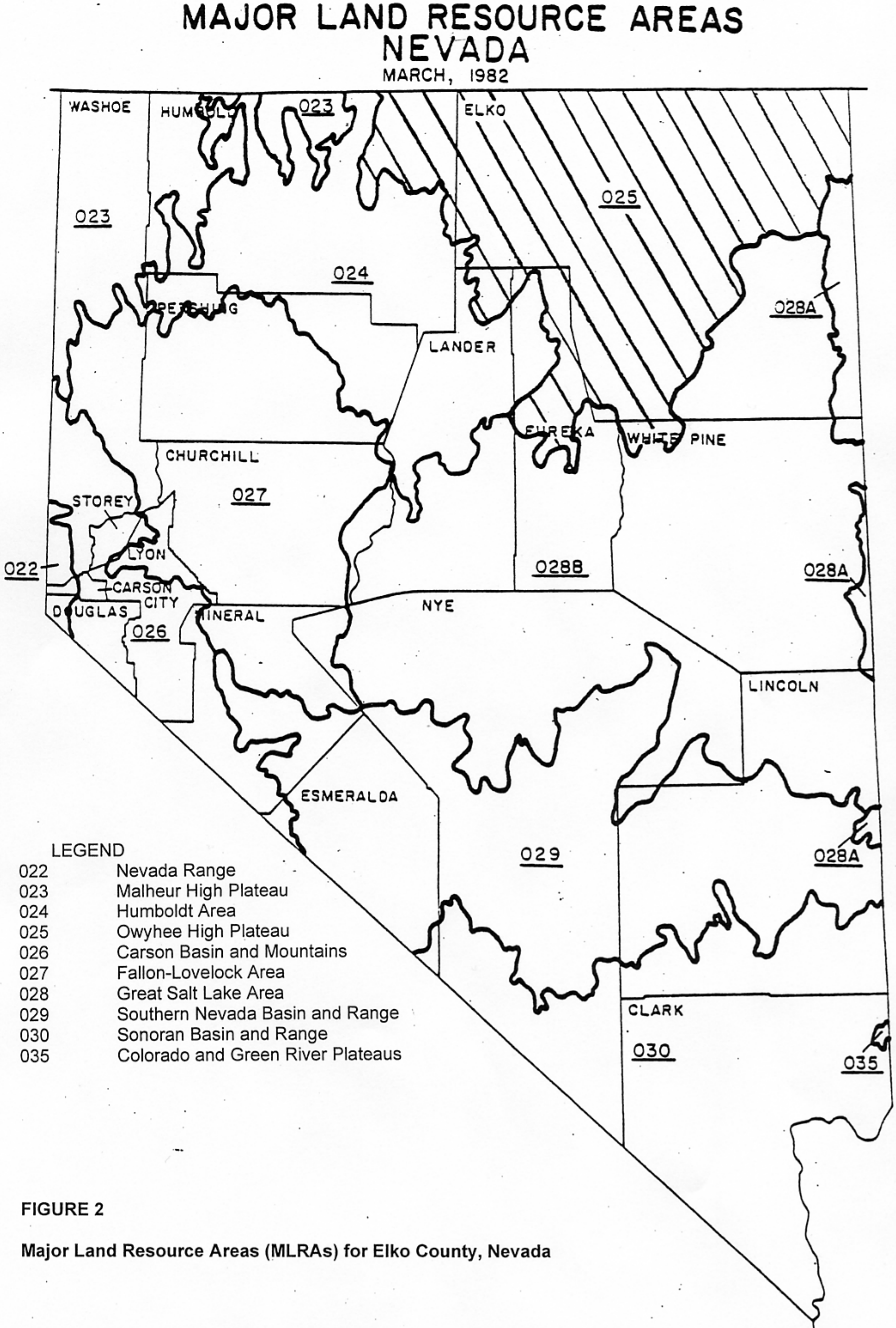

FIGURE 2

Major Land Resource Areas (MLRAs) for Elko County, Nevada

Recognizing that Sage-Grouse are a landscape scale species (i.e., prone to inhabiting large areas, using a variety of vegetation communities, found on a variety of land forms, and with at least some extensive elevational and/or seasonal migrations), management must also be on a landscape scale. A logical and definable unit for management is the watershed. Watersheds tend to be extensive, contain a variety of vegetation communities, extend over a range of elevation, and include a variety of land forms. While not a true ecosystem in and of themselves, watersheds are systems that have connectivity - all parts contribute in some manner to the acquisition, retention, transport, quality, and flow of water. Thus, water quality and quantity can be viewed as two abiotic (non-living) indicators of the health of the ecosystem.

The importance of having abiotic indicators of the health of the ecosystem is that they may be less responsive to stochastic (i.e., random) events, such as weather, that can have large influences on the biotic (plant and animal) components of the ecosystem. For example, a cold, wet storm or late frost may influence the availability of forbs and insects critical for Sage-Grouse chicks, resulting in a poor year for juvenile recruitment to the population. Just using population estimates as a measure of the management action in such a year would indicate that management may not be working. But this weather event is likely to have much less influence over the abiotic components of the ecosystem, such as water quality. Ultimately, the health of any particular species is dependent on the trends represented by the multitude of abiotic indicators, not on short-term population fluctuations.

As a result, the NNSG shifted the focus from doing only what would benefit Sage-Grouse, to managing systems in a way that will restore or retain the processes that make systems work; a shift from treating the symptom to treating the ailment. The Sagebrush Ecosystem Conservation Strategy (Strategy), as provided below, emphasizes Sage-Grouse as the featured species, but includes information on management of systems, of which Sage-Grouse are a component. Specific actions to be taken for the restoration and retention of processes for a given watershed will be included in the individual watershed action plans.

1.2 Purpose

The purposes of the Strategy are to: 1) provide a framework for managing the rangelands to improve and maintain the diversity and sustainability of natural resources and land uses within Elko County; 2) focus on managing watersheds as the basic unit of management; 3) restore and retain the processes necessary to proper functioning of our watersheds; and 4) ensure the continued existence of healthy populations of plant and animal species dependent on the sagebrush-herb ecosystem.

1.3 Need

The need for the Strategy was first expressed as a response to the potential submission of a petition to list the Sage-Grouse as threatened or endangered under the ESA. However, it became evident that a basic underlying need was to develop a better strategy for managing our rangelands. By developing an ecosystem-based strategy, the need to develop other species specific conservation plans in the future can be avoided. The need was to develop strategies for managing our rangelands on a sustainable basis, providing for socioeconomic values, as well as the natural values of the landscape. Developing such strategies in a collaborative process should also improve the stability of the solutions.

2 HABITAT CONSERVATION ASSESSMENT

2.1 Planning Area

Elko County is the second largest county in Nevada and the fourth largest county in the United States, covering 17,181 square miles, an area larger than each of the nine smallest states in the United States. The total surface area of 10,995,840 acres accounts for 15.5 percent of the total surface area of Nevada (**Figure 1**). Approximately 71 percent, or 7,852,280 acres, of the county is in public ownership, with approximately 6,778,200 acres administered by the Elko Field Office of the Bureau of Land Management (BLM), approximately 1,068140 acres administered by the Humboldt National Forest, U.S. Forest Service (USFS), and 5,926 acres administered by the U.S. Fish and Wildlife Service (USFWS).

The climate is described as a continental temperature regime with arid to semi-arid conditions in the valleys and lower mountain slopes and sub-humid conditions near the crests of the higher mountains. Precipitation is strongly orographically controlled. Air masses generally move eastward, with most of the precipitation originating from the Pacific Ocean. Average annual precipitation ranges from six inches on the valley floors to over 20 inches on the higher mountains (e.g., the Jarbidge, Independence, Ruby, and East Humboldt ranges). Arid conditions are due in large part to the rain-shadow effect created by the Sierra Nevada Range. Much of the precipitation occurs as snow, with over 100 inches occurring in the high mountains. Mean annual temperature ranges from 45^{o} to 50^{o} F, but summer temperatures can exceed 100^{o} F and winter low temperatures below 0^{o} F are not uncommon, especially in valleys where orographic ponding of cold air occurs.

Elko County includes portions of four of Nevada's fourteen hydrographic regions or water basins. The northern portion of the county (Owyhee Plateau) lies within the Columbia Plateau Province and the waters are part of the Snake River Basin. This portion of the county is characterized by rolling plateaus of low relief with steep, narrow canyons and interspersed with buttes. The remaining portion of the county includes portions of the Humboldt River Basin, Great Salt Lake Basin, and the Central Region Basin, and is within the Basin and Range Province. This area is characterized by a pattern of north-south trending mountain ranges and intervening alluvial valleys. Most of the county is more than 5,000 feet above mean sea level (amsl), with many mountain summits ranging from 8,000 to more than 10,000 feet amsl. Ruby Dome in the Ruby Mountains is the highest peak at an elevation of 11,387 feet amsl. In addition to the four major hydrographic regions in Elko County, there are forty-two hydrographic areas and sub-areas that are either partially or wholly within Elko County. These hydrographic areas and sub-areas are defined as hydrographic units within a major water basin and typically consist of a single valley or discrete drainage area. Eight of these hydrographic areas are contained within the Snake River Basin; seventeen hydrographic areas lie within the Humboldt River Basin; five hydrographic areas and four hydrographic sub-areas are within the Central Region Basin; and four hydrographic sub-areas are contained within the Great Salt Lake Basin.

The combination of climate and topography provides a variety of vegetative types, ranging from the saltgrass and salt desert shrub communities in the basins to the alpine community at the mountain peaks. The salt desert shrub communities consist of plant species with tolerance for alkali and salt affected soils and low precipitation. The northern desert shrub communities extend from intermediate to high elevations on non-saline, medium textured soils. The mountain brush communities occur at intermediate to high elevations on soils derived from volcanic and sedimentary parent material. Pinyon-juniper communities are located at intermediate elevations on limestone derived soils that are well drained, and range from shallow to deep. The forest communities consist of coniferous and shrub species on mountain slopes between 7,000 and 9,000 feet amsl with moderate to high annual precipitation. The alpine zone occurs above the timberline at approximately 10,000 feet. The extreme climatic conditions at these elevations are conducive to low growing, decumbent life forms, except for some tree species that survive on sheltered slopes. Riparian zones with deciduous trees, shrubs, and plants requiring higher soil moisture occur throughout the elevational and plant zones. The "sagebrush ecosystem" includes elements of the forest, mountain brush, northern desert shrub, pinyon-juniper, and riparian communities.

The planning area is within the sagebrush biome, the largest semi-arid ecosystem in the western United States. The sagebrush biome consists of the sagebrush steppe ecosystem type and the more arid Great Basin sagebrush ecosystem type (Kuchler 1985). The northern portion of the planning area (Owyhee Plateau/Snake River Plain) is within the sagebrush steppe ecosystem type, which is characterized by an overstory of sagebrush (*Artemisia* spp.) and understory of perennial grasses and forbs. The southern portion of the planning area is within the Great Basin sagebrush ecosystem type and also has an overstory of sagebrush, but the herbaceous component of the understory contributes a minor portion of the total plant cover (West 1983). The more arid conditions of the Great Basin sagebrush ecosystem type result in longer recovery periods following fire, or other disturbances, and restoration of plant communities is less successful (West 1983). An extensive discussion of the potential natural flora of the two ecosystem types is presented by Miller and Eddleman (2000).

The diversity of vegetation within the planning area supports a variety of wildlife species, including 246 species of birds, 76 mammals, and 28 reptiles and amphibians. Numerous species of fish occur in the streams, lakes, and reservoirs. Most of the wildlife species use riparian zones for some portion of their life cycle, or as part of their seasonal or daily range. Other species are found only in one or two of the vegetative communities described above. The combination of landscapes, geologic features, soils, vegetative communities, wildlife species, and historical sites provide a variety of recreational and land use opportunities.

Prior to 1828 the area was inhabited by Western Shoshone and Northern Paiute Indians. European influence on the landscape began in 1828 with the arrival of French fur trappers and fur traders. Various trapping and exploration parties passed through the region between 1828 and 1843, when a wagon trail was established along the Humboldt River as part of the east-west movement to California and Oregon. Ranching began in 1859 when the first large herd was wintered on the flood plain of the Humboldt River. The Humboldt River continued to be the major travel route, as the Central Pacific Railroad Company established rail tracks in 1868. Elko developed as a railroad town, with lots available for sale in 1869, but mining north of Elko soon followed and the Idaho-Elko Toll Road was constructed to connect the community and railroad hub to the mining activities to the north. Railroad, ranching, and mining have been the cornerstone industries of the county through the present day, each industry having its own economic cycles, with the "boom and bust" nature of the mining industry perhaps the most extreme. Gaming and tourism have also been a part of the economic well-being of the county in recent decades.

Following World War II, increasing population and prosperity in the United States resulted in an increase in outdoor recreation and an increased awareness by the general public of the environment. Agencies once dominated by foresters and range conservationists began adding planners, biologists, botanists, archaeologists, recreation specialists, and other resource specialist positions to the local staffs. The close relationship between commodity users and the agencies that were charged with providing food and fiber for a growing and prospering nation was being widened by a public wanting more recreational opportunities and agencies developing policies to address a myriad of new public land laws. The focus from fiber and forage production began to shift, and changes in land uses accompanied the shift, as did changes in the way lands were managed and how the agencies arrived at management decisions. These changes created an environment of stress, pitting one resource advocate group against another, often times with very little common ground being apparent. Agencies developed policies in response to public demands that lead to on-the-ground changes in management. The environmental movement of the 1960s and 1970s was challenged by the sagebrush rebellion of the late 1970s and 1980s which also spawned a state's rights movement of the 1990s.

These controversies were, and continue to be, set in the "win-lose" arena; one side cannot win without the other side losing. These controversies divert attention from the functionality of the entire system and focus instead on how to allocate resources for various interests. While the trend to "divvy up the pie" resulted in some short term improvements in range condition, the systems were still not functioning. The "divvy up the pie" strategy does not lend itself to restoring dysfunctional systems and does not lend itself to bringing interest groups to common ground. Ultimately, the win-lose system results in lose-lose because the focus is on symptoms and not processes. The move toward managing functioning systems and collaborative decision making was a response to resolving environmental issues as well as the social issues embroiled in these controversies.

The decision by the NNSG to focus on Sage-Grouse was two-fold. First, this species is considered an indicator species for the health of the land, and it uses a variety of habitats. Second, the current focus on Sage-Grouse, with potential for listing under the ESA, creates a window of opportunity to demonstrate that local planning groups can develop long-term solutions to these complex issues. Consequently, the strategy developed by the NNSG is based on an understanding of Sage-Grouse and sagebrush ecology.

The following sections provide the basis for developing ecosystem plans. As indicated above, Sage-Grouse are a landscape-scale species, as well as an indicator of the health of the landscape. The underlying assumption is that management that provides quality habitat for Sage-Grouse is likely to provide quality habitat for other sagebrush-dependent species. This should not be interpreted to mean that all species have the same habitat requirements. However, by providing the variety of conditions on the landscape needed for the seasonal habitats of Sage-Grouse, a continuum of habitat conditions would be available for other species as well.

Sagebrush is the major component of Sage-Grouse habitat; it shelters, protects, and provides sustenance for the bird. The winter diet of Sage-Grouse consists almost exclusively of sagebrush leaves. Because of this dependency of Sage-Grouse on sagebrush, the ecology of both the Sage-Grouse and sagebrush plant community need to be understood before management actions can be formulated. By understanding the plant community ecology and the plant-animal relationship, the need for ecosystem maintenance becomes more apparent.

The ecosystem approach is based on dynamic plant communities. As stated above, the landscape is heterogeneous. The heterogeneity is based in part on geologic, soil, landform, elevation, and precipitation factors, and in part on plant responses to these factors such that plant assemblages, or communities, can be identified. However, the plant communities are also dynamic and change over time. The change in plant communities over time is commonly referred to as plant or community succession. For example, a grassland that results from a fire today may be a sagebrush-grassland community at some time in the future. Both the grassland and the sagebrush-grassland are part of the sagebrush plant community.

2.2 Sage-Grouse Biology and Habitat Requirements

Sage-Grouse biology includes the basic information about the bird (i.e., taxonomy, distribution, and life history), the habits of the bird (i.e., food habits and habitat requirements), and the natural mortality factors affecting the bird (i.e., predators and diseases).

2.2.1 Taxonomy and Description

Sage-Grouse (*Centrocercus urophasianus*), is a member of the family Phasianidae (grouse and ptarmigan) and is one of seven species of grouse found in North America. They are also known as the sage hen, sage chicken, or sage cock. Lewis and Clark provided the first written accounts of this species during their 1805 expedition. The species was formally described as *Tetrao urophasianus* by C.L. Bonaparte (1827) and later placed in a monotypic genus *Centrocercus*, meaning "spiny-tailed pheasant," by Swainson and Richardson (1832). The species was later differentiated into two subspecies, the Western Sage-Grouse (*C. u. phaios*) and the Eastern Sage-Grouse (*C. u. urophasianus*) (Aldrich 1946, 1963; AOU 1957). However, similarities in appearance and morphological measurements have resulted in poorly defined ranges. The Western Sage-Grouse was considered to occur west of a contact zone traversing diagonally across southeast Oregon, northwest Nevada, and northeast California. The Eastern Sage-Grouse was said to occur east of this zone (Schroeder et al. 1999). Recent genetic work has indicated that differences between the two subspecies do exist (Oyler-McCance et al. 2001), but the difference is not sufficient to warrant a subspecies designation.

Additional DNA work has identified a small population in southwest Colorado with distinct genetic and behavioral characteristics. This population, referred to as the Gunnison Sage-Grouse, has been recognized by the American Ornithologists' Union as a new species of grouse, *Centrocercus minimus*. *Centrocercus urophasianus* is now referred to as the Greater Sage-Grouse, and this species is the focus of this strategy. Genetic testing has also identified a population of Sage-Grouse in Mono County, California and Lyon County, Nevada that may be genetically distinct (Oyler-McCance et al. 2001). The small sample size available for analysis has provided inconclusive evidence of this population being a subspecies, but there is sufficient evidence to warrant additional work.

Largest of the North American grouse, Sage-Grouse show strong sexual dimorphism. Males range from 27 to 34 inches in length and weigh five to seven pounds, while females are 18 to 24 inches in length and weigh from two to three pounds. They are a grayish-brown bird with a dark belly, and long, pointed tail feathers. The throat of the male is black, bordered with white at the rear. Two air sacs (esophageal pouches), covered with short, stiff, scale-like white feathers, are found on each side of the lower neck and upper breast. When the pouches are distended, two yellow, pear-shaped patches of bare skin (cervical apteria) are exposed. A yellow fleshy comb occurs above the eye, and long filoplumes arise from the back of the neck and head. The female has the same general appearance but lacks the air sacs and has a white throat. The feet are feathered to the toes on both sexes. Their dark belly and absence of white outer tail feathers distinguishes them from the sharp-tailed grouse during flight.

Sex ratios of male to female have been reported to range from 1:1.1 to 1:2.6 for adults (Braun 1984). Sex ratios are primarily based on information gathered from wing samples of harvested birds. Males have more conspicuous coloration than females and congregate for breeding display at the same locations for up to several months each year; therefore more adult males may be killed by predators than females, accounting for the disparity in the sex ratio. Sage-Grouse that reach adulthood are relative long-lived. However, the majority of young born in any given year will not reach the age of one. Birds that reach three or four years old are considered old birds (Wallestad 1975); however birds five years and older are not unusual (Rue 1973).

Sage-Grouse engage in a lek mating system. The males perform a strutting display (Bond 1900, Scott 1942, Gullion 1957, Schroeder et al. 1999) that includes fanning the tail feathers in an upright fashion that exposes white-tipped under tail feathers, expanding the esophageal pouches that expose the yellow skin patches, and erection of the yellow eye-combs and filoplumes. The expansion of the pouches also produces a series of "plops." These activities are accompanied by movements and postures directed at other males (Hjorth 1970, Wiley 1973a). The display is an active defense of the breeding territory by each male (Hartzler 1972). Only a few males on a lek or strutting ground do the majority of the mating (Gibson et al. 1991, Scott 1942, Lumsden 1968, Wiley 1973b, Hartzler and Jenni 1988). Mating is the only role males have in the mating system, having no incubation or parental care. Territorial behavior is not exhibited by males off the leks, and male flocks are not uncommon during the rest of the year (Beck 1977).

2.2.2 Distribution

Historically, Sage-Grouse were found throughout most of the western United States (**Figure 3**), including portions of 16 states, and along the southern border of three western Canadian provinces (AOU 1983, Aldrich 1963, Johnsgard 1973). Sage-Grouse distribution closely paralleled the range of sagebrush (*Artemisia* sp.) from British Columbia, Alberta and Saskatchewan in the north; western Nebraska and the Dakotas to the east; Nevada, Utah, New Mexico and Oklahoma to the south, and eastern Oregon, Washington, and California to the west (Patterson 1952, Aldrich 1963, Guiquet 1970, Johnsgard 1973).

Sage-Grouse currently range from southeastern Alberta and southern Saskatchewan to the north; western North and South Dakota to the east; Colorado, Utah, and Nevada to the south, and western California, eastern Oregon and Washington to the west (Johnsgard 1983, Drut 1994). The core of Sage-Grouse populations

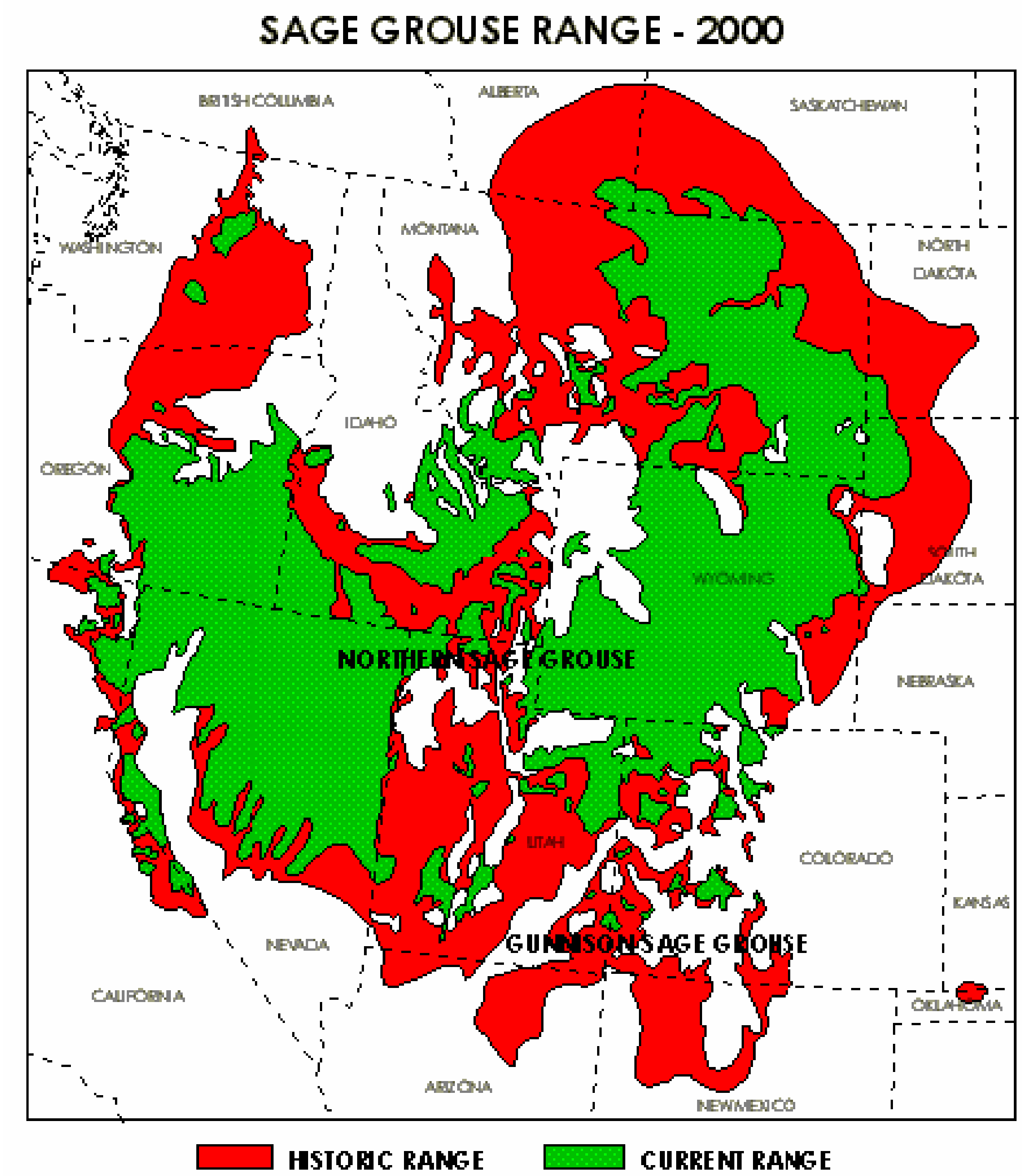

Figure 3. Historic and Current Distribution of Sage-Grouse in North America

After Schroeder (in press).

has contracted to include land in Colorado, Idaho, Montana, Nevada, Oregon, and Wyoming with remnant populations in other states (**Figure 3**). Even within this remaining core area of their range, populations have dramatically declined (Braun 1998, Wisdom et al. 1998). Sage-Grouse have been extirpated in British Columbia, Nebraska, New Mexico and Oklahoma (Braun

1991, 1993). Braun (1993) considered populations remaining in Alberta, North Dakota, Saskatchewan, South Dakota, California, Colorado, Utah and Washington to be "greatly reduced" or "marginal."

Within Nevada, Sage-Grouse are presently distributed from the approximate center of Nevada northward, with the northeastern block of counties providing the most continuous habitat (Nevada Division of Wildlife [NDOW] 2000). The distribution of historic and current leks within Elko County suggests that Sage-Grouse are found where sagebrush has dominated the landscape, historically or presently. Based on clusters of leks, known brood rearing areas, limited radio telemetry data, and professional judgment, ten Population Management Units (PMUs) were identified for Elko County (**Figure 4**). It is currently assumed that each PMU contains a Sage-Grouse population. However, until more information is available, the PMUs provide a basis for planning and plan implementation[2]. These boundaries should be considered temporary and subject to change as more is learned about Sage-Grouse distribution and movement patterns in the planning area.

Numbers of Sage-Grouse in Nevada and in Elko County are currently unknown; however, using a series of assumptions and numbers based on range wide population studies, the Sage-Grouse population for each of the ten PMUs within the planning area was estimated (**Table 1**). Based on these PMU estimates, the current estimate of Sage-Grouse within the planning area is between 37,600 and 45,100 birds. The assumptions and procedure for calculating each PMU estimate are provided in **Appendix B**
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[2] The management unit for this Strategy is the watershed; however, in deference to the Nevada State Sage Grouse Conservation Strategy, NNSG has incorporated the PMUs into the Elko County Sagebrush Ecosystem Conservation Strategy. Most of the sage grouse population and habitat data are presented herein by PMU, but will be presented in the individual watershed management plans on a watershed basis.

Figure 4 - Sage Grouse PMUs within the Elko County Planning Area

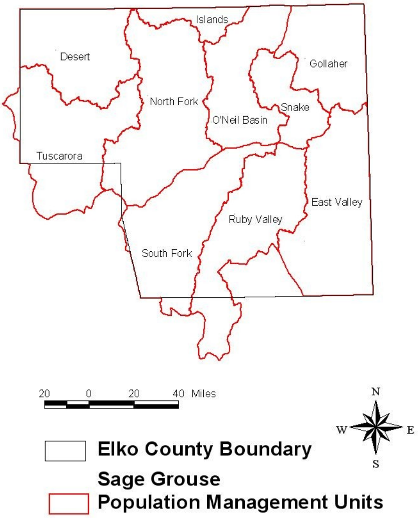
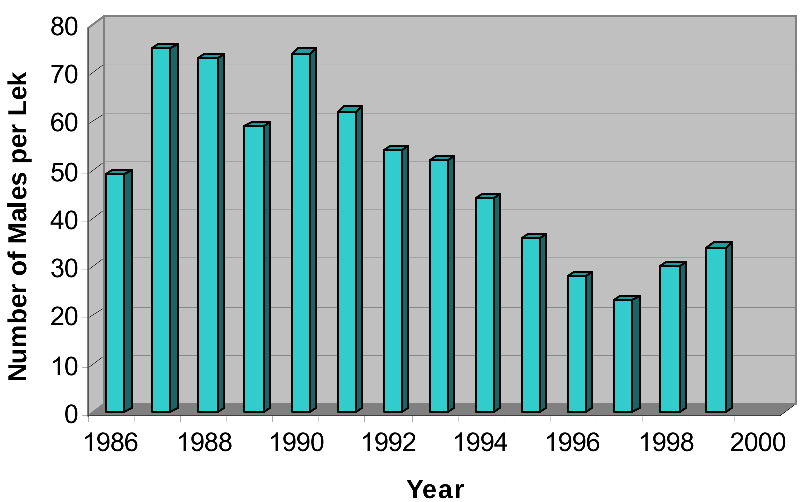


Table 1: Population Estimate for Each Population Management Unit (PMU) within the Planning Area

PMU Designation	Total Known Leks	Low-end Estimate	High-end Estimate
Desert	14	696	836
East Valley	8	398	477
Gollaher	104	5,172	6,207
Northfork	202	10,046	12,055
O'Neil	167	8,305	9,967
Ruby Valley	35	1,741	2,089
Snake	53	2,636	3,163
Southfork	46	2,288	2,745
Tuscarora	105	5,222	6,266
Islands	22	1,094	1,313
Totals	756	37,598	45,118

Trend counts, derived from counting the same limited number of leks each year, indicate that the number of Sage-Grouse in Elko County have been declining since the trend counts were initiated in 1986 (**Figure 5**).



Source: NDOW Region II Data

Figure 5. Elko County Sage-Grouse Strutting Ground Trend Counts, 1986 – 2000

2.2.3 Movements/Migration

Sage-Grouse populations can be non-migratory or migratory (Berry and Eng 1985, Connelly et al.1988, Wakkinen 1990, Fischer 1994, Beck 1975, Wallestad 1975), depending on location and associated land form. Non-migratory or "resident" populations may spend the entire year within an area 39 $mi.^2$ (10,000 ha) or less in size. Where topographic relief allows, Sage-Grouse will generally move up in elevation from spring through fall as snow melt occurs and plant growth advances (Savage 1968, Klebenow 1985). Movements between seasonal ranges vary because of differences associated with gender, behavior, seasonal habitat quality and distribution, and weather (Connelly et al. 1988).

Brood movement from nesting/brood areas to summer area may be a function of desiccation of forbs in brood areas, which causes movement to higher elevations with later plant phenology (Pyrah 1954, Crawford 1960, Gill and Glover 1965, Savage 1968, Wallestad 1971, Connelly et al. 1988, Wakkinen 1990, Fischer et al. 1966). Mid-summer movements are uncommon because the birds are molting (Dalke et al. 1963). Movements to fall/winter range correspond to increasing use of sagebrush as the major food item, and movements may be related to food quality (Beck 1977, Remington 1983, Barrington and Back 1984). Movements during winter are related to snow depths and food quality/availability (Bean 1941, Crawford 1960, Beck 1977, Autenrieth 1981, Barrington and Back 1984). Winter and nesting areas may be close to one another if autumn movements retrace summer movements (Connelly et al. 1994). Some birds may move to nesting areas in mid-winter if the weather is mild (Berry and Eng 1985, Schroeder et al. 1999).

In migratory populations, seasonal movements may exceed 47 mi. (75 km) (Dalke et al. 1963, Connelly et al. 1988) and home ranges may exceed 579 $mi.^2$ (150,000 ha) (Connelly unpub. data). There may be two or more seasonal ranges in such cases. For example, there may be a breeding range, a brood-rearing range, and a winter range, indicating that migratory Sage-Grouse populations depend on large expanses of habitat. The factors that initiate migratory movements may be the same factors that initiate seasonal movements in resident populations, especially considering that migratory populations and resident populations may share some seasonal habitats. Movements may be longer than necessary to locate acceptable habitat, suggesting site fidelity (Berry and Eng 1985, Connelly et al. 1988, Schroeder et al. 1999).

Radio telemetry data for Nevada, collected by NDOW, confirm that populations may be resident or migratory, and the movements and migration vary between and among populations. NDOW has found that migration occurs between leks, breeding areas, forage areas, and winter grounds. Some Sage-Grouse do not migrate, wintering on the breeding grounds; others migrate following the breeding season and spend summer and fall nearly 40 miles from the breeding area, returning to the breeding area to winter, while other populations separate and migrate up to twenty miles to two different wintering grounds.

2.2.4 Life History

The seasonal activities of Sage-Grouse and the use of sagebrush and other habitats are discussed below.

2.2.4.1 Breeding/Nesting

Each year, male Sage-Grouse congregate in late winter through spring to display their breeding plumage and to attract hens for mating. Generally, the lek sites are traditional, with the same lek sites used year after year (Scott 1942, Batterson and Morse 1948, Wiley 1978, Autenrieth 1981). Leks are generally small open areas from 0.2 to 12 acres in size, with either low or no sagebrush and surrounded by taller more dense sagebrush. The big sagebrush on the outskirts of the leks is necessary as a food source, for escape cover, for nesting females, and for loafing during the day (Patterson 1952, Gill 1965, Klebenow 1985). Examples of lek sites include landing strips, old lake beds or playas, low sagebrush flats, and openings on ridges, roads, crop land, and burned areas (Connelly et al. 1981, Gates 1985).

Males begin displaying in the early predawn hours, retire during the mid-morning, and sometimes return to leks from dusk until late into the night, displaying by moonlight (Simon 1940, Scott 1942, Batterson and Morse 1948). According to Connelly et al. (2000), Sage-Grouse appear to select breeding sites “opportunistically” within potential nesting habitat. Schroeder et al. (1999) state that there is no evidence that lek habitat is limiting for Sage-Grouse.

As 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 increases, new leks may be established, or old leks may be re-occupied. New leks may be established when natural or prescribed disturbances result in suitable lek habitat in Sage-Grouse range.

The lek is considered to be the center of year-round activity for resident Sage-Grouse populations (Eng and Schladweiler 1972, Wallestad and Pyrah 1974, Wallestad and Schladweiler 1974). However, habitats that are located long distances from the leks are used by migratory populations of Sage-Grouse and are essential to their survival (Connelly et al.1988, Wakkinen et al.1992). On the average, most nests are located within 4 miles (6.2 km) of the lek; however, some hens may nest more than 12 mi. (20 km) away from the lek (Autenrieth 1981, Wakkinen et al.1992, Fischer 1994, Hanf et al. 1994).

Females fly to the edge of the lek, and then walk through the lek, sometimes congregating with other females. Choice of when to mate seems to be solely a decision of the female, who indicates her readiness by crouching in front of the chosen male. After mating the female flies off to initiate a nest. Sage-Grouse males are polygynous; the only contribution made to reproduction is the mating act itself. All nest building, incubation and brood rearing is done by the female.

Nesting and early brood-rearing in Nevada generally occur from April through June. Habitats used by pre-laying hens are also part of the general breeding habitat. These areas provide forbs that are high in calcium, phosphorus, and protein, all of which are necessary for egg production.

The nest consists of a shallow depression on the ground, mostly under big sagebrush, with residual grasses or other vegetation for concealment of incubating hen (Terres 1991). Nest lining is sparse, consisting of dry grasses, sagebrush leaves and a few feathers (Batterson and Morse 1948, Autenrieth 1981). Heights of shrubs at nesting sites vary, but studies indicate that there is some preference for shrubs that are taller than the average shrub height for the given site (Keller et al. 1941, Trueblood 1954, Klebenow 1969, Wallestad and Pyrah 1974, Autenrieth 1981, Kerster and Willis 1986). Reported shrub height at nest sites range from 9 inches to 39 inches (Patterson 1952, Klebenow 1969, Autenrieth 1981, Gregg et al. 1994, Sveum et al. 1998a, Schroeder et al. 1999). Autenrieth (1981) found that a “bush providing an umbrella effect” was preferred.

Nesting habitat is characterized by primarily Wyoming big sagebrush communities that have 15 to 38 percent canopy cover and a grass and forb understory (Connelly et al. 1991, Gregg et al. 1994, Sveum et al. 1998a). Residual cover of grasses is also important (Klebenow 1969, Connelly et al. 1991, Gregg 1991, Gregg et al. 1994, Sveum et al. 1998a), ranging from 3 percent to 30 percent cover at successful nest sites. The importance of the residual cover may be relative to the structure of the shrub cover. Where the “umbrella effect” is sufficient, residual herbaceous cover may not add much protection to the nest in terms of detection by predators. However, Autenrieth (1981) found that nest sites with greater understory cover had a warmer microclimate than the ambient air temperature one meter above the nest, and that nest temperature dropped less at sites with greater understory than sites with less understory during periods when the hen was off the nest.

Winward (1991) found that herbaceous cover associated with potential nest sites, and Sage-Grouse habitat in general, could be limited by excessive shrub canopy cover. When shrub canopy cover exceeded 10 to 12 percent in the Wyoming big sagebrush vegetation type, and approximately 15 percent in basin and mountain big sagebrush vegetation types, grass and forb cover needed for Sage-Grouse cover and forage could decrease due to competition with shrubs. Therefore, maintenance of adequate nesting habitat is a function of shrub canopy cover.

Although the guidelines for maintenance of Sage-Grouse habitat (Braun et al. 1977) recommended no sagebrush control within two miles (three kilometers) of a lek to protect nesting and brood areas, several studies have demonstrated that hens will nest at considerable distance from the lek (Peterson 1980, Autenrieth 1981, Fischer 1994). Wakkinen et al. (1992) concluded that nest sites were selected independent of lek location, and Autenrieth (1981) concluded that nest locations were related to quality of nesting cover.

Clutch size (number of eggs in one nest) of Sage-Grouse is variable and relatively low as compared to other species of game birds (Edminster 1954, Schroeder 1997). Clutch size per nest normally ranges from seven to ten eggs

(Connelly unpublished data, Schroeder 1997, Wakkinen 1990). These differences may be related to habitat quality and overall condition of pre-laying females (Coggins 1998). Sage-Grouse eggs have olive or olive buff shells, marked with brown spots and dots. (Harrison 1978). Eggs are laid three to 14 days after copulation at a rate of two eggs every three days (Peterson 1980). Incubation by the female takes 25-28 days, and is initiated within two days after the last egg has been laid (Peterson 1980). During incubation the hen will leave the nest for up to approximately a half-hour, twice a day to feed and loaf (Autenrieth 1981). These recesses from incubation generally occurred during early morning and evening. Recesses during mid-morning or mid-afternoon are less common, and may be related to hen condition.

Nesting rates vary from year to year and from area to area (Schroeder 1997, Connelly et al. 1993, Gregg 1991, Bergerud 1988a, Coggins 1998). This variation is most likely a result of available quality forage (nutritional level) and the general health of pre-laying females (Barnett and Crawford 1994). At least 70 percent of the females in a population will initiate a nest each year. Higher nest initiation rates were recorded during years of higher precipitation as compared to nest initiation rates during periods of drought (Coggins 1998). Renesting rates by females who have lost their first clutch are 10 to 40 percent; far lower than that of other upland game birds (Connelly et al. 1993, Patterson 1952, Eng 1963, Petersen 1980, Bergerud 1988a). Renesting may do little to increase overall population numbers. Nest success of Sage-Grouse also varies by area and year. Of all the birds that nest, 10 to 86 percent produce chicks (Trueblood 1954, Gregg 1991, Connelly et al. 1993, Schroeder 1997). Adult females may experience higher success rates than yearling females (Wallestad and Pyrah 1974), a characteristic that may be related to past nesting experience. Sage-Grouse show a strong nest site fidelity and return to nest in the same area each year (Kerster and Willis 1986).

2.2.4.2 Brood Rearing

The entire clutch may hatch within one hour (Wallestad 1971). Young are precocial and can be led away from the nest as soon as the natal down is dry. Chicks weigh approximately one ounce (30 to 31 grams) at hatching (Peterson 1980), but gain weight quickly. Chicks begin feeding immediately after hatching. The hen broods the chicks during approximately 50 percent of the daylight hours during the first week after hatching, but rarely broods the chicks by the second week after hatching (Schroeder et al. 1999).

Early brood-rearing generally occurs close to nest sites; however, movements of individual broods may be highly variable (Connelly 1982, Gates 1985). When considered on a range-wide basis, optimum brood-rearing habitat consists of sagebrush stands that are 16 to 32 inches tall with a canopy cover of 10 percent to 25 percent and an herbaceous understory of 15 percent grass canopy and 10 percent forb canopy (this is consistent with nesting habitat). Ideally, this type of habitat will be found on at least 40 percent of the area that is considered brood-rearing habitat (Connelly et al. 2000). Hens with broods will use sagebrush habitats that have less canopy cover (about 14 percent) than that provided in optimum nesting habitat (Martin 1970, Wallestad 1971), but need at least 15 percent cover of grasses and forbs (Sveum et al. 1998b). Optimum canopy cover within brood-rearing habitat is specific to each vegetation type and range-site potential. The habitats used during the first few weeks after hatching need to provide cover to conceal the chicks, but more importantly, to provide the nutritional requirements of this period of rapid development. Brood-rearing habitats that have a wide variety of plant species tend to provide a corresponding variety of insects that are important chick foods.

Chicks are able to fly weakly at approximately 10 days, and are relatively strong fliers by five weeks (Girard 1937). At six to eight weeks, chicks acquire full juvenile plumage and resemble adult hens. When chicks are about six weeks of age, Sage-Grouse hens will usually move the chicks from the early brood habitat/nest area to summer habitat, where the majority of brood rearing occurs. This movement occurs about two weeks after males and females without broods have moved to summer range (Connelly et al. 1988).

Summer habitat consists of sagebrush mixed with areas of wet meadows, riparian, or irrigated agricultural fields (Connelly et al. 2000). Sage-Grouse broods occupy a variety of habitats throughout the summer including sagebrush, wet meadows, farmland, and other irrigated areas adjacent to sage brush. As stated above, Sage-Grouse chicks rely on insects early in their lives and gradually change over to succulent forbs and shrub foliage as they mature (Patterson 1952, Klebenow and Gray 1968, Wallestad 1971, Klebenow 1985). In general, a sagebrush ecosystem with a good understory of grasses and forbs, and associated wet meadow areas, are essential for optimum habitat.

As upland habitats begin to dry up Sage-Grouse broods move to more mesic wet meadows, where succulent grasses and insects are still available (Savage 1968, Schlatterer and Pyrah 1970, Oakleaf 1971, Neel 1980, Autenrieth 1981, Klebenow 1985, McAdoo et al. 1986). This can be especially important in drier years and during long drought periods. Klebenow (1982) found that Sage-Grouse would stay on the uplands through late July in years when precipitation was sufficient to maintain forage. During drought years, grouse switched to using meadows earlier in the summer. In addition, Nevada Sage-Grouse have a greater reliance on wet areas for their survival because Nevada normally receives less precipitation than other states supporting Sage-Grouse (Klebenow 1985).

2.2.4.3 Fall and Winter

Sage-Grouse form flocks as brood groups break up in early fall. As the meadows dry and frost leads to the drying and killing of forbs, the Sage-Grouse diet shifts primarily to sagebrush leaves (Patterson 1952, Connelly and Markham 1983, Connelly et al. 1988, Wallestad 1975). As fall progresses toward winter, Sage-Grouse move toward their winter ranges. Exact timing of this movement varies depending on the Sage-Grouse population, geographic area, overall weather conditions, and snow depth. Sagebrush is essential for survival during the fall, winter, and early spring months.

Fall habitat in northeastern Nevada consists of mosaics of low-growing sagebrush (*A. arbuscula, A. nova*) and Wyoming big sagebrush (*A. t. wyomingensis*). As with the other seasons of the year, a mosaic of sagebrush vegetation (different species, different cover values, different height classes, etc.) provides the necessary food and cover requirements during the fall period. Studies on the Saval Project (Barrington and Back 1984) found that low sage was the preferred foraging and night roosting habitat during the fall. Sage-Grouse roosted in the big sagebrush types during the day, or during nights when winds were strong or the weather consisted of rain or snow.

Seasonal movements are related to severity of winter weather, topography, and vegetative cover (Beck 1977). Sagebrush canopy at Sage-Grouse winter use sites can be highly variable (Patterson 1952, Eng and Schladweiler 1972, Wallestad et al. 1975, Beck 1977, Robertson 1991). However, Sage-Grouse habitats must provide adequate amounts of sagebrush because their winter diet consists almost exclusively of sagebrush. It is crucial that sagebrush be exposed at least 10 to 12 inches above snow level as this provides both food and cover for wintering Sage-Grouse (Barrington and Back 1984, Hupp and Braun 1989). Wallestad (1975) found that in Montana less than 10 percent of the range was available when snow depth exceeded 12 inches. If snow covers the sagebrush, the birds will move to areas where sagebrush is exposed.

Winter use areas are determined by the amount of snow, rather than an affinity for a particular site (Beck 1977, Barrington and Back 1984). Low sagebrush was used as long as available in northeastern Nevada (Barrington and Back 1984) and Idaho (Crawford 1960), with birds moving to big sagebrush sites as snow depths increased.

2.2.4.4 Year Long Habitat

From the preceding discussion it is evident that although Sage-Grouse are sagebrush obligates, they use a variety of habitats. Sagebrush habitats vary from low growing to taller sagebrush species, and from plant communities with sparse sagebrush cover to those with relatively high shrub cover. The amount of herbaceous cover also varies between seasonal habitats. There are also important seasonal habitats that do not have a sagebrush component (e.g., riparian meadows), but generally have sagebrush nearby. Sage-Grouse have also been observed in or near aspen stands and other areas with trees or very tall shrubs; however, these habitats are not used with any consistency, and they may be areas of high predation. The spatial arrangement of the habitats is also important. Leks generally have taller sagebrush cover nearby, and leks and nesting habitat generally need to be in close proximity (although instances of leks being separated from nesting habitat by long distances have been documented). Early brood habitat and nesting habitat should also be in close proximity to one another. Meadows need nearby sagebrush cover to provide the escape cover and loafing cover during summer. The variety of height and cover classes of sagebrush used for winter should also be intermixed.

Therefore, Sage-Grouse habitat, when considered over the period of a year, consists of a variety of habitats or habitat conditions. A mosaic of these habitat types or conditions must be available on the landscape to provide all of the Sage-Grouse seasonal cover and nutritional needs. The mere presence of sagebrush alone, especially uniform stands over vast acreages, should not be considered quality Sage-Grouse habitat. These stands may provide some seasonal habitat, but cannot provide all the habitat needs throughout the year.

2.2.5 Food Habits

Sage-Grouse is the only North American grouse species that does not have a muscular grinding gizzard. The Sage-Grouse gizzard is the non-muscular portion of the stomach that secretes mucous, but is incapable of macerating the food. Therefore, food sources are limited to insects and soft plant parts. As discussed below, this is an adaptation for winter survival while feeding on sagebrush.

Chick diets include forbs and invertebrates (Klebenow and Gray 1968, Drut et al. 1994). Insects are an important component of early brood-rearing habitat (Drut et al. 1994, Fischer et al.1996a). Insects, primarily beetles and some ants, comprised over 50 percent of total diet the first week after hatching (Klebenow 1969). Savage (1968) reported that ants were a frequent food item, observing Sage-Grouse feeding directly at the ant hill. Autenrieth (1981) found insect availability to be critical in the first three weeks after hatching. Johnson and Boyce (1990) determined through feeding trials that Sage-Grouse chicks require 15 grams of insects per day to maintain one to three-week old chicks in healthy condition. Chicks greater than three weeks old survived without insects in the diet, but growth rates were significantly reduced. Insects occurring in juvenile Sage-Grouse diets include beetles (Order Coleoptera; Families Scarabeidae, Chrysomelidae, Tenebrionidae, Carabidae, Coccinellidae), ants (Order Hymenoptera; Family Formicidae), grasshoppers (Order Orthoptera; Family Locustidae), weevils (Order Coleoptera; Family Curculionidae), and lace bugs (Order Hemiptera; Family Tingidae) (Rasmussen and Griner, 1938, Klebenow and Gray 1968, Peterson 1970). Proportion of each insect in the diet varied with age of the chicks, and may be reflective of the habitats used and the life stages of the insects.

Forbs increase in the diet after the first week and remain the major food item for juveniles throughout the summer. Some of the forbs found in quantity in the diets of juvenile Sage-Grouse include common dandelion (*Taraxacum officinale*), common salsify (*Tragopogon dubius*), prickly lettuce (*Lactuca serriola*), pepperweed (*Lepidium densiflorum*), Harkness gilia (*Linanthus harknessii*), tapertip hawksbeard (*Crepis acuminata*), loco (*Astragalus convallarius*), phlox (*Phlox longifolia*), and common yarrow (*Achillea millifolum*) (Klebenow and Gray 1968, Peterson 1970). Sagebrush (*Artemisia* sp.) occurs in only trace amounts until chicks are about five weeks old (Klebenow and Gray 1968, Klebenow 1969, Peterson 1970).

The proportion of insects and plant material in the chick diet are indirectly proportional to each other. Insects make up the greatest proportion of the young chick diet and the percentage of insects declines as the percentage of plant material increases (Stiver personal communication). Plant use parallels the phenology of a given species (Klebenow and Gray 1968). As plants desiccate, Sage-Grouse cease to feed on them.

Summer food habits of adult grouse are similar to juvenile food habits, with some differences in proportion of foods eaten. Plant material comprises a larger proportion of the adult diet in early and mid-summer and insects make up less of the adult diet during these periods. However, the actual food items (i.e., species of plant or insect) taken by adults overlaps considerably with juveniles (Rasmussen and Griner, 1938, Wallestad et al. 1975). Alfalfa (*Medicago sativa*) and sweet clover (*Melilotus* sp.) are eaten by Sage-Grouse (Batterson and Morse 1948, Autenrieth 1981, Peterson 1970), but these species may be taken incidental to dandelion, salsify, prickly lettuce, and insects (Batterson and Morse 1948, Peterson 1970).

The use of sagebrush increases in late summer and continues to be the major food item until spring (Girard 1937, Rasmussen and Griner 1938, Patterson 1952, Leach and Hensley 1954, Klebenow and Gray 1968, Peterson 1970, Wallestad et al. 1975). Several species of sagebrush are used by Sage-Grouse including Wyoming big sagebrush (*Artemisia tridentata wyomingensis*), mountain big sagebrush (*A.t. vaseyana*), low sagebrush (*A. arbuscula longiloba*), black sagebrush (*A. arbuscula nova*), fringed sagebrush (*A. frigida*), and silver sagebrush (*A. cana*).

2.3 Sage-Grouse Ecology

Sage-Grouse are considered a sagebrush ecosystem obligate species. Obligate species are those species which are restricted to certain habitats or to limited conditions during one or more seasons of the year to fulfill their life requirements. Sage-Grouse are only found where species of sagebrush exist and they feed on sagebrush exclusively during an extended period of the year. Sagebrush species provide nesting, brood, and fall/winter cover as well as forage throughout the year. Ecology of a species is based in part on the plant-animal relationships, and provides an understanding of why the animal species uses various habitats throughout the day or year. In the preceding sections the biology of the species was presented – what habitats are used, what foods are used, and what seasonal movements the birds undertake. In the following sections, the plant-animal and animal-animal (predator-prey) relationships are discussed, to provide an understanding of why the various habitats and foods are used; and therefore, why some of the seasonal movements occur.

2.3.1 Forage Quality

The dependence of Sage-Grouse on sagebrush for food and cover has long been known (Patterson 1952). But only recently has the question of quality of forage been raised (Remington and Braun 1985). Optimal foraging theory predicts that animals forage in a way that maximizes their assimilation of energy and/or nutrients per unit time or per unit of energy expended (Schoener 1971). Because nitrogen is basic to most metabolic processes, cellular structure, and genetic coding, as well as a critical element in growth of all organisms (Mattson 1980), nitrogen assimilation, especially prior to and during reproduction, should contribute to forage selection.

However, plants contain compounds that make them less palatable or even toxic to animals, or may affect the digestibility of the plant tissue. Plant compounds may affect either herbivore fitness (increased mortality or lowered growth rate or fecundity) or herbivore foraging activities (Rhoades and Cates 1976). These effects appear to be achieved by two actions. The chemical compounds may act as digestibility-reducing agents. In this role they may form relatively indigestible complexes with plant proteins that reduce the rate of assimilation of dietary nitrogen, inhibit microbial digestive enzymes, and inhibit microbial activity in ruminants. Or, the compounds may act as toxins and act upon metabolic processes that are topologically internal to the herbivore. Since both effects and both types of chemical actions can impact herbivore inclusive fitness, plant defenses need to be considered in optimal foraging studies (Rhoades and Cates 1976).

Plants typical of resource limited habitats (e.g., sagebrush in arid rangelands) generally have a low maximum potential growth rate. These plants also have a low nutrient absorption capacity that limits their ability to acquire mineral nutrients, and have a low photosynthetic rate that limits their ability to acquire carbon. The limited ability of these species to absorb nutrients from the soil and to fix carbon reduces their ability to acquire the resources for regrowth after herbivory as the availability of resources in the environment declines (i.e., as soil moisture decreases during the growing season).

Availability of resources in the environment can be affected by competition. The lack of sagebrush growth or production in decadent stands is likely the result of competition for nutrients. The effect of insufficient mineral nutrition in older plants that have carbohydrate reserves is to reduce growth more than photosynthesis. This results in an accumulation of carbohydrate reserves; and therefore, more carbon is available for production of carbon-based chemical compounds.

The dominant plant types in most arid and semi-arid habitats of North America are woody perennials, and the principal anti-herbivore compounds in the dominant woody perennials are the terpenoids and phenols. This is consistent with the resource availability theory briefly outlined above (i.e., dominant plants in arid habitats will be slow growing because of nutrient and moisture deficiencies, and will accumulate carbon-based metabolites, such as terpenoids). Sagebrush, juniper, and rabbitbrush all contain large quantities of terpenoids. Terpenoids are mainly cyclic unsaturated hydrocarbons with varying degrees of oxygenated substituent groups attached to the basic carbon ring. The number of five carbon units determines the class of terpenoid (e.g., monoterpenoids, diterpenoids, etc.), and the oxygenated substituent group determines the specific compound (e.g., one of the many monoterpenes is camphor).

Monoterpenes have been identified as digestibility-reducing agents for deer (Nagy et al. 1964, Nagy and Tengerdy 1967, Oh et al. 1967, 1968, 1970, Radwan and Crouch 1974, Schwartz et al. 1980) sheep (Oh et al. 1967), and cattle (Eller 1971). These chemicals have also been linked to Sage-Grouse forage preferences (Remington 1983, Barrington and Back 1984, Welch et al. 1991). These compounds are part of the group of compounds referred to as volatile oils and are found in highest concentrations in the leaf epidermal cells. The specific role of monoterpenes in the sagebrush energy budget and physiological processes is not completely known. However, the monoterpenes do appear to be part of the primary metabolic pathways. As such, they would be expected to have a primary function to the plant and be produced during the growing season. They have been suggested as storage compounds for the plant (Loomis and Croteau 1973) that can be hydrolyzed and translocated to other parts of the plant as needed (Rhoades 1979). Monoterpenes and other volatile oils may be used during winter to allow sagebrush to carry on photosynthesis during periods when the ground is frozen and nutrients are otherwise unavailable. Upon hydrolysis, they can provide the plant with nitrogen, carbon, and other elements.

Other plants use other means to store essential nutrients rather than as complex compounds like monoterpenes. However, a compound that also has defensive capabilities and can make the plant less likely to be selected by herbivores, would be more likely to evolve than a compound without defensive properties. If the compounds have defensive properties, the defensive role would be expected to vary during the various life stages of the plant in proportion to the amount of nutrients or energy required by the plant during these other life stages. Therefore, the level of activity of the metabolic pathway(s) that produces monoterpenes may be determined by the physiological state of the plant. This would result in variable concentrations of monoterpenes in the plant over time. Such a scenario would present herbivores with forage quality options, and we can make hypotheses regarding when a plant should be selected as forage and when it should be avoided.

As juvenile plants grow and increase in size and complexity, physiological aging occurs. This manifests itself when the rate of root growth falls below the rate of shoot growth, resulting in nutritional demands of the shoots exceeding the absorption capacity of the roots. At this stage of growth and/or aging, the growing points of the crown (apical and lateral buds) begin to compete for nutrients, and the growth of the internodes and leaves becomes progressively more nutrient limited than carbon limited. The changes in carbon/nutrient balance are then favorable for increased production of fiber (e.g., lignin) and carbon-based defensive compounds (e.g., monoterpenes). The result is that leaves of physiologically-aged plants are small, have a low nitrogen concentration, more cell wall (lignin), and are rich in carbon-based compounds in comparison to leaves of less physiologically-aged plants. As such, the physiologically-aged plants are lower quality forage than their counterparts.

It is important to note that physiological aging is not necessarily a function of time. It differs from maturity in one important respect. Whereas maturity (age at which the plant can reproduce) is under genetic control, physiological aging is a phenotypic response to an internal nutrient stress resulting from external conditions acting on normal growth processes. Or more simply stated, a mature plant can have the characteristics of an old plant if the mature plant is subject to nutrient stress. Conversely, an old plant can have the characteristics of a mature (younger) plant if nutrients are not limiting. More importantly for Sage-Grouse, this means that forage quality can be managed.

A physiologically-aged (i.e., stressed) plant is not likely to have the energy or nutrients available for developing reproductive parts (e.g., flowers and seeds). Seeds generally have high nitrogen levels. Therefore, a plant that exhibits a high level of reproductive parts should have a carbon/nutrient balance that favors decreased production of carbon-based defensive compounds (i.e., will have lower volatile oil content). Decadent stands of sagebrush that produce little, if any, seed would have a carbon/nutrient balance that favors increased production of carbon-based compounds (i.e., will have higher volatile oil content). Consequently, the external appearance of the plant (i.e., presence or absence of reproductive parts) should be an indicator of the internal physiological state of the plant (i.e., level of carbon-based compounds).

2.3.2 Adaptations to the Sagebrush Ecosystem

The preceding discussion indicated that sagebrush habitats provide Sage-Grouse with foraging choices that can improve their fitness. However, even in stands of sagebrush with the low levels of digestibility-reducing compounds, these compounds are still present and Sage-Grouse must neutralize their effect. The following discussion reviews the behavioral, physical, and physiological adaptations that Sage-Grouse use to exploit the sagebrush ecosystem. These adaptations, when considered together, allow Sage-Grouse to not only survive the relatively cold winters, but also to prepare for the breeding season by increasing their energy reserves prior to breeding and egg laying. The significance of these adaptations to an ecosystem that is considered to be of relatively poor quality and low productivity should not be underestimated.

Behaviorally, Sage-Grouse demonstrate the ability to select plants of different forage quality. Wyoming big sage was preferred over other species of sagebrush in Colorado (Remington 1983), low sage (*Artemisia arbuscula or nova*) was selected in Idaho (Crawford 1960, Dalke et al. 1963), and early sagebrush (*A. arbuscula ssp. longiloba*) was preferred in northeastern Nevada during the fall and early winter, until snow depths precluded the availability of this low growing species (Barrington and Back 1984).

Selection of individual plants of a given species has been demonstrated (Back et al. 1987, Welch et al. 1988, Welch et al. 1991). Remington (1983) found that selection of individual plants within a species at feeding sites results in a higher quality diet (i.e., higher protein content and lower oxygenated monoterpene content). The use of more vigorous plants growing on recently disturbed sites (road edges, mima mounds, mixed species seeding) has also been observed (Remington 1983, Back et al. 1984), and that these plants had higher protein content than sagebrush in monotypic stands of tall sagebrush (Remington 1983). Beck (1977) noted that quality of sagebrush (chemical composition) may determine why Sage-Grouse used some sites and did not use other sites with similar vegetative characteristics.

While some animals have the ability to reduce the volatile oil content of their forage through masticating (chewing), where the oils volatilize and escape to the atmosphere, or through eructation (belching), where gases are released before entering the rumen, Sage-Grouse do not have these capabilities. Their gross intake of terpenoids as a percentage of their diet is greater than that for any other vertebrate (Remington 1983). However, rather than releasing the terpenoids, Sage-Grouse have several adaptations to avoid exposure to the terpenoids. Sage-Grouse are the only grouse species that does not have a muscular gizzard (the second compartment of the stomach). The non-muscular gizzard stores the food and secretes mucous that softens the food. This physical adaptation enhances the ability of Sage-Grouse to digest sagebrush, but also precludes the use of hard foods (e.g., seeds, twigs, buds, dried berries) in winter. This is probably the single most important reason why Sage-Grouse are sagebrush obligate species. The green leaves of sagebrush are perhaps the only soft food available to Sage-Grouse during the winter months.

This physical adaptation is also related to the behavioral adaptation, or feeding habit, of Sage-Grouse. Foraging consists of cutting the leaf, rather than plucking the entire leaf (Back, unpublished data). If the leaves were plucked, then grinding in the gizzard would be required to break down the outer cell walls of the leaf to allow the leaf contents to be digested. This would release the terpenoids within the digestive tract, which could then enter the caecum, decreasing the microbial activity and reducing the ability of Sage-Grouse to extract the nutritional components of the sagebrush leaves. However, the exposed edge of a cut leaf provides a point of entry for digestive fluids to enter the leaf and digest the soft-walled interior cells, leaving the outer cells with high lignin content intact. The outer cells are the storage sites for the terpenoids found in sagebrush. The intact leaves are unable to enter the caecum because of their large size relative to the caecal orifice (Fenna and Boag 1974). The caecum is where complex carbohydrates are broken down. Bypassing the caecum prevents breakdown of the lignin in the out leaf cells and the monoterpenes remain in the leaf. The “empty shell” of the leaf is then excreted in fecal droppings. High levels of terpenoids were found in Sage-Grouse fecal droppings (Barber et al. 1969), and low levels of volatile oils were found in the caecal contents (Barber 1968, Barber et al. 1969), indicating that most of the volatile oils that pass through the Sage-Grouse digestive system remain in the leaf tissue.

Another behavioral adaptation to the sagebrush ecosystem is the ability to conserve energy. Sage-Grouse have been observed using snow burrows (Back et al. 1987). Snow burrows provide a warmer microenvironment than the surrounding ambient air temperatures. Gullion (1970) found that temperatures under eight inches of soft snow were between 10^{o} F and 27^{o} F when ambient air temperature was as low as -31^{o} F. For an activity to contribute to energy saving, it must help maintain the body temperature above the lower critical temperature (LCT). This is the temperature below which a resting animal must increase its metabolic rate to meet the environmental demands for heat. The LCT for Sage-Grouse has not been determined. However, the LCT for captive ruffed grouse ranged from a mean of 21^{o} F in February to 33^{o} F in March (Rasmussen and Brander 1973). If the Sage-Grouse LCT is similar to the LCT for ruffed grouse, then it is common for Sage-Grouse to be exposed to winter ambient air temperatures below the LCT throughout the much of their occupied range. In northeastern Nevada, snow burrowing was an effective energy conservation behavior for more than 50 percent of the nights between mid-November and mid-March of 1983-84 and 1984-85 (Back et al. 1987). Snow burrowing during this period was observed when temperatures were less than 14^{o} F in all but one instance (83 observations). Sage-Grouse will travel considerable distance to find suitable snow burrowing sites. In northeastern Nevada, Sage-Grouse were observed leaving evening foraging sites at dusk and flying up to six miles distance and up to 2,000 feet in elevation to night roosting sites (Back, unpublished data). These sites consisted of deep, powder snow in which the birds would burrow.

2.3.3 Winter/Spring Nutrition and Reproductive Success

Remington (1983) found that winter energy reserves of fasting adult females and adult males were from three to four and a half days, and four to six days, respectively. While winter conditions are not likely to result in the need for Sage-Grouse to fast for this period of time, breeding activities reduce the time available for feeding and these reserves reach maximum levels just prior to breeding. The importance of the snow burrowing behavior is underscored by the fact that Sage-Grouse gain weight between January and March (Beck and Braun 1978). This indicates that the energy reserves are important for breeding and nesting activities. The breeding display conducted by males creates high energy demands and females spend little time feeding during incubation; both sexes lose weight during this time period (Beck and Braun 1978). Breeding and egg laying/incubation are the most significant activities conducted by Sage-Grouse, and any behavior that increases the ability to be successful in these activities is inherently important to the population. Dry, cold winters may be more stressful to Sage-Grouse because conditions for snow burrowing are not available and energy conservation would be limited.

Studies of red grouse (in Scotland) and ruffed grouse diets in relation to reproduction indicate that high quality diets result in greater production (Moss et al. 1974, 1975, Beckerton and Middleton 1982). The pre-laying period for females may also be critical to Sage-Grouse populations. The nutritional and energy reserves gained in winter from a diet of sagebrush peak just prior to breeding (Beck and Braun 1978). As spring forbs begin to appear, females shift their diet to include forbs, and availability of forbs with high nutritional value appear to influence the productivity of Sage-Grouse hens (Barnett 1993, Barnett and Crawford 1994). The hen must consume a diet with sufficient amounts of the essential amino acids, vitamins, and mineral to produce an egg, and to supply that egg with all of the nutrients needed by the egg throughout the incubation period. For optimum survival and early growth of the chicks, the hen must also provide a yolk with sufficient reserves for the newly hatched chick (Scott 1972).

Two other points are essential to understanding the relationship between diet, egg production, egg quality, and quantity of eggs. First, to produce an egg, the female must have a dependable supply of total protein and essential amino acids to produce the follicle or yolk in the ovary and to secrete the albumen (egg-white) portion of the egg during passage of the yolk down the oviduct. Although there is some ability of an under-nourished female to borrow some of these requirements from her own tissue, the number of eggs produced will be less and the size of the eggs will be smaller under these conditions (Scott 1972). Secondly, the egg has an exact amino acid composition. If only one essential amino acid is lacking in the diet or cannot be obtained from the female's own tissue, no egg can be produced (Scott 1972).

Thus, it appears that winter diet contributes to the energy reserves that are needed to maintain a female during egg-laying and incubation, while the early spring diet of forbs contributes to egg quality and quantity. The interaction of these two periods of differing nutritional diets is not known; however, the quality of an egg may be of little consequence if the hen does not have the energy reserves to maintain long incubation bouts. Conversely, a high level of incubation of low quality eggs may result in high hatching success, but low chick survival. Therefore, winter-spring nutrition should be considered as a continuum of the breeding cycle, rather than two separate processes with separate underlying ecological outcomes (i.e., winter survival and breeding success).

This link extends beyond the nesting season. The nutritional requirements for egg production in birds are very similar to the requirements of young birds for survival and optimum growth from hatching to approximately three to six weeks (Scott 1972). As discussed above, the habitats used by female Sage-Grouse prior to egg production, during incubation, and for early brood rearing are often the same habitat. The open sagebrush with abundant herbaceous vegetation provides the nutritional needs of the hen, cover requirements for the nest, and nutritional needs of the newly hatched chicks.

The transition between rapid growth of chicks and slow growth/maintenance of juveniles coincides with a change in diet and habitat use. During the first six weeks after hatching, the chicks grow very rapidly. The diet consists of foods high in protein and minerals (especially calcium). The variety of amino acids, minerals, and levels of vitamins required by chicks declines as they grow older (Scott 1972). However, as the chicks grow larger, more food is used for maintenance and less is used for growth. During this period, the quantity of insects in the chick diet declines. This coincides with movement to summer brood habitat where forbs remain available, especially on wet meadows. The use of sagebrush as a food item for juveniles begins to increase as summer ends. When the birds mature, the nutritional needs are for maintenance only, until the bird enters the breeding cycle (late winter). The level of insects and forbs in the adult diet remains relatively high during the summer as the adults replace feathers during the annual molt. When the molt nears completion, the adult maintenance diet is reflected by the proportion of sagebrush in the diet.

The habitats used by Sage-Grouse throughout the year for foraging are a function of their differing nutritional needs and a function of where those needs can be obtained in a changing environment. The habitats used by Sage-Grouse throughout the year for cover are a function of energy demands, predation pressure, and proximity to quality forage.

2.3.4 Predation Ecology

Predation is one[3] of the various animal-animal relationships that determine habitat selection and survival. Predation is discussed here because of the public concern regarding this process and to underscore the link between predation and habitat.

In terms of ecosystem energy pathways, prey species function to transform and concentrate

[3] Competition, between members of the same species (intraspecific competition) and among different species (interspecific competition), is also a factor in determining habitat selection and survival. Other animal-animal relationships include symbiosis and parasitism.

energy from plant or animal sources into tissue of sufficient volume to make an efficient transfer of that energy to the next trophic level (i.e., little fish are eaten by big fish). Therefore, predation is part of the ecology of every animal species, and it is the fate of every Sage-Grouse embryo produced to be eaten during some stage of the life cycle. In contrast, it is the goal of each embryo to survive long enough to breed. For most prey species, very few of the young survive to breed; mortality is greatest during the early stages of development and decreases after young reach adult size or breeding age. This pattern applies to Sage-Grouse.

Population increases occur when more young survive to adulthood (i.e., increased recruitment to the population), or when adult mortality declines (i.e., increased survival), or when both occur. Population declines occur when the number of young surviving to adulthood (i.e., recruitment) is less than the number of adults lost from the population (i.e., adult mortality). The factors that can influence these processes are numerous and their interrelationships are complex.

Any factor that detracts from the health of the individual Sage-Grouse, interferes with the ability of an individual Sage-Grouse to detect predators, decreases the ability of Sage-Grouse to avoid detection by predators, or concentrates Sage-Grouse into limited habitat areas, will decrease the probability that an individual Sage-Grouse will survive. Conversely, any factor that contributes to the health of an individual Sage-Grouse, increases the ability of an individual Sage-Grouse to detect predators, increases the ability of Sage-Grouse to avoid detection by predators, or results in Sage-Grouse being distributed in space and time, will increase the probability that an individual Sage-Grouse will survive. The relative number of predators to the number of Sage-Grouse, and to abundance of other prey species, also influences the probability that a predator will encounter individual prey species. Many of the factors that contribute to Sage-Grouse health, ability of Sage-Grouse to detect predators, ability of Sage-Grouse to avoid detection, and to the distribution of Sage-Grouse in space and time, are habitat related. Those factors that contribute to the probability of encounter are more population related.

Consequently, when discussing predation as a factor in a declining prey population, there are two components to the “equation”: 1) the quality of the habitat, which determines prey susceptibility (or conversely, predator efficiency); and 2) the relative population sizes of predator and prey species, including alternative prey species. In addition, these two components are interrelated, further complicating the understanding of predation ecology. These two components are discussed below.

2.3.4.1 Habitat Quality as Related to Predation

The role of diet selection and nutrition in relation to production was discussed above. A female that only leaves the nest twice per day to feed, defecate, and exercise (Petersen 1980) is less likely to be detected leaving or arriving at the nest than a hen that does not have sufficient energy reserves and leaves the nest more frequently. Predators such as ravens and crows that perch and detect movement probably locate nests by observing the hen and searching the area near the observation, or following her movements as the hen returns to the nest. Ravens also detect nests during the egg-laying period before the hen has initiated incubation by locating the unattended nest while searching on the wing (Autenrieth 1981). Nest predation by ravens has been cited as a major factor affecting Sage-Grouse production (Batterson and Morse 1948, Autenrieth 1981). Nest site selection (habitat quality) would influence the ability of aerial predators to detect the nest and habitat quality would also influence the ability of perching predators to detect hen movements in the vicinity of the nest. Habitat quality has been related to nest success in several studies (Bean 1941, Wallestad and Pyrah 1974, Connelly et al. 1991, Gregg et al. 1994, DeLong et al. 1995, Sveum et al. 1998a). Therefore, improvement in the quality of nesting habitat over larger acreage should increase nest success and produce more juvenile birds.

The discussion of forage quality and Sage-Grouse adaptations to the sagebrush ecosystem indicates that the quality of the winter forage and the availability of forbs in spring may directly influence the ability of the hen to produce quality eggs and to incubate the eggs with minimal time away from the nest. A poor quality egg that is successfully hatched results in a chick that may not have the yolk sac reserves to withstand wet, cold weather immediately after hatching, or may not have the ability to quickly develop and escape predators. These types of interactions between habitat quality and climate may be the causal factors of decreased juvenile survival, and predation may be the manner in which the decrease is expressed. In other words, the poor quality nutrition for the hen may result in chicks that are more susceptible to effects of weather, but predators are able to remove the weakened chicks before they die directly from a weather event.

Annual reproductive success (proportion of hens that hatch one or more eggs) ranges from 15 percent to 70 percent (Schroeder et al. 1999). After hatching, the chicks are dependent on the hen for survival for the first week. Their ability to detect and escape prey is limited, and mortality during this stage of their life cycle is high. Therefore, a habitat that provides food and cover during this stage of their life cycle is critical to chick survival. As described above, this habitat is generally a mix of sagebrush with an open canopy and an abundance of forbs and grasses (see Section 2.2.4.2). The forbs and grasses provide habitat for insects that are the primary Sage-Grouse chick food item, and the forbs, grasses, and shrubs provide cover for the chicks. The quality of the brood habitat would be one factor that determines how many of the additional juveniles survive to contribute to the breeding population.

As juveniles approach adult size, the species of predators to which they are vulnerable changes. Use of limited acreage of riparian habitat in late summer results in Sage-Grouse being concentrated and often using open habitats (meadows). Avian predators and larger carnivores that frequent riparian habitats become the primary threats to survival. However, the ability of juvenile Sage-Grouse to fly and escape predators is well developed, and open habitats may also increase the ability of Sage-Grouse to detect approaching predators. Mortality rates reported for juvenile Sage-Grouse vary; 62 percent between hatching and autumn in Colorado (June 1963), 40 percent from hatch to hunting season in Montana (Wallestad 1975), and 59 percent between June and early August in Colorado (Keller et al. 1941). The data collected by NDOW indicates that juvenile mortality between summer and the fall hunting season in northeastern Nevada is approximately 50 percent.

Movement to fall and winter range disperses the birds over a wider range of habitats, decreasing the probability of predator-Sage-Grouse encounters. As winter snow depths reduce the availability of habitat (Beck 1977, Barrington and Back 1984), Sage-Grouse once again congregate. Bean (1941) observed golden eagles attacking Sage-Grouse in winter in Idaho, although Beck (1977) found eagle attacks of Sage-Grouse to be relatively rare in Colorado, and Wallestad (1975) concluded that adult mortality was relatively insignificant. Winter conditions, availability of other prey species, and abundance of predators all contribute to the level of winter predation. Hogue (1954) found that rabbits and jackrabbits were the primary prey species of coyotes and eagles in winter and that Sage-Grouse were a secondary prey species. This relationship is subject to change when jackrabbit populations decline.

The spring breeding season represents another period of time when Sage-Grouse are concentrated on relatively small acreages. The traditional use of the leks each year provides a food resource for predators that is consistent over time and space. Although predators frequently attack Sage-Grouse at leks, their success in securing a meal appears to be low (Scott 1942, Stanton 1958, Rogers 1964, Wiley 1973b, Autenrieth 1981). This is not totally unexpected because it is unlikely that this breeding strategy would have developed if mortality rates on the breeding grounds were consistently high. The selection of open sites adjacent to cover as leks, as well as the timing of the display activity, has been proposed as a response to predation pressure (Hjorth 1970, Hartzler 1974, Bergerud 1988b, Phillips 1990). Monitoring of ten leks in northeastern Nevada between 1982 and 1986 indicated that predation at the leks was less than one percent of the males each year (Back, unpublished data) except for 1986 when at least one predator-killed Sage-Grouse was found at each active lek. The mortality at leks by the end of the 1986 breeding season was approximately 11 percent of the adult males. This indicates that at least periodically, predation at leks can be substantial and contribute to the imbalance in the sex ratio of adult birds (Schroeder et al. 1999).

The flocking nature of Sage-Grouse and the movement between habitat patches over time distributes Sage-Grouse "randomly" in both space and time. Habitat quantity influences the encounter rate between predator and prey under this scenario. The more prey habitat available, the longer the search time required to locate prey when the prey species are not uniformly distributed throughout the habitat. Therefore, reduction of habitat quantity increases the effectiveness of predators. For example, lack of upland sagebrush sites with sufficient forbs to provide Sage-Grouse insect and nutritional needs results in earlier use of riparian meadow habitats (this can also occur during drought), before chicks have the ability to effectively escape from predators. The limited abundance of this habitat type concentrates the birds into fewer acres, decreasing the time required for predators to locate the broods. Therefore, either poor habitat quality, insufficient quantity of habitat, or drought conditions can increase the level of predation on juvenile birds, affecting recruitment.

2.3.4.2 Predator and Prey Populations as Related to Predation

If habitat quality factors are held constant, it is simple probability statistics that either increasing the number of predators or the number of prey, or both, will increase the probability of predator-prey encounters. And conversely, decreasing the number of predators or the number of prey, or both, will decrease the probability of predator-prey encounters.

Although there is no hard data to confirm that there are more predators today than at some previous point in time, long time residents and ranchers were unanimous on this point during the issue discussions for this Strategy. Specifically, numbers of ravens and crows (corvids) appear to have increased more than other species. Evidence to support this position consists of the means by which these species benefit from human activities. Power transmission and telephone lines create nesting opportunities for corvids in habitats where none previously existed. The poles can also be used as perches from which these species can wait to observe habitats in search of ground or shrub nesting birds. Trees planted as part of rural landscaping where only shrubs previously existed create additional nesting sites. The increase in roads, especially improved roads, results in additional wildlife mortalities. These road kills may either be the mainstay diets of some corvids, or a supplement that allows the individuals to survive conditions that would otherwise be periods of food shortages and resulting in some population control. Similarly, these additional food resources may allow all the young in a corvid clutch to survive, when previously only one offspring may have successfully fledged. Landfills, including those associated with large communities and those associated with rural ranches and mining operations, are also dependable sources of food that can carry corvids through otherwise stressful periods.

Côté and Sutherland (1997) found that control of nest predators improved hatching success of breeding bird populations, but did not result in an increased breeding bird population. This is to be expected where the breeding bird population is stable; the increased hatching success results in more fledglings that are susceptible to other predators that prey on fledglings. Under circumstances of poor quality nesting habitat with adequate brood habitat, predator control may increase recruitment. However, the population would start to decline whenever predator control measures cease because the quality of the nesting habitat remains as the overriding factor affecting nest predation.

Perhaps a scenario that is more relevant to the current situation in Elko County is increasing predator populations (at least corvids) and declining Sage-Grouse populations. Again, if habitat quality factors are held constant, then probability statistics would indicate that predation could rise to a level that increases the rate of decline in the Sage-Grouse population. This would continue until Sage-Grouse (nests, chicks, juveniles, and adults) are so scarce that predators cannot afford to spend the energy necessary to locate Sage-Grouse, or until alternative prey populations are sufficiently high (relative to Sage-Grouse populations) to cause predators to switch to alternative prey.

Predator control, or the reduction of predator populations, is more likely to be effective when habitat quality is relatively high, but the Sage-Grouse population is low and the predator population is high. Under this scenario, the abundance of predators negates the effectiveness of habitat quality and the Sage-Grouse population is not sufficiently high to produce enough chicks to maintain population levels. Due to the high number of predators, there aren't enough places to hide. Under this scenario, predator control that is focused around the nesting and early brood habitat may be highly effective in allowing more eggs to hatch and more chicks to survive to the juvenile age class and eventually be recruited into the adult population.

The preceding discussion is not meant to imply that predation is not an issue, but puts predation in perspective. The effects of predation on population dynamics cannot be clearly understood until habitat quality is at "optimum," at which time the interaction between habitat quality and predation is minimized. Under optimal habitat conditions, nest success and juvenile survival should exceed the level needed to just maintain a stable population, and population increases would be anticipated. Where poor habitat quality is the overriding factor in determining predator efficiency, whether it be success at nest predation, chick predation, juvenile predation, or adult predation, predator control can only be a temporary measure to increase Sage-Grouse populations. As soon as the predator control is removed, the predator numbers and predator efficiency will increase to pre-control levels. Where predator populations and survival have been artificially increased as a result of man's activities, improving prey habitat may not be a sufficient effort to offset the advantage that has been given to predators. Under these circumstances, predator control should be an effective measure in bringing the predator populations to near normal levels or below.

As stated above, recruitment must exceed adult mortality for populations to increase. The wing data and harvest data for Elko County indicates that recruitment of young Sage-Grouse into the population is not in excess of the adult mortality in most years. A 37 percent nest success, combined with an estimated 50 percent juvenile mortality between hatching and late summer and estimated 50 percent juvenile mortality between late summer and the fall hunting season, would indicate that overall predation is a significant issue. What is not clear is what factors are contributing to these high mortality rates. Are there simply more predators? Are there habitat quality factors present that contribute to predator effectiveness? Are there habitat quality factors present that decrease Sage-Grouse health, making them more susceptible to predation? Are there habitat quantity factors present that cause Sage-Grouse to concentrate into small areas and contribute to predator effectiveness? Are there habitat quality and climatic factors interacting that cause high chick mortality? These questions need to be answered before the issue of predation can be adequately assessed and addressed. However, it is likely that all of the factors mentioned above are contributing to the predator-prey relationship, and measures necessary to address all the factors should be considered in the management strategy.

2.4 Sagebrush Ecosystem

Understanding Sage-Grouse ecology also requires an understanding of the ecosystem and the dynamics of the ecosystem over time. Both long-term climatic cycles (i.e., glacial and interglacial periods) and short-term cycles (periods of above normal precipitation or periods of drought) influenced plant community dynamics. Long-term climate cycles caused large spatial shifts in plant distribution (Miller and Eddelman 2000). Plant species migrated, hybridized, or went extinct in response to changes in climatic conditions (Tausch et al. 1993). However, the plant communities did not respond to these changes as intact species assemblages (Nowak et al. 1994). The individual range of tolerance for temperature, moisture, and other factors, resulted in variation in the individual species' rates of migration and direction of the migration (Graham and Grimm 1990). During the past two million years (Pleistocene) several relatively long glacial periods (i.e., 50,000 to 100,000 years), separated by shorter interglacial periods (i.e., 10,000 to 20,000 years), have occurred (van Donk 1976). Interglacial periods have comprised only about 85,000 years of the last 850,000 years (Tausch et al. 1993). The significance of the long-term climate cycles is that the geologic processes of weathering, soil development, and stream hydromorphology occurred under "stable" conditions (i.e., long periods of time of either glacial or inter-glacial climates). These processes were the foundation for the plant and animal communities that now inhabit the Great Basin.

The Holocene (last 12,000 years) has had periods of climate that were warmer/wetter, warmer/drier, cooler/drier, and cooler/wetter than the present pattern (Miller and Wigand 1994). Even these periods were considered long-term due to the fact that they occurred long enough to change plant community dynamics, fire frequencies, and seasonal precipitation patterns (Whisenant 1990, Miller and Wigand 1994). The periods of most interest occurred between 500 and 700 years ago and 400 to 500 years ago, prior to European settlement. Miller and Wigand (1994) indicate that a period of severe drought and fire occurred between 500 and 700 years ago. Pollen studies indicate that juniper woodlands were greatly reduced during this period, being replaced by grasslands-sagebrush communities that were able to tolerate the more xeric conditions. This was followed 400 to 500 years ago by a pattern of increased winter precipitation and lower temperatures that reversed the trend in declining woodlands and expanding grassland-sagebrush communities. The period, known as the Little Ice Age, ended about the mid-1800s (Ghil and Vautgard 1991), or coincident with settlement of the Great Basin. The rising temperatures following the Little Ice Age were associated with an increase in sagebrush abundance relative to grasses in eastern Oregon (Wigan 1987), based on pollen data. This would indicate that the fire interval (period of time between fires at a given site) increased, allowing sagebrush to dominate the grassland-sagebrush communities and juniper woodlands to expand into sagebrush sites.

Superimposed on these long-term and moderately long-term cycles of climatic pattern were the short-term cycles of drought (i.e., years with less than 85 percent of the mean annual precipitation) that occurred approximately 20 to 30 percent of the years (Miller and Eddelman 2000) and cycles of normal and above normal precipitation. The affect of these short-term cycles on plant production are well documented and incorporated into production estimates in the Natural Resource Conservation Service (NRCS) range site descriptions and soil surveys.

The vegetation communities occupying a given site are a function of climate, topography, soils, and disturbance, which are in turn a function of the cycles discussed above. The long-term cycles influence the particular plants that are likely to be found in space and time; the moderately long-term cycles influence the fire frequency that determines the community dynamics (succession); and the short-term cycles influence the productivity of a site and interact with the moderately long-term cycles in determining fire frequency and fire intensity. Fire intervals in low sagebrush communities may have been as long as 100 to 200 years (Young and Evans 1981, Miller and Rose 1999). Wright and Bailey (1982) estimate the fire interval of Wyoming big sagebrush sites to be 50 to 100 years in the shrub-steppe region, but may have been greater than 100 years in the Great Basin (Miller and Eddelman 2000). Fire intervals may have been as short as 12 to 25 years in the mountain big sagebrush communities (Burkhardt and Tisdale 1976, Gruell et al. 1994). The short-term cycles were also likely to have influenced reestablishment of sagebrush following fire and the continued recruitment of sagebrush into the plant communities (Perryman et al. 2001, Maier et al., 2001).

Using this understanding of climate cycles, one can create a description of the vegetation landscape of the pre-European settlement. The period of drought and fire between 500 and 700 years ago reduced the extent of pinyon-juniper woodlands, expanding the extent of the sagebrush-herb community. The pollen record from southeastern Oregon (Mehringer and Wigand 1987) indicates that grasses were more abundant preceding this period of drought and fire, and that sagebrush increased during this period. During this drought period fire would have created expanses of mountain big sagebrush in the areas of decreased pinyon and juniper woodlands. Lower precipitation would have resulted in the more drought tolerant Wyoming big sagebrush migrating higher in elevation and replacing mountain big sagebrush at the lower portion of the mountain pediments. Similarly, mountain big sagebrush would have migrated either in elevation or to north and east aspects where more mesic conditions would have prevailed. Fire in the Wyoming big sagebrush types would have been dependent on the age or condition of the stand. During prolonged drought, young stands of Wyoming big sagebrush on the more arid sites would have been less subject to fire due to the lack of production of fine fuels (i.e., herbaceous vegetation). However, the deep-rooted and drought tolerant sagebrush would have increased in total cover with episodic establishment during short-term periods of normal or above normal precipitation (Maier et al., 2001). Therefore, as stands of Wyoming big sagebrush increased in age and crown cover, the requirement of fine fuels to carry the fire between shrubs would have been reduced by competition from shrubs, and "crown fires" would have occurred.

An important distinction to make is that drought favors sagebrush dominance where sagebrush already exists (i.e., established sagebrush plants are more efficient at nutrient and moisture assimilation than grasses), but reduces the potential for sagebrush seed to germinate and establish. Therefore, fire within the period of drought would favor grasslands and lack of fire would favor increase in woody dominance where woody species were previously established.

The resulting landscape would have included areas of pinyon-juniper at the higher elevations or north slopes at mid-elevations, with mountain big sagebrush on the sideslopes, Wyoming big sagebrush in the valleys and lower sideslopes, and low sagebrush on ridges or sideslopes where soils were not suitable for mountain big sagebrush. A variety of age classes of mountain big sagebrush was likely to have occurred due to the frequency of fires in this community.

During this drought and fire-prone period, fire at the upper elevation pinyon-junipers would have maintained open stands by decreasing shrubs and young seedlings of pinyon and juniper. The mountain big sagebrush communities generally recover quickly from fire, but the recovery time may have been increased due to the poor moisture conditions, which would have increased the fire interval. The general successional pattern would have been a grassland-forb dominated community following a fire, with sagebrush establishment occurring over a longer interval. Intermediate fires would have reduced the sagebrush cover, but due to the patchy nature of grass-fueled fires, patches of sagebrush would have remained as a potential seed source to hasten the shrub recovery.

In the more arid Wyoming big sagebrush sites, the lack of fine fuel production from poor moisture conditions would have led to the build up of dense stands of sagebrush. Once in this condition, fire would have been intense and probably occurred over large acreages. The successional pattern would have been a slow recovery of the grasses and forbs due to the effects of an intense fire on the soil, seed bank, and plant root systems. The reestablishment of sagebrush into these sites may have taken many decades. The poor moisture conditions and large size of the burns would have limited the opportunities for sagebrush establishment and required many years for sagebrush to migrate from the edges of the burns. Any intermediate fires would have added significantly to the time required for shrub dominance to reoccur. Unlike the patchy mosaic of mountain big sagebrush age classes, the Wyoming big sagebrush sites would have had age classes represented as ecotonal gradients with the older age classes at the edge of a burned area and the younger age classes at the interior of the burned area. Initially, the mosaic of these burned areas would have been on a larger scale than the mountain big sagebrush sites; perhaps involving entire basins between mountain ranges. However, as the ecotonal age classes developed, the fire pattern would have been dependent on fuel loading. The distribution of fuels along the ecotone would have limited the extent of the fires, resulting in a mosaic of age classes. The size of these patches would have been larger than the mountain big sagebrush age class patches, but smaller than the large expanses of old sagebrush stands that dominated the early phase of this climatic period.

With the initiation of the Little Ice Age, several hundred years of cold, wet conditions prevailed until the mid-1800s (Neilson 1986, Pielou 1991). The climatic conditions for fire ignitions were limited, but plant production was greater than the previous climatic period. Therefore, the fire interval during this period was controlled more by climate than by fuel loading. Expansion of the pinyon-juniper into the mountain big sagebrush sites reversed the trend that occurred during the drought and fire period. Wetter conditions favored a full understory of herbaceous species in the sagebrush community, slowing the establishment of pinyon and juniper. A patchwork of mountain big sagebrush, low sagebrush, and pinyon-juniper would have been present on the higher elevations and sideslopes. Pinyon-juniper woodlands would have been open, and a fire frequency of 12 to 25 years in the mountain big sagebrush community would have also hindered establishment or survival of pinyon-juniper seedlings during this period.

The mosaic of age classes that had been created in the Wyoming big sagebrush sites during the previous period of drought and fire would have been diminished during the early phase of the Little Ice Age. The effect of colder, wetter conditions at the lower elevation Wyoming big sagebrush sites would have been an increase in the herbaceous understory and increased sagebrush seedling establishment. Fires under these conditions would have been less intense than the crown fires during the previous period of drought, and the herbaceous plants would have quickly responded to fire. The patchy nature of these types of fires would also have left islands of sagebrush that would have hastened the re-establishment of sagebrush into the grasslands. The succulent vegetation in the riparian zones would have had sufficient fuel moisture to control the spread of these grass-fueled fires, limiting the size of the patches. However, with climatic conditions that did not favor fire, the recruitment of sagebrush into the stand would have increased sagebrush crown cover over time, creating large expanses of older sagebrush. The increased fire interval of 50 to 100 years would have been sufficient for sagebrush to dominate the stands.

The longer fire interval in the Wyoming big sagebrush sites and the propensity of the "crown fires" to burn large acreages during short-term periods of drought, were likely to create a less distinct mosaic than in the mountain big sagebrush sites. The age classes occurred in the ecotone from the edge of the burn to the interior of the burn, rather than as distinct patches of age classes. The extent of the age classes was dependent on the time since the last fire.

Low sagebrush sites at the more arid lower elevation sites were not likely to burn very frequently due to the lack of herbaceous material, low shrub crown position, and less overall shrub crown cover than the Wyoming big sagebrush sites. However, small inclusions of low sagebrush within the Wyoming big sagebrush communities were probably impacted due to the intense heat of the crown fires.

When the early explorers entered the Great Basin near the end of the Little Ice Age, the landscape may have appeared to be sagebrush from the sideslopes of the mountain ranges across the valleys and up the sideslopes of the next mountain range, with pinyon-juniper at the moderate elevations, and other coniferous trees at high elevations to subalpine/alpine zones.[4] The sagebrush mosaic and age distribution would have been a result of the fire history of the preceding 500 years. What appeared to be a monoculture of sagebrush actually ranged from stands dominated by sagebrush, often quite extensive in nature, to grasslands (most recently burned areas). The highest diversity of age classes occurred in the mountain big sagebrush communities, and lower age class diversity occurred in the Wyoming big sagebrush communities. The amount of perennial grasses and forbs present would have been a function of the age class and cover condition of the sagebrush communities.

The changes discussed above are macro-changes that occurred over broad areas and long time intervals. The macro-changes were the result of many site-specific and plant community-specific changes over time and space. Succession, the orderly change in plant communities over time, was one of the plant-community specific changes that occurred. While useful in providing a basic understanding of plant community dynamics, the successional model is currently being replaced with the state and transition model (Laycock 1991, West 1999) and other multi-trajectory models that reflect empirical field data.

Two of the major stresses on plant physiology that drive plant community changes are competition for nutrients and moisture. In the absence of grazing, sagebrush will dominate a site at the expense of herbaceous plants. This sagebrush dominance is achieved through competition for nutrients and moisture. Sagebrush has an extensive near-surface root system that allows this shrub to effectively compete for nutrients and moisture near the surface where grasses and forbs obtain their moisture and nutrients. However, sagebrush also has a taproot system that provides access to soil moisture that has exceeded the depth of the herbaceous plant roots. This deeper root system allows sagebrush to continue growing throughout the year and during periods of drought. During each period of drought, the herbaceous species initiate growth using root

[4] Playas and salt-desert shrub communities were also part of the landscape, but their location on the landscape and extent were more a function of water levels and soils; and therefore, are not discussed.

reserves and soil moisture from winter storms. If spring moisture is not available, the plants shorten their growth cycle, which also decreases the amount of root reserves that can be replaced. Consecutive years of drought result in root reserves insufficient to sustain some plants, allowing sagebrush roots to take their place.

The time interval over which this process takes place depends on the site productivity and the disturbance that may occur during the process. As implied above, the general direction of the plant community following fire was from a grass-forb dominated community, to a grass-forb-shrub community, to a shrub-grass-forb community, to a shrub-dominated community (**Figure 6)**. The shrub-dominated community was not without grasses or forbs, but would have had less grasses and forbs than the other successional stages. The abundance of forbs and grasses would have represented equilibrium of site capacity and short-term climatic conditions. Complete shrub dominance (i.e., a near complete lack of forbs or grasses) was not likely to have occurred, except at low elevation, low precipitation sites, with poor soil productivity.

If each of the four plant community phases discussed above is considered a state and the change from one to another is a transition, then the successional model begins to take on the state and transition model character. At each state, the transition to the next state can be modified by other factors. For example, the grass-forb dominated community could be maintained through short disturbance intervals, such as repeated fires or frequent drought cycles that prevented sagebrush from establishing. Similarly, the shrub-grass-forb state could have been modified to the grass-forb state or the grass-forb-shrub state, depending on the extent and intensity of the disturbance. The overall time interval required to achieve the shrub-dominated state is representative of the average disturbance interval for each range site.

2.5 Factors Affecting Sage-Grouse Populations or Habitats

The following issues were identified by the NNSG membership as potential factors contributing to the decline in Sage-Grouse throughout the West, and particularly in Elko County:

- Habitat Quantity
- Habitat Quality/Nutrition
- Habitat Fragmentation
- Changing Land Uses
- Livestock Grazing
- Fire Ecology
- Predation
- Disturbance
- Disease
- Hunting
- Cycles
- Climate/Weather

Some of the factors, such as habitat quantity, habitat quality/nutrition, habitat fragmentation, fire ecology, changing land uses, livestock grazing, and disturbance, are addressed in the Strategy. Specific actions can be implemented through a watershed plan to eliminate or reduce the potential impacts from these factors. Other factors, such as predation and hunting, fall under the specific jurisdictions and laws and the NNSG can develop recommendations for changes, but implementation would occur through other processes. Finally, factors such as disease and cycles are not within the control of the NNSG, but their impact on the populations needs to be considered.

Each PMU was assessed to determine the population and habitat risks. Each risk factor is discussed below. The rationale for the assignment of risk for each factor is included in **Appendix C**. The risks were based on local knowledge and other factors, and were averaged over the entire PMU. This risk assessment was for planning purposes only, and used to rank the PMUs.

2.5.1 Habitat Quantity

Changes in habitat quantity result from alteration of sagebrush habitats to other vegetation types. These changes may be short-term, or temporary, if the alteration results in sagebrush reestablishment over time, or they may be permanent if the alteration prevents sagebrush reestablishment (see Section 2.5.4. for a discussion of permanent changes). Wildfires, and to a lesser extent, historic livestock grazing practices, have resulted in the conversion of approximately 251,600 acres of sagebrush rangelands to annual grasslands in Elko County since 1980. The acreage converted has included Sage-Grouse winter, breeding, nesting,

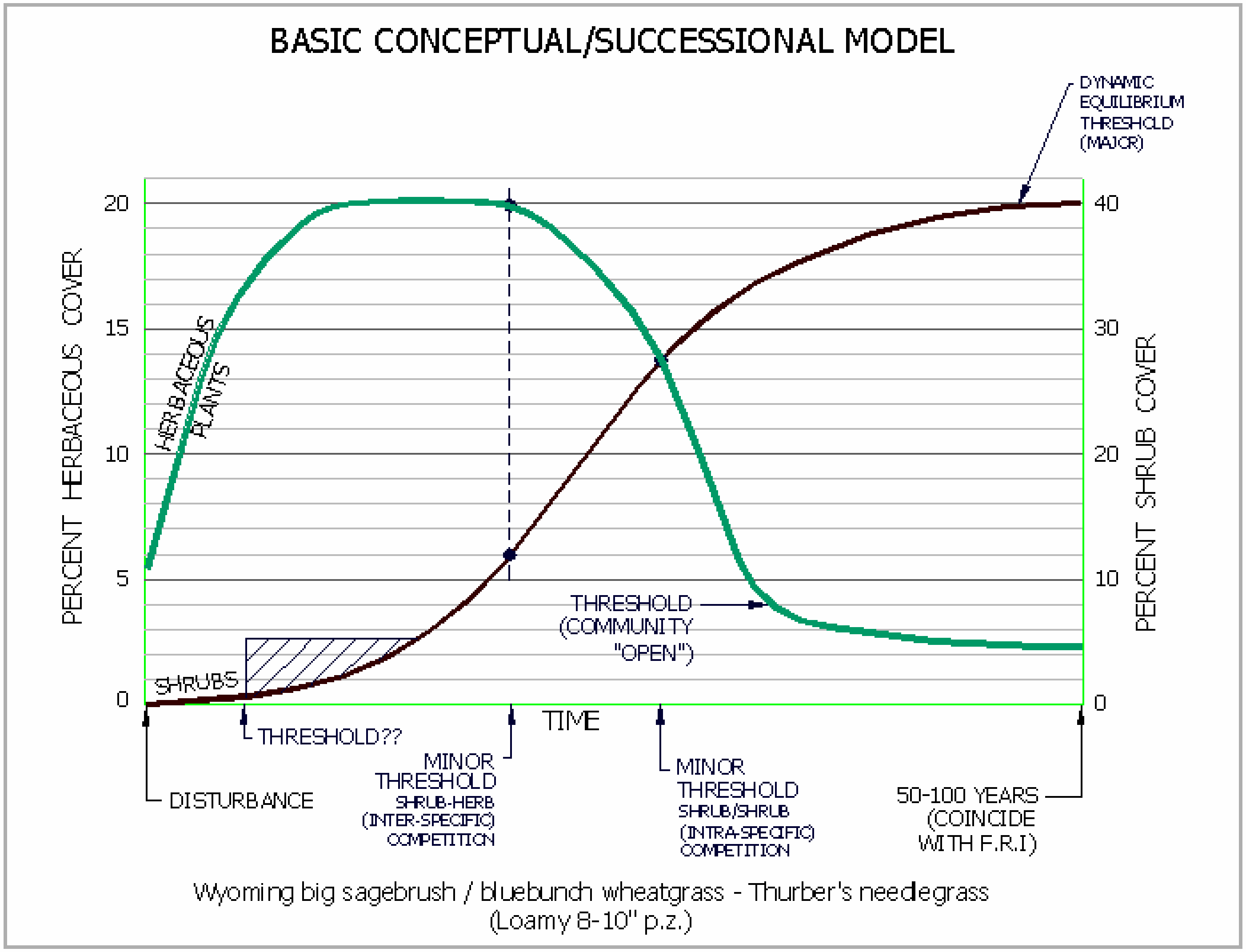


Figure 6: Basic Conceptual Successional Model for the Loamy 8-10" Precipitation Zone (p.z.) Range Site

and brood habitat. Once converted to annual grasslands, these areas will not revert back to a sagebrush community without extensive measures. The resulting annual grasslands create a greater risk of additional habitat loss due to the ease with which the annual grasslands can be ignited and spread fires into adjacent, intact sagebrush habitats. Within the Strategy area, large blocks of annual grasslands are most prevalent within the western portion of Elko County; however, cheatgrass is an understory component of many plant communities throughout the county.

The encroachment of pinyon-juniper woodlands from woodland sites to rangeland sites has also been responsible for loss of sagebrush habitats. Approximately 354,500 acres of pinyon-juniper encroachment has occurred within the planning area. Fire suppression or extended fire intervals allow pinyon-juniper to spread across the landscape (Tausch 1999). Chemicals in the foliage of the juniper trees prevent other species of grasses and shrubs from germinating or establishing under the juniper canopy. As the juniper begins to dominate the site, the shrub-herb community is essentially lost or greatly reduced, depending on the site conditions. Sage-Grouse do not use pinyon-juniper woodlands, and the encroachment of this plant community into sagebrush-herb communities represents a loss of habitat for Sage-Grouse. Due to the loss of understory in many of the pinyon-juniper stands, conversion back to sagebrush-herb communities is not a simple process. Where sagebrush still exists in the understory, several options for restoration are available. The issue of pinyon-juniper encroachment is most prevalent in the southern half of the Strategy area.

During the late 1950s and early 1960s, several varieties of crested wheatgrass were used to control halogeton and increase livestock forage production on western rangelands. These seedings were conducted primarily on gentle terrain at lower elevations (Wyoming sagebrush sites). The converted sites impacted nesting habitat, early brood habitat, and winter habitat. Although some seedings were used by Sage-Grouse for breeding (leks), the overall impact has been considered to be detrimental to Sage-Grouse (Braun 1998). Some seedings where sagebrush has reestablished have been noted as being used by Sage-Grouse for winter use (Back et al. 1984) and nesting (K. McAdoo, personal communication). BLM records (Rich 1999) indicate that the cumulative acreage of rangeland seedings on BLM administered lands in the west increased from approximately 100,000 acres in 1962 to 2.75 million acres by 1997. This acreage does not include private land seedings. According to the BLM Elko Field Office, about 396,500 acres of public lands within the Elko Field Office area were converted to crested wheatgrass or other exotic species (not including fire rehabilitation projects). This represents about three percent of the land area in Elko County. Private land seedings were likely to have affected at least the same amount of acreage.

Not all sagebrush removal was followed by seeding of exotic grasses. Sagebrush control projects designed to remove sagebrush and allow native grasses to increase in abundance followed a pattern similar to crested wheatgrass seedings. Brush control projects on BLM administered lands in the west accounted for approximately 100,000 acres in 1962 and increased to approximately 1.4 million acres by 1976. Only about 300,000 acres of BLM administered lands have been converted to grasslands since 1976 (Rich 1999). Where sagebrush has been allowed to reestablish on these lands, Sage-Grouse habitats have likely been reestablished. Where follow-up treatments have been conducted, Sage-Grouse have been effectively removed from the acreage. Sagebrush rangelands have also been converted to a variety of other agricultural uses, including hay production, through various forms of irrigation. While this acreage has reduced the amount of winter or nesting habitat, much of the irrigated land has received use as summer foraging habitat.

The rapid expansion of the mining industry in and around Elko County starting in the 1980s also impacted Sage-Grouse habitats. Environmental analysis of mining impacts for operations managed by Barrick Goldstrike Mines, Inc., Newmont Mining Corporation, AngloGold, Inc., Glamis Dee Gold Mining Co., and others have indicated loss of habitat, either temporary or permanent, due to mine development. While most of the acreage will be reclaimed to support sagebrush communities, some acreage has been converted to salt desert shrub or exotic grasses, and some acreage represented by the open pits will remain permanently unavailable to Sage-Grouse. Some of these impacts have been mitigated by off-site projects intended to rehabilitate annual grasslands, and Barrick Goldstrike Mines, Inc. contributed mitigation funds to experimental land treatments that have been instrumental in developing management tools for this Strategy. Although mining disturbance is very visible during active mining, the actual acreage involved represents less than two percent of Elko County's land mass.

2.5.2 Habitat Quality/Nutrition

This factor was discussed above (Sections 2.3.1, 2.3.2, and 2.3.3). The quality of the habitat contributes to the effectiveness of many of the other factors. Disease, predation, hunting, and disturbance are less likely to effect populations when habitat quality is high and both the birds and the populations are resilient. Population impacts from unfavorable weather conditions are also somewhat ameliorated by having high quality habitats. Managing for quality habitats, while maintaining and restoring habitat quantity, are probably the two most important factors for long term sustainability of Sage-Grouse populations.

Habitat quality also pertains to the integrity of the plant communities. Invasive weeds, annual grasses, and exotic species (desired or undesired) all detract from habitat quality. For each invasive weed, annual grass, or exotic species there is one less forb, native grass, or sagebrush seedling that can be supported within the community. These species also increase the risk of conversion from a shrub-herb community to an annual grassland-noxious weed community following catastrophic events (see habitat quantity, above).

Habitat quality was also addressed by conducting a habitat condition assessment. The purpose of the assessment was to determine five broad categories of habitat condition and mapping the location of habitats of each condition class within each PMU. The habitat condition assessment procedure is included in **Appendix D** and the habitat conditions are displayed in **Figure 7**. The five habitat conditions (R-0, R-1, R-2, R-3, and R-4) are described as follows:

- R-0: Habitat areas with desired species composition that have sufficient, but not excessive, sagebrush canopy and sufficient grasses and forbs in the understory to provide adequate cover and forage to meet the seasonal needs of Sage-Grouse.
- R-1: Habitat areas which currently lack sufficient sagebrush and are currently dominated by perennial grasses and forbs, yet have the potential to produce sagebrush plant communities with good understory composition of desired grasses and forbs.
- R-2: Existing sagebrush habitat areas with insufficient desired grasses and forbs in the understory to meet seasonal needs of Sage-Grouse.
- R-3: Sagebrush habitat areas where pinyon-juniper encroachment has affected the potential to produce sagebrush plant communities that provide adequate cover and forage to meet the seasonal needs of Sage-Grouse.
- R-4: Habitat areas which have the potential to produce sagebrush plant communities, but are currently dominated by annual grasses, annual forbs, or bare ground.

The acreage of each habitat condition rating by PMU is provided in **Table 2**. The habitat condition assessment will be used as a planning tool for the watershed assessments. Approximately 78 percent of the planning area is comprised of R-0, R-1, and R-2 habitats; therefore the potential exists to improve habitat quality on almost 8 million acres.

In addition to the upland habitats, the riparian meadows and springs are important habitats for Sage-Grouse in late summer. The BLM Elko Field Office has rated 912 miles of riparian areas in terms of lotic proper functioning condition (PFC) and has estimated that 178 miles (19.5 percent) of the riparian areas were at PFC, 153 miles (16.8 percent) were functioning at risk with an upward trend, 122 miles (13.4 percent) were functioning at risk with a downward trend, 125 miles (13.7 percent) were functioning at risk and trend was not determined, and 335 miles (36.7 percent) were rated as not functioning. In addition, of the approximately 5,600 acres of lentic habitat within the planning area, approximately 2,700 acres

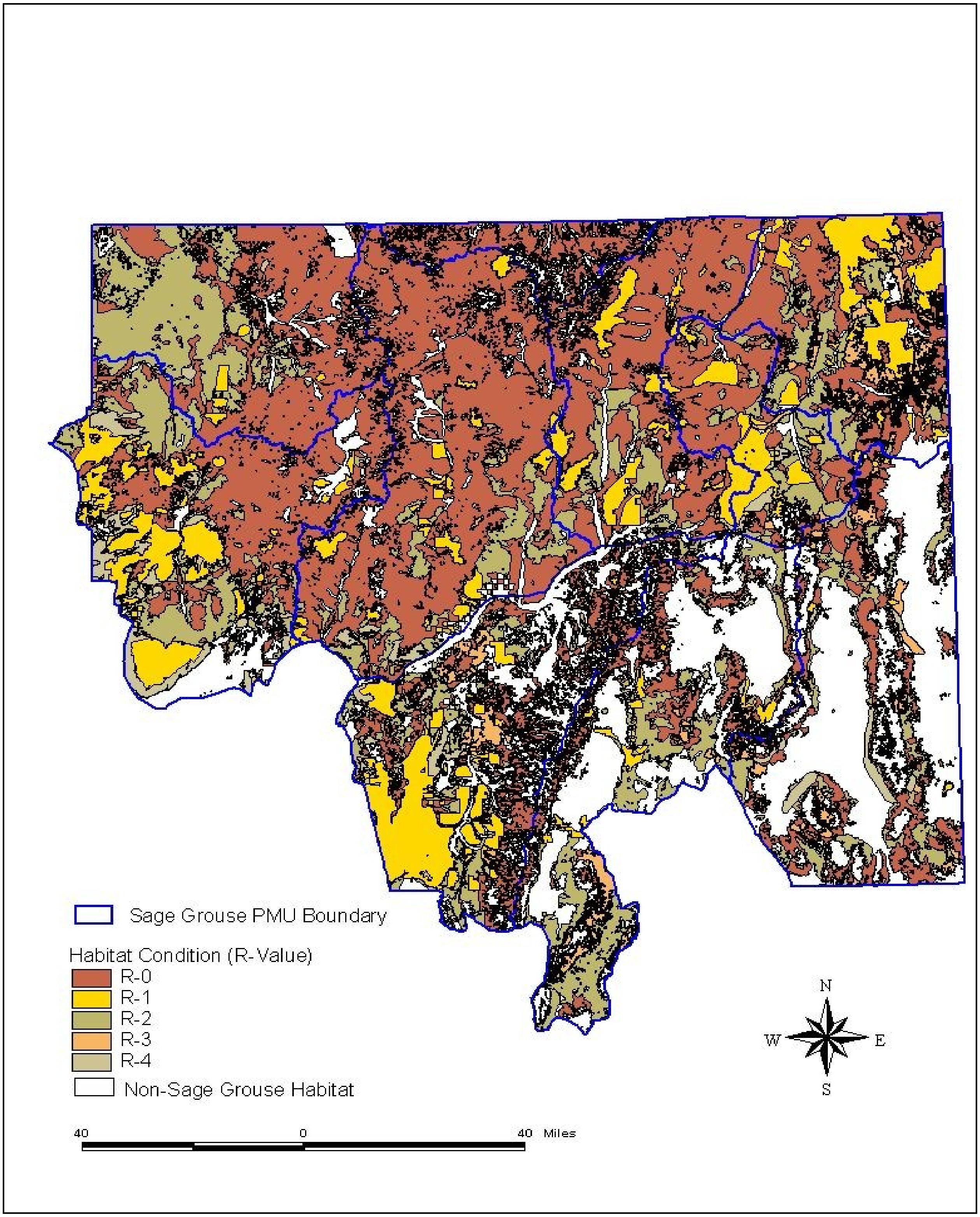


Figure 7: Sage-Grouse Habitat Condition Ratings Map

Table 2: Estimated Acreage of Habitat Condition by Population Management Unit (PMU) within the Planning Area

PMU	R-0 (Intact)	R-1 (Perennial Grassland)	R-2 (Poor)	R-3 (P/J)	R-4 (Cheatgrass)	Non-Habitat	Total
Desert	568,272	17,860	438,631	0	7,856	75,963	1,108,582
Island	192,912	410	0	0	0	66,064	259,386
North Fork	1,261,252	92,011	189,240	2,485	19,119	167,124	1,731,231
Tuscarora	588,029	284,186	284,108	0	126,560	102,229	1,385,112
South Fork	364,428	272,808	187,934	57,022	37,573	450,171	1,369,936
ONeil Basin	630,096	144,535	130,189	4,033	2,926	102,342	1,014,121
Snake	245,647	103,340	119,904	11,078	14,524	43,627	538,120
Gollaher	366,148	204,442	162,402	139,454	0	39,771	912,217
Ruby Valley	253,339	41,233	318,979	62,080	4,332	435,077	1,115,040
East Valley	334,982	8,789	186,311	78,339	38,683	143,543	790,647
Total	**4,805,105**	**1,169,614**	**2,017,698**	**354,491**	**251,573**	**1,625,911**	**10,224,392**

have been evaluated with regard to PFC. Of the acreage evaluated to date, 2,137 acres (78.5 percent) were rated at PFC, 70.5 acres (2.6 percent) were functioning at risk with an upward trend, 97.1 acres (3.6 percent) were functioning at risk and trend was not determined, 288.2 acres (10.6 percent) were functioning at risk with a downward trend, and 130.2 acres (4.8 percent) were not functioning. These totals do not include riparian habitats on private lands and represent only the total riparian areas that have been assessed.

The habitat quality concept is illustrated in **Figure 8**. The habitat parameters from the Sage-Grouse Guidelines (Connelly et al. 2000) were used to determine where Sage-Grouse seasonal habitats occur within the basic conceptual successional model. Pre-nesting, early brood habitat, and nesting habitat all fall within the time period when herbaceous vegetation is dominant or co-dominant with sagebrush. The forbs and insects are important components of the pre-nesting diets of hens and early diets of chicks. The abundant herbaceous cover also provides the lateral screening cover for the nest site and to help conceal the hen when she leaves or returns to the nest. Late summer and winter habitats have a higher component of shrubs than the "production" habitats associated with nesting and early brood habitat. Herbaceous vegetation in the uplands is not an important factor in late summer and winter.

2.5.3 Habitat Fragmentation

Habitat fragmentation consists of breaking up large areas of habitat into smaller, isolated areas of habitat. Species need to move through "non-habitat" to use the resulting patchwork of suitable habitats. The "non-habitats" can be physical/psychological barriers (e.g., roads or fences), blocks of unsuitable habitat (e.g., crested wheatgrass seeding or annual grassland), or other zones that a species avoids due to predation risks (e.g., adjacent to transmission lines). Fragmentation impacts vary by species due to the home range, daily range, and territorial requirements of different species. A species that spends an entire lifetime on only a few acres may not be impacted by the construction of a road or implementation of a crested wheatgrass seeding within a quarter mile of its home range, whereas a species that requires a large home range or seasonal habitat area may be impacted by breaking a large block of habitat into smaller patches. There is very little data pertaining to road density and Sage-Grouse. There is evidence that Sage-Grouse will use roads for leks, but the level of traffic would have to be light during the hours of breeding display for this to be successful. In general, the fewer the roads and the lighter the traffic level, the less impact there is to Sage-

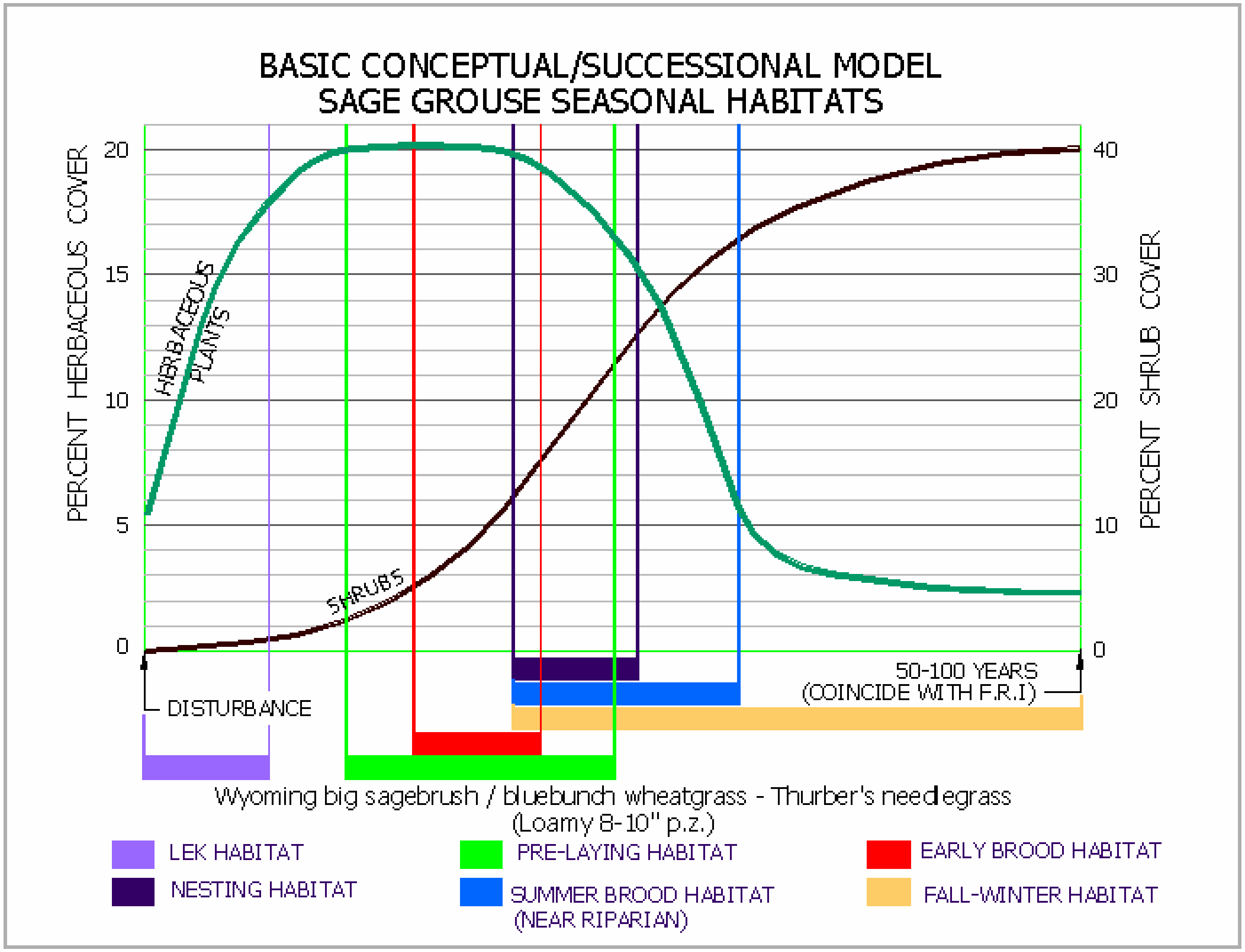


Figure 8: Sage-Grouse Seasonal Habitats with Respect to the Basic Conceptual Model, Loamy 8-10" p.z. Range Site

Grouse from roads. Preliminary estimates of road mileage within the planning area include 775 miles of primary and secondary roads (paved Interstate highway and State highways, respectively), 2,511 miles of hard improved roads (gravel/county roads), and 17,833 miles of unimproved roads. This equates to approximately 1.2 miles of road per square mile. Utility line support structures may also influence habitat use. There has been some suggestion that predation on male Sage-Grouse at leks is increased by raptors using transmission line supports as perches near leks. This has not been demonstrated in a scientifically controlled study and seems very unlikely to occur. The premise by Hall (in press) that transmission line structures provide an advantage for raptors to prey on males at leks needs to be examined. Leks are used for many years. This consistency in time and space makes the lek a predictable resource. Raptors will attempt to exploit this resource with or without perches. A resource that is predictable in time and space can be hunted efficiently on the wing, using the element of surprise. Use of existing cover (i.e., flying low over the sage brush to decrease the angle of detection) and using the existing topography (i.e., approach from the blind side of the ridge) are more likely to be successful than initiating the attack from a perch in full view of ten to 50 prey. Although the literature indicates that attacks by eagles at leks are common, the attacks are most often unsuccessful (Scott 1942, Stanton 1958, Rogers 1964, Wiley 1973b, Autenrieth 1981). The timing of the breeding display before dawn to shortly after sunrise has been hypothesized as a response to predation pressure (Hjorth 1970, Hartzler 1974, Bergerud 1988b, Phillips 1990). This is a period when sufficient light is present to effectively display but there is insufficient light to make the Sage-Grouse highly visible. It is also the time when owls return to their day roosts and prior to initiation of hunting by eagles, although there is some overlap of the breeding display with the hunting period of both owls and eagles.

The addition of support towers or other perches into otherwise perch-free habitats does not necessarily equate to increased predation pressure on the leks. Avian predators can prey on males at the lek with or without the transmission line. However, where the support tower is relatively close to the lek, the presence of a predator in full view may be sufficient to make the males too “nervous” to display, resulting in lek abandonment. There is likely some “comfort zone” that Sage-Grouse have with regard to elevated perches such as rock outcrops, woodlands, and transmission lines. Avoidance of these structures up to a distance whereby detection of a raptor leaving the perch allows sufficient time for escape would seem to be a prudent behavior.

In contrast to leks, nests are a resource that are unpredictable in space, but somewhat predictable in time (i.e., only during the breeding season). Detection is a necessary step to successful predation. A “perch and search” approach is an effective strategy for this type of resource, especially when there are cues to the nest location. The hen leaves the nest at least twice per day to feed, defecate, and exercise; this is accomplished by sneaking through the vegetation until some distance from the nest. At this point, the hen may fly to another area. If the flight is detected, or if the hen is detected while sneaking from the nest, ravens will investigate the area in search of the nest. This may be unsuccessful for several attempts; however, the hen leaves the nest by a different route during each recess, and the patient predator can narrow down the search area within a few days. The end result is a high level of nest predation.

Successful Sage-Grouse hens have high nest site fidelity. However, if nest success in an area is low due to nest predation, fewer and fewer young would be produced. Eventually, over a period of years, the number of nesting hens in the vicinity of the transmission line would be expected to decline through natural mortality. Without replacement hens being produced, breeding opportunities for the males would decline, and subsequently, attendance at the lek would decline.

2.5.4 Changing Land Uses

Change in land use refers to a change from wildlife habitat or livestock grazing to another land use that represents a long-term or permanent change. This includes changes associated with construction of reservoirs, recreational developments, urban sprawl, or other developments. The impacts are similar to those discussed under Habitat Quantity, but because of the permanent or long-term nature of these changes, the habitat values are generally not recoverable.

Human population growth and the trend for rural lifestyles have resulted in urban development within former Sage-Grouse habitats. In Elko County this is best exemplified by the development of the Spring Creek area, approximately 30 square miles in extent, with zones of development and undeveloped zones. Similar, but less extensive developments have taken place around Jackpot, Wendover, Carlin, Osino, and Adobe Summit. Not all of these have impacted Sage-Grouse habitat, but they do represent an expansion of human population into rangelands. South Fork Reservoir and the associated recreation area and housing developments are also examples of permanent land use changes that reduce the amount of habitat available to wildlife and change the other range uses of the area. These types of land use changes are anticipated to increase as the population of Elko County increases, or as demands for certain types of recreation increase.

In Elko County the opportunity for urban development is somewhat limited by the current land status. Most of Elko County is public land administered by federal agencies. The bulk of the private land is associated with the checkerboard land status along the railroad corridor and a few large blocks of private land created through various land exchanges. The private lands within the checkerboard corridor have been recently made available for purchase and rural developments and ranchettes have increased in these areas, or are likely to occur.

2.5.5 Livestock Grazing

Perhaps one of the most controversial but least understood issues is livestock grazing. Those who advocate listing Sage-Grouse under the ESA portray livestock grazing as the major factor in Sage-Grouse declines across the West (Kerr 2001, Braun 2001), while those who support the livestock industry portray livestock grazing as the major factor for the existence of Sage-Grouse (and other wildlife) in the West. Both views have some substance, and both views have some fallacy.

Beck and Mitchell (2000) reviewed the limited information regarding livestock grazing impacts on Sage-Grouse habitat and found that livestock grazing practices or range improvements that remove sagebrush from a site have adverse impacts on Sage-Grouse, at least for the short-term. Long-term studies of these practices were not presented. Grazing levels that created poor conditions on rangelands or meadows also had adverse impacts on Sage-Grouse. Livestock grazing resulted in some nest desertion and egg destruction. Potential population impacts were only related to practices that impacted nest success and early chick survival. Conversely, light to moderate grazing of meadows created conditions favorable for Sage-Grouse by reducing dense grass growth and stimulating forb growth and nutritional content. Rest-rotation grazing systems promoted forb production, and practices that reduce sagebrush cover were associated with increased herbaceous cover (Beck and Mitchell 2000). Although the studies of these issues are limited in number, the general conclusion is that livestock grazing practices and range improvements that maintain healthy rangeland and riparian conditions are compatible with Sage-Grouse management, and those practices or range improvements that degrade rangeland and riparian conditions create adverse impacts to Sage-Grouse.

The Elko Field Office, BLM administers 226 grazing allotments within the planning area totaling approximately 8,585,000 acres. Ninety-five of these allotments, accounting for 5,313,000 acres (or 62 percent), have been through the allotment evaluation process and have had final multiple use decisions issued. These allotments are under grazing systems intended to improve rangeland health with regard to the RAC Standards and Guidelines.

One of the keys to understanding historic impacts and current grazing “impacts” is to understand plant physiology and how herbivory[5] interacts with the plant. Plant physiology varies with life form (e.g., shrubs, grasses, forbs), seasonal growth patterns (e.g., cool season grasses vs. warm season grasses), and life history (e.g., perennial plants vs. annual plants). The following discussion is applicable to perennial plants of the various life forms and seasonal growth patterns. Annual plants do not conform to this general pattern.

[5]Herbivory is the removal of foliage or plant parts by animals, wild or domestic. Grazing in this document is used to indicate foliage removal by domestic livestock only.

For established plants, growth at the beginning of the growing season is based on the carbohydrate reserves in the root system. As the above ground leaves develop, they begin to conduct photosynthesis and produce additional carbohydrates for plant growth. Eventually, the transfer of carbohydrates from the roots to the growing shoots ceases, as the above ground plant parts reach sufficient mass to support additional growth. At this point, additional growth results in carbohydrates transferred from the above ground plant parts to the roots, replacing the carbohydrates used thus far in the growing season. Nutrients and water continue to be transported to the above ground parts of the plant to be used for reproduction. The replacement of root reserves continues until the seeds (or fruits) are ripe and the plants begin to desiccate in advance of dormancy during the non-growing season (**Figure 9**).

The various grasses, forbs, and shrubs initiate growth at different times and go dormant at different times, or in the case of sagebrush, continue to conduct photosynthesis throughout the year. But in general, they follow the pattern of carbohydrate use and production described (simplified) above. From this discussion, it is apparent that a plant must have sufficient root reserves at the beginning of the growing season to support the plant until sufficient new growth is obtained so that the equilibrium between carbohydrate use and carbohydrate production is established. The level of root reserves for the current year is determined during the previous growing season by factors such as moisture and nutrient levels, competition with other plants, herbivory, or disturbance (e.g., fire).

The carbohydrate cycle provides one mechanism for understanding how herbivory can affect plant condition and survival. Using the carbohydrate cycle model, the potential impacts of foliage removal can be analyzed. Grazing early in the season reduces the amount of above ground foliage, requiring more root reserves to be utilized before reaching the equilibrium point. Root reserves that are used to produce the early green up are removed as foliage by the herbivore. Repeated grazing of the same plant in the same year during the early growth period stresses the plant, perhaps to the level that formation of the reproductive parts cannot be achieved, especially if the growing season is not of sufficient duration to allow the plant to replenish the root reserves. Repeated early season grazing over subsequent years continually lowers the root reserves, reducing the ability of the plants to produce seeds (Laycock 1979). However, this requires that all plants be grazed and that all portions of the plant be removed. Any herbivory that results in only a portion of the plant being removed, or only affects a portion of the total number of plants, would have less of an impact. Repeated spring grazing by domestic sheep in southeastern Idaho resulted in a decrease in perennial forb cover and increases in the cover of shrubs and grazing-tolerant perennial grasses (Bork et al. 1998).

Not all plants initiate growth at the same time; therefore, the herbivore may switch among plants during the season. The more species of plants available, the less likely any one species will experience the bulk of the herbivory. Also, with a shorter the grazing period, it is more likely that some plants will be in a growth stage that is not impacted by herbivory. Altering the grazing period from one year to the next also reduces the likelihood that any one species would be impacted every year. Slight to moderate levels of grazing, with non-uniform distribution of the grazing, are likely to have less impact during the early season than heavy, repeated, and uniform grazing within a pasture.

Grazing during the latter portion of the growing season can limit reproduction and reduce the ability of the plant to replenish the root reserves. Regrowth of foliage is less likely as soil moisture declines, and the plant has switched physiological pathways to produce the reproductive parts. Without regrowth, the unused foliage must replenish the root reserves. The caveat provided above for early season herbivory also applies; partial removal of the foliage, or only grazing some of the available plants, will reduce the impact.

Grazing the above ground foliage during the dormant period does not impact the carbohydrate reserves. Foliage removal during this period does not impact the plant; however, the protein level of the foliage declines as the foliage dries out, reducing the value of the forage to the herbivore. Bork et al. (1998) found that repeated fall grazing by domestic sheep in southeastern Idaho decreased shrub cover and increased perennial grass and forb cover. Sheep utilized more brush in their diet during this time period because of the lowered

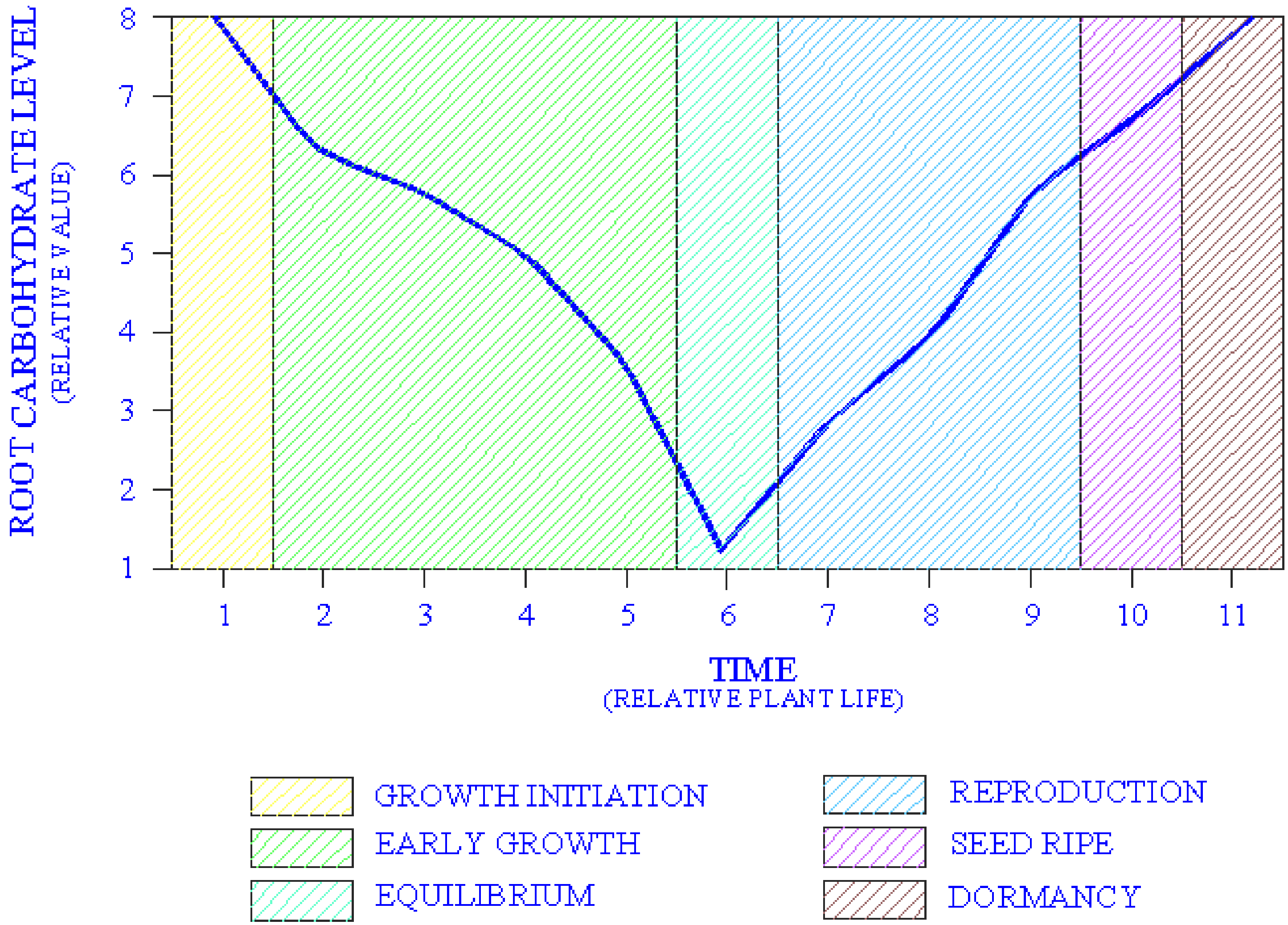


Figure 9. General Root Carbohydrate Cycle - Perennial Plants.

nutritional value of the dormant herbaceous vegetation.

West et al. (1984) found no increase in total herbaceous production in big sagebrush range in Utah following 13 years without livestock grazing. In southeastern Idaho, 25 years without livestock grazing in the sagebrush steppe resulted in only a five percent increase in basal cover of perennial grasses (Anderson and Holte 1981). Neuman (1993) demonstrated that root stress (in the form of oxygen deficiency and root restriction), reduces leaf growth and results in increased starch concentration in the leaves (i.e., carbohydrates were not translocated to the roots). Therefore, in the absence of herbivory, the ability of the plant to replenish root reserves can be impacted by other factors, and thus the long-term changes in plant communities that result from plant-plant interactions can occur.

The previous discussion demonstrates that herbivory by wild or domestic animals can impact the herbaceous vegetation; however, it also demonstrates that herbivory can be conducted with minimal impact to the vegetation. By adjusting grazing systems to vary the seasonal timing and intensity of herbivory, and allowing plants to replenish the root reserves, grazing and other land use objectives can be achieved. These impacts and lack of impacts are put into historical perspective in the following discussion.

Over the last 150 years, the combination of plant-animal interactions (herbivory) and plant-plant interactions (competition) have resulted in changes in the plant communities on western landscapes. The prevalence of grazing in the West has resulted in many people reaching the conclusion that all of the plant community changes have been the result of livestock grazing. As the above discussion demonstrated, herbivory can impact vegetation, but the degree of impact is dependent on the intensity of herbivory (i.e., how much of each plant and what proportion of the total number of plants are consumed), the period of time that the herbivory takes place (i.e., early, late, or after the growing season), the duration of the herbivory (i.e., how long during the growing season the herbivory occurs), repeated herbivory at the same time of the year every year, and other stresses on plant physiology.

As discussed in detail in Section 2.4, major climatic changes were occurring at the time of European man's settlement of Nevada. The Little Ice Age was ending and the climatic regime experienced in the 300 years preceding about 1850 was changing from cold and wet to warm and dry. The climatic conditions that supported relatively high vegetation cover, including both sagebrush and herbs, changed to conditions that favored the competitive advantages of shrubs and trees, especially sagebrush (longer growing season, deeper root system, and adaptations for retaining limited moisture). The season-long grazing practiced during the early part of this period, combined with a gradual shift to a warmer and drier climate, proved favorable for shrub dominance over most of the Great Basin. However, the introduction of intensive season-long grazing did not immediately create noticeable impacts. The seedbank of perennial grasses and forbs was extensive due to the lack of grazing and high moisture levels preceding 1850. The combination of available seeds and slowly changing climatic conditions allowed heavy grazing pressure to occur over a 20 to 50 year period without causing alarm. Some of the impacts were ameliorated by the removal of sagebrush for fuel in the vicinity of mining communities, reducing the competitive stress to herbaceous plants. Sheep grazing and winter grazing by cattle also impacted the amount of sagebrush on the landscape by the early 1900s. But as the climatic conditions became more favorable for shrubs, the combination of competition between shrubs and herbaceous plants, and season-long grazing depleted the understory of many range sites. The combination of sheep and cattle on the same ranges, either concurrently or sequentially, exacerbated the impacts to the vegetation.

Establishment of the Forest Reserves, precursors to the National Forests, and later the establishment of the Grazing Service, currently the Bureau of Land Management (BLM), resulted in changes to grazing on public lands. Although the initial missions of the Forest Service (USFS) and the BLM included forage production, the management objectives were to improve range condition that had deteriorated during the 1800s and early 1900s. The dominance of the shrub component of the plant communities eventually led to "range improvement" practices. Range improvements included sagebrush control, fencing to create pastures for livestock control, and eventually, crested wheatgrass seedings to increase forage production. Water developments, such as spring developments, water distribution systems, and wells were also completed to facilitate livestock distribution. Some of these range improvements, such as the water distribution systems, wells, and fences, had immediate benefits for wildlife. Where crested wheatgrass was established to replace halogeton, some improvement for wildlife occurred. However, where sagebrush lands were converted to crested wheatgrass, the net impact in the short-term was loss of wildlife habitat. Irrigated pastures also increased habitat values for wildlife, but degraded riparian areas decreased wildlife habitat values.

As the science of range ecology developed, the grazing systems were being designed based on an understanding of plant physiology. Rest-rotation and deferred-rotations systems were based, in part, on the carbohydrate model presented above. A three-pasture rest-rotation system limits the impacts of herbivory on the forage plants by allowing early grazing one year, complete rest the second year, and late or dormant season use the third year. This provides two full growing seasons out of every three years for the plants to complete the growth cycle to produce seeds and replenish root reserves. The one year of early season grazing may not stress the plants if the stocking rate, duration of grazing, and distribution of livestock are adjusted to the site. A deferred rotation basically changes the use from early season to late season from one year to the next. As with the rest-rotation system, this allows herbivory during one growing season, but eliminates livestock grazing during the growing season or until late in the growing season the following year. Short-duration, high intensity grazing and active herding of livestock are two other practices that show promise for minimizing the impacts of herbivory on western rangelands.

These types of grazing systems have resulted in improvements in range condition. However, as indicated in Section 2.2.4.1, when Wyoming sagebrush exceeds 10 - 12 percent canopy cover, or mountain big sagebrush exceeds 15 - 20 percent canopy cover, sagebrush begins to out compete and displace the herbaceous understory (Winward 1991, 2000), even in the absence of grazing. The stress placed on the herbaceous plants affects the ability of the plants to replenish the root reserves, and eventually the herbaceous plants are greatly reduced within the community. The site-specific plant equilibrium discussed at the end of Section 2.4 would not be achieved in the presence of grazing. In the absence of grazing, the competitive interactions between shrubs and herbaceous plants would be expected to lead to shrub dominance, but not the complete absence of herbaceous plants. In the presence of grazing, the additional stress of herbivory would drive the system to a greater degree of shrub dominance, further decreasing the herbaceous understory (**Figure 10**). This movement beyond the historic plant equilibrium may represent crossing a plant community threshold, and is one "impact of grazing" on rangeland vegetation. However, this impact is largely from lack of vegetation management, rather than from grazing (i.e., lack of disturbance, such as fire, to remove the shrubs). Maintenance of the herbaceous understory is dependent upon disturbance to the sagebrush overstory; changes in grazing practices alone cannot prevent sagebrush from becoming the dominant vegetation. Once sagebrush is dominant, changes in grazing practices alone cannot restore the herbaceous understory.

As demonstrated in **Figure 10**, the "impact" of grazing is less when the grazing occurs in the grass-dominated stages, rather than in the shrub

A second "impact of grazing" on rangelands is the manner in which grazing can drive the system. As discussed above, competition between shrubs and the herbaceous understory occurs when shrubs obtain about 10 to 12 percent canopy cover in Wyoming big sagebrush communities and 15 to 20 percent in mountain big sagebrush communities (Winward 2000). Once that threshold is reached, the system will move to shrub dominance over time due to interspecific competition if disturbance does not occur. The introduction of livestock grazing into this plant community dynamic decreases the time necessary to reach shrub dominance. Therefore, the natural disturbance interval is no longer the appropriate interval for the system. A shorter interval must be imposed on the plant community if livestock grazing is present, at least in the Wyoming big sagebrush plant communities.

A third "impact of grazing" is the reduction of herbaceous fuels in the sagebrush-herb community, especially where season-long grazing is practiced. The removal of the fine fuels effectively prevents fires from spreading

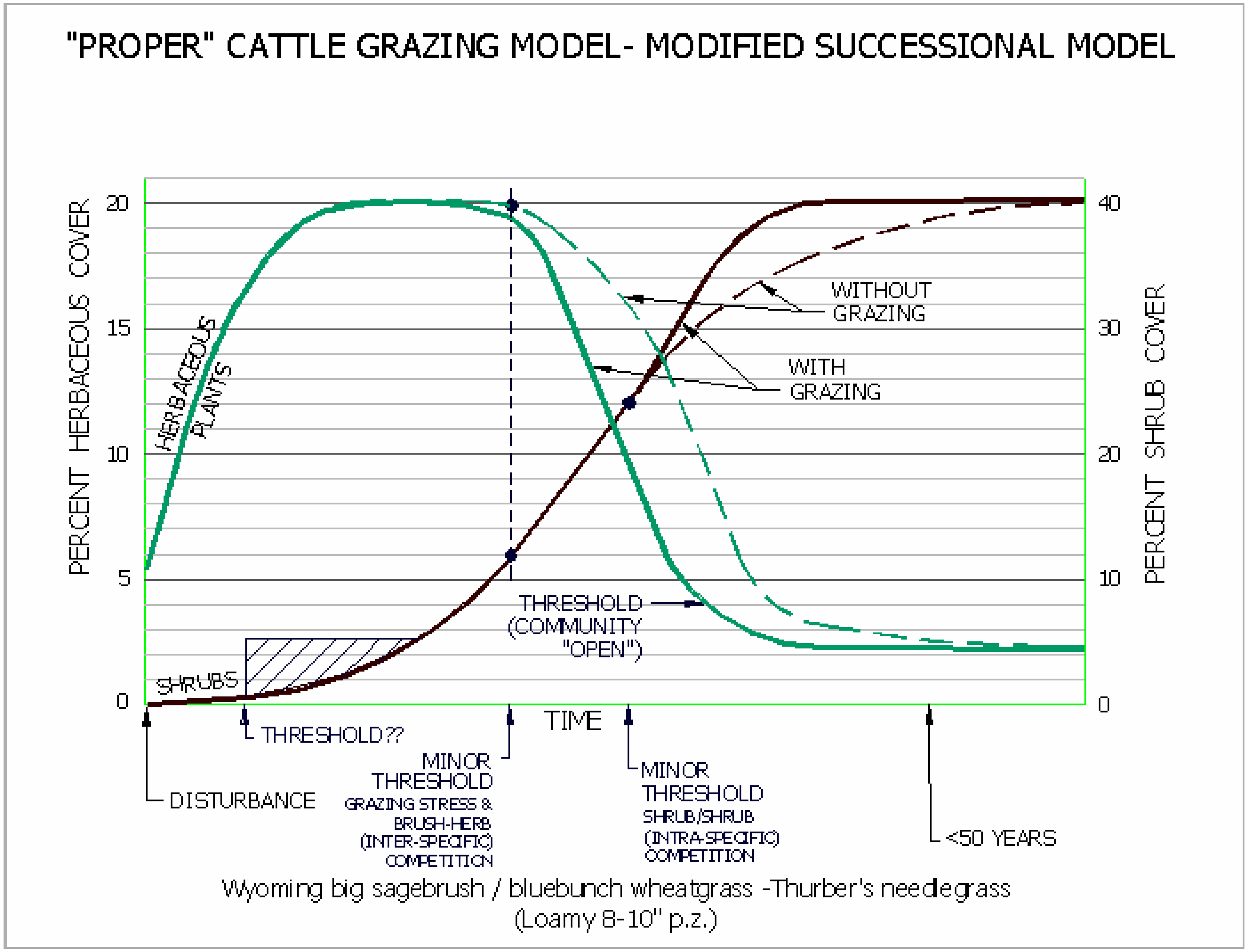


Figure 10: Basic Conceptual Model With Proper Grazing, Loamy 8-10" p.z. Range Site

over large acreages, extending the fire interval. The absence of disturbance allows the woody fuels to accumulate in excess of “natural” levels. As the shrub density and/or crown size increases, the shrubs become sufficiently close that the fine fuels are no longer required to maintain fire spread. The resulting “crown fires” are generally of high intensity and severity, with high potential for type conversion to annual grasslands. This “impact” can be eliminated by implementing fuels management plans that break up the contiguous fuels created under this scenario.

Recently, emphasis has focused on the maintenance and rehabilitation of riparian systems. Riparian stability or instability is generally perceived to be the result of poor land management practices, including improper livestock grazing. While improper grazing can certainly create riparian damage, there may be other underlying factors that contribute to riparian degradation. As with the other issues affecting Sage-Grouse, there are many factors involved. Masters et al. (1991) present the case that base level lowering within a hydrographic basin creates a steepened gradient, which then induces accelerated flow, causing the formation of a headcut. As a headcut migrates upstream, a corresponding downstream deposition of eroded material results in the creation of deltas, sandbars, or build up of flood plains. The areas of deposition often become wetlands and improve the functioning of the downstream system. However, the major impact of base level lowering is the general lowering of the water table. Areas that once supported riparian vegetation, such as stringer meadows and flood plains adjacent to the creeks, cease to function as riparian systems, and sagebrush, rabbitbrush, or other shrubs establish on the elevated banks.

These changes in riparian areas resulting from base level lowering occur with or without livestock grazing, but can occur more rapidly with improper grazing. The prevalence of grazing in the West has tended to mask these other factors. But the 500 foot drop in base level in the Humboldt River system from where the Humboldt River emptied into Lake Lahontan and the current level of the Humboldt Lake (Sink) is still affecting the entire drainage system across northern Nevada (Masters et al. 1991). This is a process that initiated prior to European settlement of Nevada (Schumm and Hadley 1957, Davis and Elston 1972), and will continue into the future, irrespective of past, present, or future land use. Changes in grazing systems or removal of grazing from a meadow will not prevent the loss of the meadow if the erosion processes associated with base level adjustments are the driving factor.

Recently, studies in western and central Nevada have identified that some riparian issues may be the result of climatic factors occurring over 2000 years ago (Miller et al. in press). Deposition of wind blown sediments into drainages during extended drought may have built up the floodplains beyond the capacity of the streams to flush these sediments under drought conditions. Vegetation establishment on these areas of deep, fine sediments was sufficient to maintain the floodplain during normal events, but extreme events appear to cause these systems to seek the former equilibrium base condition (i.e., the channel level prior to sedimentation build up). Some of these extreme events that caused major headcutting occurred before the introduction of domestic livestock into Nevada. This could be evidence that some of the incised streams may be a result of factors other than livestock grazing, or a combination of factors, including livestock grazing. Suzie Creek and Dixie Creek in Elko County may be two examples of streams where downcutting is occurring through fine, wind deposited sediments that accumulated thousands of years ago.

This is not to imply that all riparian problems are the result of base level lowering and historic drought conditions. Utilization mapping of allotments in Elko County consistently demonstrate the heaviest utilization occurs on riparian areas and upland areas adjacent to water sources, especially where grazing occurs late in the season (or hot season). Because riparian systems have higher soil moisture levels, the plants have the ability to regrow after grazing and can replenish the root reserves, if grazing does not occur throughout the entire season. In addition, soil compaction occurs in moist soils as the result of concentrated use by livestock, reducing the water holding capacity of riparian soils. Bank trampling can also result in a change in the stream channel morphology, increasing the potential for erosion.

Rehabilitation of riparian systems has been the focus of livestock management over the last 20 years. Attempts to fence riparian zones resulted in drastic changes in the vegetation, but long-term maintenance of exclosures has been ineffective, and the "improvements" can be reversed in relatively short time if the fences fall into disrepair. In addition to creating a maintenance problem, fencing riparian areas also resulted in some areas converting from a riparian meadow to riparian shrub zones. The rank growth of grass and/or shrubs changed the wildlife values of these fenced areas, benefiting shrub-dependent species and decreasing the value of these areas for open meadow species, such as Sage-Grouse.

Small exclosures around springs or riparian zones are being replaced with riparian pastures. This essentially creates a small pasture within a larger existing pasture. The riparian pasture is large enough to permit grazing under controlled or prescriptive conditions. By including some adjacent rangelands within the pasture, the pressure on fences is reduced because the livestock are farther away from the riparian vegetation and are not as persistent in trying to enter the pasture. The prescriptive grazing allows for management of the upland vegetation and the riparian zone.

Proper management of riparian systems requires an understanding of the ecological basis for the overuse that occurs in these systems. In northern Nevada, grazing occurs while the cow is lactating. A lactating cow has higher nutritional and water requirements than a steer. During the early part of the growing season, the nutritional needs can be met while grazing fresh grass on the uplands. The succulent herbaceous forage provides much, but not all of the water requirements. Therefore, some use of a riparian area or an area near a water source is anticipated. As the growing season progresses and the upland vegetation begins to lose moisture content, more of the cow's water needs must be met by either free water, or from more succulent vegetation found in riparian areas. This increased need for water coincides with higher daytime temperatures and increased solar radiation. The cows seek areas with shade, such as willow stands, aspen stands, pinyon-juniper woodlands, or areas of Basin big sagebrush. As the uplands continue to desiccate, the protein level of the herbaceous vegetation declines, and the nutritional demands of the lactating cow can no longer be met by grazing the uplands. The quantity of forage required to obtain the same level of nutrition increases as the forage dries in late summer. Foraging efficiency becomes a factor in where to forage. Steep hillsides with dry forage do not provide the same efficiency as valley bottoms with riparian vegetation, water, and shade. Therefore, the riparian areas become more attractive.

The situation with yearling steers is similar, but the nutritional and water requirements are not as great as for a lactating cow. Therefore, steers can and do get more of their water requirement from the upland vegetation longer into the season, and they can meet their nutritional needs from the upland vegetation until late summer. Steers are also more likely to feed on steep slopes. As a result of these factors, utilization mapping of yearling steer operations tend to show less concentrated use of the riparian zone and more extensive use of the uplands. However, steers left in one pasture for the entire grazing season, or for just the period of August through September, will increase their use of the riparian zone as the summer passes. The level of impact to the riparian zone depends in part on the extent of the riparian zone, as well as the number of steers in the pasture.

Riding to move livestock out of riparian areas and experiments with herding to keep livestock on the move have shown promise as techniques that can minimize impacts to riparian systems. However, to be effective, there must be another water source or riparian area to which the livestock can be moved. Using the uplands and riparian areas in conjunction with each other by moving livestock out of riparian areas or by herding, rather than using the uplands and riparian areas sequentially, has potential to decrease impacts to the riparian areas.

These techniques can be facilitated by proper vegetation management. Foraging efficiency is not only dependent on the nutritional level per bite of forage, but also on the number of bites of forage that can be obtained over time. Rangeland dominated by sagebrush with a depleted understory cannot be foraged as efficiently as the same landscape with less shrub cover and more herbaceous cover. Old, ungrazed plants are less palatable to livestock and have less nutritional value compared to younger plants or plants that have been moderately grazed the previous year. Consequently, portions of pastures that are distant from water are likely to have more older or ungrazed plants than areas closer to water. Herding livestock into these areas to force them to graze the plants will stimulate new growth in subsequent years, making the plants more nutritious and palatable to livestock. Shrub thinning to create opportunity for establishment of more herbaceous plants can also be used to attract livestock to these areas. As a result, some grazing pressure can be transferred from the riparian areas to the uplands.

As we develop a better understanding of the processes that affect landscape changes (i.e., geomorphic processes, plant-animal interactions, plant-plant interactions), the ability to manage these changes will increase. As we develop a better understanding of how these various processes interact, the "cause and effect" relationships that we perceive today are likely to change.

2.5.6 Fire Ecology

The trend toward increased size, intensity, and frequency of wildfires in recent years has focused attention on fire ecology. The discussion in Section 2.4 includes some historical information regarding fire ecology. The climatic, paleobotanic, and historic evidence indicates that fire was a factor in the sagebrush ecosystem long before European man's arrival (Miller and Wigand 1994, Miller and Rose 1999, Miller and Eddleman 2000). The landscape that existed in the early 1800s was a result of the interaction of geomorphic conditions, climatic factors, and fire history. The role of Native Americans in modifying the landscape in northeastern Nevada is not well documented. Escaped fires from camps are likely to have occurred on occasion, but the intentional use of fire to affect vegetation change on the landscape may not have been a technique used by Shoshone and Paiute tribes in this area. The reliance on pine nuts as a food staple would suggest that extensive burns in the pinyon-juniper woodlands would not have been beneficial in the short-term.

Geomorphic features, such as soil, topography, and drainage patterns influence fire behavior. Soils determine the productivity of a site, as well as the vegetation that exists on the site. Low sagebrush is generally associated with claypan soils. This plant community has low fuel loading, low structure, and wide spacing between plants, all factors that retard the spread of fire. Conversely, deep soils along drainages or valley bottoms often support dense vegetation, such as Basin big sagebrush and Great Basin wildrye. The heavy fuel loading, continuous fuels, and high structure are factors that create intense fire conditions. Topography can also influence the spread of fire. For example, south facing slopes generally are dry sites that do not support dense vegetation. These slopes can function as a fire break under some conditions. The more mesic north slopes support a higher fuel loading, such as the mountain brush type, and are more likely to carry a fire than the vegetation on a south slope.

Perhaps the major factor in presettlement fire patterns was the configuration of drainages on the landscape. The extensive dendritic patterns typical of the North Fork of the Humboldt River, consisting of many tributaries dissecting the landscape, were riparian areas of high fuel loading, but also areas of fuel with high moisture content. During "normal" years, these natural greenstrips probably acted as fire breaks, limiting the size of fires. The topography associated with these drainages may also have influenced the fire pattern. The drainages with east-west orientation would be bordered on the north side by a south-facing slope, further adding to the fire break potential. During drought years when fuel moisture would have been lower, the high fuel loading typical of riparian areas would have contributed to the fire intensity and allowed fires to continue across the landscape. Other areas, such as Ruby Valley and Independence Valley (east of Wells), were lacking the extensive dendritic drainage patterns. In these areas, mountain creeks become intermittent flows at the valley floor where the flows enter the ground water in the alluvial deposits. Fires in these closed basins probably burned the entire valley, depending on local winds and storm precipitation.

Climate changes also influenced fire ecology. The 300 years preceding European settlement of Nevada was a period of cooler temperatures and higher precipitation than currently exists (Miller and Eddleman 2000). The increased moisture would have favored plant production, and the combination of cooler temperatures and higher moisture conditions would have been less favorable for large, intense fires. In general, small, widely spaced fires are expected under these conditions, resulting in a mosaic of vegetation age classes on the landscape. However, even during this period known as the Little Ice Age, drought conditions occurred periodically. The high fuel loading created during the wet years would have created conditions for large, intense fires in the drought years.

Fire history also influences the vegetation that exists on a site at any given time. For example, in a Wyoming big sagebrush site, during the first ten years after a fire the site is generally dominated by grasses. During the next ten to 15 years, shrubs begin to establish and add to the fuel loading. From 15 to 40 years post-fire, the shrub component increases and the herbaceous vegetation decreases. After 40 years, the shrub component dominates the site and fuel loading is high. A lightning strike in each of these site conditions will result in different types of fires with different vegetation responses.

Each range site responds to varying fire intensities differently from other range sites. However, some general patterns exist that serve as a basis for understanding the role of fire frequency or fire interval. Fire frequency is the number of times a site burns over a specified number of years. For example, four burns in 100 years. Fire interval is the average time between burns. Using a fire frequency of four burns in 100 years equates to a fire interval of 25 years. In general, fire frequency and fire interval are related to fuel loading and the frequency of ignitions.

For a mountain big sagebrush community, historic fire intervals are estimated to be on the order of 25 years (Winward 2000, Gruell et al. 1994, Miller and Rose 1999). Following a fire in this community, mountain big sagebrush often establishes within the first few years. Within ten to 15 years, a brush community is well established and the site has sufficient fuel loading to burn again under “normal” conditions. This vegetation community is generally found above 6,500 feet amsl and is subject to a higher frequency of storm events or ignition strikes. This results in a long term average fire frequency of approximately four fires every 100 years, or a fire interval of 25 years. Due to the random nature of lightning strikes and the variability of conditions (relative humidity, fuel moisture, wind speed, etc.) at the time of a lightning strike, there is considerable variability associated with the 25 year average fire interval.

The fire interval for Wyoming big sagebrush communities is somewhat longer, perhaps 50 to 100 years (Wright and Bailey 1982), or as short as 40 years (Winward 2000). Wyoming big sagebrush is found at lower elevations than mountain big sagebrush and on more xeric sites. Wyoming big sagebrush seedling establishment is also dependent on two consecutive years of normal or above normal winter precipitation (Maier et al. 2001); therefore, establishment of this species after a fire is weather dependent. Sagebrush seed does not establish far from the mother plant, which also limits the rate at which Wyoming big sagebrush recolonizes a burn. As indicated above, it may take up to 40 years before Wyoming big sagebrush is sufficiently established to provide fuel loading capable of sustaining a fire. Considering the combination of conditions suitable for ignition and time required to establish sufficient fuel loading, a 40- to 100-year fire interval for this vegetation community is a reasonable estimate.

Low sagebrush, as indicated above, does not burn often. Estimates of presettlement fire intervals for the low sagebrush community range from 100 to 200 years (Young and Evans 1981, Miller and Rose 1999). This may be less a function of fuel loading, which may reach optimum in less than 100 years, and more a function of ignition frequency under the extreme conditions (extremely low relative humidity with high winds) necessary to burn this vegetation type. The conditions under which low sagebrush communities burn are the conditions under which catastrophic fires occur, and every plant community burns.

At the end of the Little Ice Age and the introduction of livestock in the Great Basin, the conditions that led to these fire intervals changed. The Little Ice Age ended around 1850 and the climate started to shift from cool and wet to warm and dry. These climatic changes over the last 150 years, in the absence of grazing, would have resulted in less fuel production, but increased frequency of suitable burn conditions. More frequent burns would have resulted in less shrub dominance on the landscape and more areas dominated by herbaceous plants. The spacing of the bunch grasses would have been greater, due to the reduced moisture availability. However, livestock grazing also influenced the fire interval. Season-long grazing and the high stocking rates that were typical of the late 1800s and early 1900s reduced the availability of herbaceous fuels by late summer. Shrub removal as fuel for mining communities, shrub reduction by sheep grazing, and reduced shrub establishment due to drier conditions also reduced fuel loading. Consequently, lightning strikes, no matter how frequent or under all but extreme conditions, were not likely to start a fire, or the fires were not able to spread very far.

Changes in grazing following the creation of Timberland Reserves (1891), implementation of forest grazing regulations (1911), and passage of the Taylor Grazing Act (1934) resulted in fewer livestock and better distribution of livestock on public lands. Sagebrush was reestablishing in areas where it had been removed for fuel as the mining boom waned. By the mid-1900s sagebrush was a dominant plant on the rangelands and a variety of age classes existed. Fuel loading had increased by this time, but grazing was still sufficiently heavy to keep fine fuels in check. The lack of herbaceous understory and the abundance of sagebrush, along with the spread of halogeton, resulted in sagebrush control and crested wheatgrass seedings to increase livestock forage. Cheatgrass was becoming more common in the understory of many sagebrush communities and dominating disturbed sites, but was not a major concern in the 1950s.

Records of large wildfires between 1900 and 1960 are negligible. However, in the 1960s, several large fires occurred in northern Nevada. The northern portions of Lander and Eureka counties had large acreages burned, and cheatgrass began its domination of Boulder Valley and areas near Beowawe and Dunphy, Nevada. Over the next 40 years, areas that had historic fire intervals of 40 to 100 years prior to settlement and only small fires between 1850 and 1960, burned on average once every decade. The spread of cheatgrass from these areas to other sagebrush communities increased the flammability of these communities, resulting in cheatgrass dominance as fires started in these altered plant communities. By 1999, the open stands of sagebrush of the 1950s had become dense stands of sagebrush, many with a cheatgrass understory. The extreme conditions in July and August of 1999, combined with thousands of lightning strikes, caused wildfires that burned over 1.7 million acres in the Great Basin. Similar situations occurred in 2000 and 2001, but involved less acreage in Nevada. Not all of the acres burned converted to cheatgrass and not all of the acreage required emergency rehabilitation; however, the acreage that was sagebrush is not likely to support sagebrush for the next 10 to 15 years or longer.

The major fire outbreaks that have occurred over the last four decades have been the result of changing conditions on the landscape (e.g., changes due to livestock grazing, cheatgrass expansion, sagebrush domination, cumulative impacts of historical fire suppression efforts, etc.) and changing climatic conditions. Consequently, the fire interval has decreased on large acreages of rangelands to a decade or less. This decreased interval (or increased fire frequency) is not favorable for shrub establishment. Continuation of this pattern will result in a change from sagebrush dominated rangelands to grass dominated rangelands; either perennial grasses, annual grasses, or a combination of both.

Since 1980, approximately 1.8 million acres of sagebrush habitats have been affected by fire in Elko County. Intact sagebrush remains on 9,809,800 acres, perennial grasslands (i.e., areas seeded to crested wheatgrass since the 1950s, areas seeded following fires since 1980, areas burned above 6,000 feet elevation in the past five years and not seeded following wildfire, and areas burned below 6,000 feet elevation in the past ten years and not seeded following wildfire) occur on approximately 1,342,000 acres, and annual grasslands (cheatgrass monocultures created by wildfires and to a lesser extend, livestock grazing) occur on 326,300 acres.

The pinyon-juniper woodland has undergone similar changes in fire ecology. Miller and Tausch (2001) estimated that juniper and pinyon woodlands have increased ten-fold during the past 130 years in the Intermountain West. Much of this acreage involves lands that formerly supported sagebrush and Sage-Grouse habitats. Within the planning area, pinyon-juniper encroachment is estimated to have occurred on approximately 354,500 acres. The reader is directed to literature by Miller and Rose (1995, 1999), Miller and Wigand (1994), Miller et al. (2000), Gruell et al. (1994), and Neilson (1987) for discussions of fire history, fire ecology, and post-settlement changes in the pinyon-juniper woodlands.

2.5.7 Disturbance

Disturbance refers to direct interference with Sage-Grouse, rather than a habitat disturbance, and can include many types of disturbance. Increased traffic on a road that formerly had little traffic and is located near a lek is an example of a disturbance that may cause the birds to abandon a lek. This has been documented near new mines when the traffic level increases. Similarly, a new housing development near seasonal habitats may result in Sage-Grouse abandoning that habitat as people or their pets disrupt seasonal activities. The impact of military flyovers has been raised as a concern, but studies have not been conducted to determine if impacts actually occur. Recreational viewing of Sage-Grouse at leks or on wintering grounds is also a concern if the number of visits becomes high or the actions of those viewing the birds are not appropriate. Very little work has been done to document these types of impacts or the extent to which they affect populations. However, disturbance is an issue that should be included in planning documents.

2.5.8 Predation

Section 2.3.4 discussed predation ecology as a general discussion. The following discussion focuses on predation specifically as it relates to Sage-Grouse.

Predation is the most important proximate cause of Sage-Grouse mortality (Braun 1975, Bergerud 1988a, Autenrieth 1986, Schroeder et al. 1999); almost every Sage-Grouse will eventually be eaten. Sage-Grouse are known to be included in the diet of a variety of species **(Table 3).** Sage-Grouse eggs, new-born chicks, and juvenile birds have a greater number of predators and are more vulnerable to predators than are adult birds. The differential adult sex ratio also indicates that males have higher mortality than females (Schroeder et al. 1999).

Table 3: **Sage-Grouse Predators and Life Stage at which Predation Occurs**

Predator	Life Stage at which Predation Occurs			
	Nest/eggs	Chicks	Juveniles	Adults
Golden eagle		x	x	x
Red-tailed hawk			x	x
Ferruginous hawk			x	x
Swainson’s hawk			x	x
Rough-legged hawk			x	x
Northern harrier		x	x	
Gyrfalcon				x
Northern goshawk				x
Cooper’s hawk				x
American kestrel		x		
Merlin		x	x	
Common raven	x	x		
American crow	x			
Black-billed magpie	x			
Coyote	x	x	x	x
Red fox	x	x	x	x
Weasels	x	x	x	
Badger	x			
Bobcat			x	x
Ground squirrels	x			
Elk	x			

Sources: Girard (1937), Rasmussen and Griner (1938), Allred (1942), Carhart (1942), Batterson and Morse (1948), Patterson (1952), Presnall and Wood (1953), Hogue (1954), Nelson (1955), Hartzler (1974), (Beck 1977), Autenrieth (1981), Gill (1965), Holloran (1999), and DeLong et al. (1995).

Nest predation has been considered by some researchers to be the primary limiting factor for Sage-Grouse populations (e.g., Batterson and Morse 1948, Autenrieth 1981, Gregg 1991, Gregg et al. 1994), and predation on eggs and birds was considered by Schroeder et al. (1999) as the primary cause of mortality. Reported nest success varies from less than 15 percent to as high as 86 percent (Schroeder et al. 1999), and is influenced by weather and habitat quality, as well as by predation. Studies have demonstrated that the primary nest predator species varies among study sites. Avian predators, primarily corvids (ravens, crows, and magpies), were the major predators of nests in Oregon and southern Idaho (Batterson and Morse 1948, Autenrieth 1981), while ground squirrels and badgers were the major predators in a study in Colorado (Gill 1965) and Wyoming (Patterson 1952).

Survival of newly hatched chicks may also be influenced by predation, but nutrition, habitat quality, and weather are also significant variables in chick mortality (Pyle and Crawford 1996, Sveum 1998b, Blake 1970, Rich 1985).

Survival between hatching and the end of summer varies from approximately 40 percent (June 1963) to 60 percent (Wallestad 1975). Although a greater number of predators are known to prey on juvenile Sage-Grouse, several factors lower the mortality rate at this life stage. After about six weeks of age the juveniles are able to take advantage of cover, detect predators, and escape by flying. Due to these factors, successful predators are more likely to take an individual juvenile Sage-Grouse as the birds increase in size and ability to escape, whereas a single predator is more likely to take an entire clutch of eggs or brood of newly hatched chicks.

Data from 1998 for Elko County indicate a 37 percent reproductive success rate. The mean brood size in Elko County between 1966 and 2000 was 3.9 juveniles per hen (NDOW Region II Files). The average clutch size for Sage-Grouse is between 6.6 and 9.1 eggs (Schroeder et al. 1999). Using the mid-range of the average clutch size (i.e., 7.9) and the average brood size during summer, a mortality rate of approximately 50 percent occurs between egg-laying and summer. Wing data collected in Elko County during hunting seasons from 1996 through 2000 indicated that by fall, the average number of young per hen was 1.48 (range 0.78 young per hen in 1996 to 2.19 young per hen in 1999; NDOW Region II Files). This is well below the 1.75 young per hen ratio needed to just maintain the population level (Stiver, personal communication). Assuming the average clutch size is 7.9 (mid-range given above), the combined mortality rate of eggs and juvenile birds from April to October is approximately 80 percent.

Predation of adult Sage-Grouse occurs, but overall survival of adult birds ranges from 55 to 67 percent for females and from 38 to 60 percent for males (Zablan 1993, Connelly et al. 1994, June 1963). Although there are several predators of adult Sage-Grouse (Table 1), the relative impact of these predators on the population is less because the encounters may be less frequent during portions of the year and predators are less effective when preying on adults (Bean 1941, Beck 1977).

Connelly et al. (2000) found that although predation was the most common cause of death for adult Sage-Grouse in Idaho, the high annual survival rate of adults (Connelly et al. 1994) and low mortality over winter indicated that predation had little impact on Sage-Grouse populations. Even with low reproductive rates, sufficient recruitment of young birds to the population was occurring to maintain population levels.

As discussed in Section 2.3.4, predation rates need to be considered in conjunction with the habitat quality, and both factors may need to be addressed within a watershed to improve Sage-Grouse populations.

2.5.9 Hunting

The axiom that upland species, being density regulated, are virtually unaffected by hunting pressure has a long history in the field of wildlife management (Errington 1945, Mardsen and Baskett 1958). Studies of hunting impacts on Sage-Grouse in Colorado showed that harvest was a function of the total birds available in the fall (Braun and Beck 1985). Hunters generally harvested between 7 and 11 percent of the birds available in the fall, regardless of season length and bag/possession limits. The study concluded that hunting had no measurable impact on spring densities of Sage-Grouse. Wallestad (1975) also concluded that hunting had little influence on Sage-Grouse populations in

Montana. Information from Idaho (Gray 1967, Autenrieth 1981), Oregon (Willis et al. 1993), and Wyoming (Patterson 1952) indicate that harvest rates range from less than 3 percent to approximately 25 percent.

Zunino (1987) and Stigar (1989) studied hunted and non-hunted areas over a four-year period in northern Washoe County, Nevada. The hunted area purposely received high hunting pressure and had a harvest rate of 25 percent, which is the upper value for the normal harvest rate of less than 3 percent to 25 percent. The number of birds increased on both the hunted and non-hunted areas, but the increase was greater on the non-hunted area. Artificial nest predation studies on the same area indicated that the populations were also withstanding severe nest predation by ravens (Stigar 1989, Alstatt 1995). The studies indicated that while hunting was the major cause of fall mortality, the populations were able to withstand some level of harvest, even while experiencing high levels of nest predation.

In contrast, studies on bobwhite quail (Robinette and Doer 1993), sharp-tailed grouse (Gregg 1990) ruffed grouse (Kubisiak 1984), and Sage-Grouse (Johnson and Braun 1999) suggest that hunting may be an additive form of mortality. These conflicting studies may be the result of studying populations during different population trends (increasing or decreasing) or populations existing in different quality habitats, which could influence recruitment.

The early studies occurred during periods of population highs when the number of reproducing females was high and production would also have been high. A "surplus" of young is produced when populations are increasing (i.e., more recruitment than mortality), and such populations can withstand hunting pressure.

Connelly et al. (2000) analyzed band returns and radio-location/return data for Idaho Sage-Grouse over a 23-year period. Harvest rates for females were greater than for males. Forty-six percent of the adult female mortality occurred in September and October compared to only 28 percent of the adult male mortality, with 95 percent of the combined September-October mortality due to hunting. The differential mortality rates during this time period were attributed to females with juveniles remaining on meadows and riparian areas, while males and unsuccessful females were more dispersed in the upland vegetation. The relatively high rate of female mortality at this time of the year suggests that hunting may be additive to winter mortality, decreasing the size of the spring breeding population.

This study occurred during the decline in Sage-Grouse across the west. A population that is declining by definition does not produce sufficient young to offset adult mortality. Therefore, additional mortality in the form of hunting leads to further population declines. Thus, this "new" science must be taken in context with the population dynamics and should not be interpreted that hunting will always cause population decreases. Population trend is an important factor in determining the level of hunting that is allowable.

Concern exists that local, isolated populations may be vulnerable to concentrated hunting pressure and some studies suggest that this is possible (Autenrieth 1981, Zunino 1987, Connelly et al. 2003). These populations may require special attention if they are to remain viable.

2.5.10 Disease

Sage-Grouse are known to harbor a variety of disease and parasitic organisms. Schroeder et al. (1999) provide a comprehensive listing of the parasites and disease agents. The mere presence of a disease organism or a parasite does not necessarily indicate a population level effect. Herman (1963) pointed out that a "healthy" wild animal carrying only a single pathogenic agent is a rare occurrence. Therefore, some background level of disease or parasites exists, but under most conditions these agents may be of little significance. However, under certain environmental circumstances, such as drought, one or more disease agents or parasites may increase to a level that impacts the local population (Herman 1963). The causal factors are likely to be different for different outbreaks and different localities.

Although disease outbreaks in Sage-Grouse have been documented (Grover 1944, Batterson and Morse 1948, Honess and Winter 1956, Thorne 1969, Wallestad 1975), the conditions under which the outbreaks have occurred have not always been well documented. For coccidiosis, outbreaks appear related to drought, drying water holes, and/or contaminated water. As with most diseases, transmission is favored when Sage-Grouse have a high probability of contact with other infected Sage-Grouse, or when they are forced to use limited habitats. The concentration of birds at limited water sources may result in fecal contamination of the water and surrounding soils (Thorne 1969). A reversal of the conditions or seasonal dispersal of Sage-Grouse can alleviate the problem (Wallestad 1975).

However, the West Nile virus, has been recently introduced to the United States and has been the documented proximal cause of death in many avian species, including Sage-Grouse. No Sage-Grouse mortality has been attributed to this virus in Nevada, and due to the arid conditions, the risk may be lower in Nevada than in some other states. This is due to the fact that the virus is carried and spread by mosquitoes. Until there are reported cases in Nevada, the impact of this virus on Sage-Grouse populations is unknown.

2.5.11 Cycles

Rich (1985) analyzed 32 years of Sage-Grouse lek counts in southern Idaho and determined that population peaks occurred about every ten years. Although Rich (1985) found some climatic factors that correlated with the population changes, cause and effect relationships were not evident. Braun (1998) reviewed population data throughout the area of Sage-Grouse distribution and concluded that Sage-Grouse populations do not fluctuate on a regular or cyclic basis.

In Nevada, the population data has indicated declining populations since the 1950s, with some rebound in the 1970s. If cycles are occurring in Nevada, they are being masked by the downward trend in the state population.

2.5.12 Climate/Weather

Long term climatic changes are discussed elsewhere in the document in relation to vegetation and Sage-Grouse populations. Other than extended periods (i.e., hundreds of years) of drought, or periods like the Little Ice Age, where climatic changes drive plant community changes, climate is not a major factor in short-term population fluctuations. However, weather, which is a short-term expression of climatic factors, is likely to have influence on annual populations.

Weather can influence the availability and quality of Sage-Grouse food and energetics. As discussed above, newly hatched chicks have limited reserves in the yolk sac and must acquire a high energy/high nutritional diet during the first few days after hatching. This diet is composed primarily of insects, and insect availability is highly dependent on weather. Cold, wet weather causes many insects to seek shelter and become inactive, reducing their availability to Sage-Grouse chicks. Chicks that are stressed are more vulnerable to predators and to direct effects of weather. If chicks survive the first few days, warm, dry weather can reduce forb production on upland sites, forcing the birds to use riparian areas before they have developed sufficient mobility and flight capability to escape predators. During cold, dry winters Sage-Grouse may not find suitable snow for snow roosting, reducing their ability to build up energy reserves for spring breeding. All of these factors can limit recruitment to the population in any given year. Because these types of weather events generally occur over a broad area, population effects can be realized.

In contrast, warm, wet springs that promote forb production and insect abundance, or wet summers that extend the growing season on the upland sites, and winters with abundant snow should all contribute to higher Sage-Grouse population recruitment. Therefore, weather is a factor in Sage-Grouse population changes, but not a factor that can be managed.

2.6 Historical Perspective - Sage-Grouse and the Sagebrush Ecosystem

2.6.1 Presettlement

Sage-Grouse bones estimated to be 4,500 years old have been located in northeastern Nevada (Hockett, pers. comm.), and Schroeder et al. (1999) indicate that Pleistocene fossils of Sage-Grouse have been found within the historical distribution of Sage-Grouse, but are somewhat limited. This may be due to the relatively recent origin of grouse in general, or for Sage-Grouse in particular (Short 1967), or due to the fact that bird bones are fragile and easily consumed by large mammalian predators, and that Sage-Grouse spend most of the year in upland habitats where conditions for fossilization are less than optimum. Nonetheless, the discussion of sagebrush ecology over the last 12,000 years would apply to development or use of habitats by Sage-Grouse.

The period of drought and fire that occurred between 500 and 700 years ago would have resulted in abundant breeding habitat, nesting habitat, and early brood habitat near the transition zone of Wyoming big sagebrush to the mountain big sagebrush communities. The drier conditions during this period would have created snow-free conditions at the moderate slope elevations where mosaics of mountain big sagebrush would have occurred. Stands with substantial understory of herbaceous vegetation would have been used for nesting and early brood use. The areas of low sage, or recently burned Wyoming big sage would have provided breeding habitat (leks) when adjacent to areas with mature sagebrush. Extensive areas of Wyoming big sagebrush sites that had not been recently burned would have provided winter cover. Areas that had been recently burned would have provided little habitat, other than leks, for Sage-Grouse. Winter habitat was probably the habitat that was most unpredictable in space and time. During the early phase of this period, the large fires would have resulted in widely spaced patches of this tall, dense sagebrush. This would have either limited the size of local populations, or resulted in long movements between breeding-summer habitats and winter habitat. As a mosaic of age classes developed, winter habitat may have become more predictable in space, but limited in the acreage available.

Where all of the habitats occurred in a local area, population levels were probably moderately high, depending on the availability of herbaceous understory in the nesting and brood rearing areas. The dry conditions during this period would have limited the herbaceous understory at the lower elevation Wyoming big sagebrush sites, but the impact of this dry period on the higher elevation mountain big sagebrush sites is not clear. Lack of herbaceous production could have limited the insect populations on which Sage-Grouse chicks depended. Annual recruitment of Sage-Grouse may have been highly variable during this climatic period.

With the advent of the Little Ice Age, Sage-Grouse habitat use would have shifted. The lower temperatures and increased precipitation, especially winter snow, would have precluded the use of the mountain big sagebrush sites as nesting and early brood use habitat. However, the increased production of the Wyoming big sagebrush sites would have improved nesting and early brood rearing habitat. The mountain big sagebrush sites and riparian zones would have provided summer brood habitat, and the lower elevation mosaic of Wyoming big sagebrush age classes and low sagebrush would have provided fall and winter habitat. As sagebrush stands aged and were subject to intense crown fires during short-term drought cycles, winter habitat, breeding habitat, nesting habitat, and early brood rearing habitat became less predictable in time and space. The large fires associated with the older sagebrush stands would have reduced the mosaic of habitat types and the longer fire interval would have created sagebrush dominated stands over time.

According to this reasoning, the landscape that occurred at the time of European contact would have been dominated by sagebrush from the mountain sides, across the valleys, to the mountains of the adjacent range. Upper elevation vegetation would have varied with elevation and fire history, but pinyon-juniper, aspen, subalpine fir, limber pine, whitebark pine, and other tree species were found in the various mountain ranges (Charlet 1998). The understory of herbaceous plants would have been a function of the time lapse since fire; large areas of grassland from recent fires would have been widely scattered across the landscape and grassland-sagebrush or sagebrush-grassland would have dominated most of the lower elevation sites.

2.6.2 Settlement and Post-Settlement

The records of the early fur trappers and explorers vary in their accounts of the condition of the western landscape. Some of this variation can be attributed to their purpose for traveling the area and their frame of reference after experiencing the grasslands of the Great Plains. Lands dominated by sagebrush, especially older sagebrush with a depauperate understory, would not have appeared to be productive for grazing animals and would not support large populations of wildlife. Conversely, the areas that had recently been burned and meadows would have appeared as viable grazing lands and supported higher levels of wildlife. Part of the variation can be attributed to the time of year when individuals traveled through the area. Due to the length of the journey and the weather constraints for making the journey, early travelers to Oregon and California often traversed the Great Basin at the end of, or after the growing season when herbaceous plants were not very succulent, and many forbs had lost their above ground parts. Part of the variation can also be attributed to the travel routes followed. Although the fur trappers were inclined to explore the mountains, the travelers to Oregon and California avoided the arduous mountain passes when possible. Their travels were through the valleys and along the river courses. The valleys tend to be the drier range sites, with lower site potential than the higher precipitation zone range sites. Part of the variation must also be attributed to the site-specific landscape condition. As described above, areas of plentiful grass existed where fire had been recent and areas almost devoid of grass would have existed where fire had not occurred for 70 to 80 years, or where precipitation was low.

The history of settlement of the Great Basin is well documented and only highlighted below to establish baseline conditions for predicting Sage-Grouse populations. For each period of time, significant ecological events are discussed and related to vegetation on the landscape.

The period of exploration and travel across the Great Basin had few ecological implications. The numbers of explorers and fur trappers were too few to have much of an impact, except for reducing beaver populations where they could be found. Similarly, the early travelers were confined to the trails and their time at any one location was brief.

The era of livestock use of the Intermountain West began with the Mormon settlements in Utah and spread to Idaho, Nevada, and California (Stewart 1941). These early settlers practiced subsistence agriculture because there were no transportation systems to existing markets. However, with the mining boom, starting in 1849 in California and 1859 in Nevada, subsistence agriculture gave way to agricultural production to supply newly created markets (Short 1965). Construction of the railroad soon followed, expanding the market and providing a means of transportation to distant markets. In 1863, overstocked ranges and drought conditions in California led to cattle drives through the Sierra Mountains to the Great Basin (Short 1965). The livestock industry continued to expand and the use of rangelands occurred in an unconfined, uncontrolled manner of grazing. Very little supplemental winter feed (hay) was harvested, and livestock depended on the open range for year-long forage. During this period, the perennial native grasses were greatly reduced and sagebrush and other shrub species increased in dominance (Young et al. 1979).

Mining operations sprang up throughout the state, and these new communities needed fuel. Forests in the Jarbidge area and Tuscarora/Independence Mountains were virtually removed to provide timbers for buildings and mine supports, and fuel for heating and cooking. When trees became too scarce, sagebrush was harvested by the wagon load. This removal of sagebrush was the first major shrub reducing activity since initial settlement. In other parts of Nevada, pinyon-juniper woodlands were cut down to provide charcoal for precious metal processing. Vast tracts of woodlands were denuded to supply the demand for wood, leaving only the seedlings that eventually re-established woodlands on these sites (Tausch, pers. communication).

In addition to fuel, mining towns needed food. Sheep and cattle were grazing the rangelands during this period, and great numbers of sheep were herded through Elko County during the late 1800s and early 1900s. Although some sheep operators had a base ranch, many sheep bands ranged over wide areas, creating conflicts with cattle operators. By 1890, the potential of many range sites had been greatly reduced. The perennial grasses were extremely susceptible to intensive, season-long grazing pressure, and seed banks built up during the presettlement period would have been depleted. As a result, shrubs dominated most of the western rangelands (Young et al. 1979). Sheep grazing was reduced in the West with the establishment of forest reserves, the precursors to national forests. During the first decade of the 20th century, forest reserves were created in most western states, providing some control over the nomadic sheep operations.

The winter of 1889-90, known as White Death, was a culmination of events that changed the livestock industry. Regional drought occurred in the spring-summer of 1889, resulting in low grass production. The heavy rains in November came too late to provide fall regrowth, and heavy snows in December stranded livestock across the range. The animals soon used whatever standing forage was available, or the limited hay that had been harvested if they could negotiate the deep snows to return to the ranches. A spring blizzard that started with rain and snow was followed by falling temperatures; this was too much stress for animals that had been on starvation diets for months. In northern Nevada alone, it was estimated that approximately 250,000 head of livestock perished that winter and spring (Hazeltine et al. 1961). The flooding that occurred in the spring of 1890 was not noted as causing soil or stream channel erosion (Blackburn, personal communication) in contrast to what may have been expected from such an event. The prior grazing of the watersheds had not caused deterioration of the watersheds to the point where the vegetation could not attenuate flows, and the riparian systems functioned to trap sediment, rather than contribute to the sediment load. The aftermath of White Death was a change in livestock grazing operations. Hay production began in earnest, and irrigation to increase hay production was initiated (Young et al. 1979). The meadows were cut for hay in the summer and grazed in the fall, stressing the Great Basin wild rye and causing deterioration of the meadows. By 1910, much of the upland range had also been depleted and the 1910 spring flood produced stream channel cutting and entrenchment; a trend that continues during major high flow events.[6]

Predator control was initiated with the introduction of livestock, but was not formalized into an organized program until after 1900. In 1915 the first rabies cases in Nevada were documented in Humboldt and Elko counties (Sans 1915), resulting in state and federal programs to control predators in an effort to prevent livestock losses to rabies. The programs have included hunting, trapping, poison baits, and aerial shooting. Use of poisons was restricted by presidential order in 1972. Coyote, bobcat, and mountain lion were the major target species, but badger, fox, raccoon, skunk, and porcupine were also included in the program. Between 1915 and 1979, over 373,900 coyotes, bobcats, and mountain lions were killed in Nevada. Coyotes comprised the bulk of the predator killed through the control program, accounting for more than 301,000 of the total predator removal. Over a 24-year period for which data were recorded by county (1937 to 1962, exclusive of 1940 and 1958), approximately 35 percent of the statewide predator removal occurred in Elko County. Assuming that this percentage applies to the period 1915 to 1979, it is estimated that 131,700 predators were killed in Elko County. The data are presented in tabular and graphic format in **Appendix E**.

Predator control efforts varied considerably over the years. During the period 1915 to 1933 the mean annual predator removal was 5,400 animals, during 1934 to 1939 the mean dropped to 1,000 per year, but increased to 7,600 per year during 1935 to 1948. The mean declined between 1949 and 1952 to 2,500 per year, increased to 7,500 per year between 1952 and 1959, and reached the highest mean during the period 1960 to 1965 with an average of 10,300 predators killed per year. The mean declined to 5,100 between 1966 and 1979. The variability was due in part to changes in budget, which translated to a change in effort during some years, or different in techniques, and shifts in public attitude.

Fire suppression was also initiated, probably informally at first, but eventually in an organized campaign by the U.S. Forest Service. Smokey Bear became a national icon representing the effort to prevent forest (and range) fires. Fire suppression efforts continue to the present, although fire policy has undergone some revision in recent years.

Non-native, invasive species were also introduced into the rangelands during the period of settlement and in the years that followed.

[6] Research conducted by the Rocky Mountain Research Station indicates that hillslopes were stripped of sediment during a severe drought about 2000 years ago. Consequently, streams are currently sediment limited, resulting in degradation. The most recent incision began about 300 years before present, and major episodes of incision have occurred during most high flow events in the last 50 years (Miller et al. in press). Although many stream systems have a natural tendency to incise, human disturbance and improper grazing have increased both the rate and magnitude of these events.

Halogeton and downy brome (cheatgrass) were two species that received attention in Nevada during the 1950s and 1960s. Cheatgrass has since become a dominant species on millions of acres of rangeland in Nevada. Other exotic invasive species, including perennial noxious weeds, have established within Elko County in recent years and may be expected in the future to dominate areas that currently support cheatgrass monocultures.

The Taylor Grazing Act was passed in 1934 to protect public grazing lands, develop public domain lands for grazing, and stabilize the public range-dependent livestock industry. The recognition of rangelands as a national resource and the creation of the Grazing Service (later to become the BLM) provided the link to manage the lands between national forest lands. The implementation of the Taylor Grazing Act and management of the national forests led to establishment of grazing districts, allotments, and range improvements. The range improvements included fencing to control livestock movements and implement livestock grazing systems, water developments, sagebrush control, exotic grass seedings, weed control programs, and sagebrush preservation (as discussed in Sections 2.5.1 and 2.5.5). Rangeland seedings and brush control activities on public lands peaked in the 1960s. The acreage of public lands managed by the BLM (western states) on which brush control was practiced increased from approximately 100,000 acres in 1962 to approximately 1,380,000 acres by 1970 (Rich 1999). Seeded acreage increased from approximately 100,000 acres in 1962 to approximately 2,250,000 acres by 1982 (Rich 1999). While portions of this acreage may now provide some Sage-Grouse seasonal habitats, the removal of sagebrush and conversion to crested wheatgrass had an immediate impact on Sage-Grouse distribution.

Mining activity waxed and waned over the years, but continued in one form or another into the mid-1900s. The resurgence of mining resumed with the development of processes to extract microscopic gold from large quantities of low-grade ore. This resulted in a mining boom in the mid-1980s that is currently continuing, but at reduced levels due to the current price of gold.

The period of 1950 to 1980 was a time of slow to moderate growth in Elko County. The livestock industry and railroad were the major employers and mining (primarily the Carlin Mine) was a minor industry. The roles soon changed, with the mining boom of the 1980s that was accompanied by unprecedented growth in Elko County.

2.6.3 Effects of Settlement on Sagebrush Ecosystem/Sage-Grouse Habitat

Changes to the sagebrush ecosystem started with the trapping of beavers, but the grazing and mining associated impacts during the latter 19th and early 20th centuries were significant in terms of Sage-Grouse habitat. Increased mining and the development of ranching led to environmental change. Shrub and tree removal made room for new shrubs and understory plants. These disturbances were distributed in time and space as mining districts and their associated populations developed. For some areas, the removal of shrubs represented the first disturbance to these shrublands in more than 100 years. Although Sage-Grouse broods may have responded to the release of the understory grasses and forbs, use by broods would not have been significant until the shrub canopies began to develop. Therefore, the initial response may have been a reduction in Sage-Grouse numbers accompanying the reduction in acres of suitable habitat, followed by an increase in Sage-Grouse numbers as the habitat recovered to a grass-shrub community. The creation over time of grassland, grass-shrub communities, shrub-grass communities, and shrub communities on the landscape would have provided the seasonal habitats required by Sage-Grouse in a local area. Therefore, Sage-Grouse were locally abundant, but regionally rare during the period following mining and ranching activity.

Following the winter of 1889-90, ranchers used irrigated meadows to provide winter feed. Livestock grazing reduced dense meadow vegetation, resulting in regrowth of the herbaceous plants, and the accompanying insects provided grouse with a dependable late summer food supply. The combination of removal of sagebrush, pinyon pine, and juniper from mining activity and grazing by livestock meant less old, dense sagebrush, more grass and grass-shrub communities, and improved summer habitat. Farming and ranching also led to predator control efforts that led to increases in prey populations, including Sage-Grouse. In response to these factors, Sage-Grouse populations began to increase, becoming regionally abundant, rather than only locally abundant.

These gains may have been short-lived due to the numbers of livestock, especially sheep, which grazed the rangelands in the late 1800s and early 1900s. In areas were the mosaic of grass and grass-shrublands existed, the forbs and insects required for Sage-Grouse chicks were not abundant due to the grazing pressure. Where old stands of sagebrush existed, trampling by livestock may have actually opened up the stands, but the herbaceous plants thus released were soon consumed. The expectation is that Sage-Grouse numbers were regionally low during this period, fluctuating in response to spring weather events, but declining overall.

The exception may have been in some portions of northern Elko County. Gruell (1998) recounts the recollections of three individuals whose families homesteaded in the area during the late 1800s. All three recall abundant grass and very little sagebrush in the Bruneau River country. Sagebrush was more common in the Independence Mountains and the Adobes, but cutting hay from the ridges was common (probably Basin wildrye). Sage-Grouse were also reported to be common in the Bruneau region. Based on the amount of grassland, one would have to assume that the observation of Sage-Grouse in the area was related to summer use. In the areas of higher brush cover near Gance Creek and elsewhere along the Independence Mountains, Sage-Grouse were "plentiful." These descriptions indicate that fire or other disturbance had occurred previous to the time that these homesteaders lived in these areas. The abundance of grass began to change in the 1890s and early 1900s with the high numbers of sheep introduced into this region. Gruell (1998, page 114) states that there were 560,000 sheep running in the Independence Mountains, and all three individuals interviewed indicate that grasslands declined with the heavy use.

During the period of high sheep numbers, shrubs were on the increase, but grasses still remained. Although grazed down by the end of summer, the spring growth was probably sufficient to provide insects for Sage-Grouse chicks. Nesting cover would have been limited, but nest success was not as dependent on nest cover because of the extremely active predator control programs. Therefore, while habitat conditions were less than ideal, predators were not present in sufficient numbers to keep the Sage-Grouse populations suppressed.

Another effect from heavy livestock grazing at this time was the reduction in fine fuels. During the period of time that shrubs were recovering from the shrub harvest as fuel for mining camps or previous range fires, grazing with high numbers of livestock reduced the fuel loading and fine fuels needed to maintain fire. This combination of grazing and fire suppression eventually led to shrub dominance in these rangelands. This occurred over a long period of time between 1910 and 1950. The increased shrub cover provided better nesting habitat for Sage-Grouse, especially where combined with adequate spring growth of herbaceous vegetation. Heavy grazing of the uplands would have reduced their value as early summer brood habitat, but winter habitat would have been increasing in both quality and quantity during this period. The summer habitat of meadows and riparian areas would have been adequate, but stream incisions following extreme events continued during this period and some water tables were dropping. Pre-laying hen nutrition was likely a stress factor on the population due to the degree of grazing and lack of early spring forbs, especially at the latter portion of this period. However, predator control was operating at peak level, and Sage-Grouse chick recruitment was probably high for the number and quality of eggs produced. Weather during winter, breeding season, and immediately after hatching would have been a major factor in population fluctuations. The low quality habitat could support relatively high populations of Sage-Grouse when combined with predator control, but a few years of poor weather would have reduced recruitment and populations would have declined drastically, only to rebound when the weather conditions were favorable.

During the 1930s, cheatgrass and halogeton were also becoming noticeable, but cheatgrass did not expand explosively until the fire years in the 1960s. By then, cheatgrass had established in the depleted understories of sagebrush dominated communities, poised to dominate these sites when the fires occurred. Following fire, the ability of this species to form a closed community or steady state[7] (Laycock 1991, West 1999), has prevented sagebrush and other perennial plant species from reestablishing, eliminating Sage-Grouse habitat from these sites.

Apparently brush was sufficiently abundant in the 1940s to warrant mechanical and chemical control as rangeland improvement practices. Shrub control activities peaked in the 1960s (Rich 1999, Miller and Eddleman 2000). Where native understory herbaceous plants existed prior to treatment, an improvement in grass and forb production was realized. Sagebrush eventually reestablished in these treatment areas with a corresponding increase in Sage-Grouse populations. Where the understory was depleted prior to treatment, invasive annuals established with the few surviving perennial plants. However, varieties of introduced wheatgrasses, collectively known as crested wheatgrass, were seeded on rangelands with depauperate understories in order to establish perennial grasslands. These monocultures dominated rangelands for many years where soils were productive, effectively eliminating Sage-Grouse, except for some breeding display activities. Through natural establishment (secondary succession over time), many of these seedings currently have sufficient stands of sagebrush and adequate herbaceous cover to provide nesting habitat for Sage-Grouse. This use of older seedings by other shrub-associated bird species has been scientifically documented (McAdoo et al. 1989).

The period from 1960 to the present represents a period when sagebrush continued to increase on many rangelands, except where fire converted these areas to annual grasslands or where pinyon-juniper encroachment occurred. In areas where sagebrush dominance increased and understory vegetation decreased, the value of these areas as nesting and early brood habitat decreased. These stands of sagebrush provided winter cover, but as discussed above, the quality of the forage was low. Conversion of sagebrush lands to agriculture (e.g., irrigated meadows, irrigated hay production, crested wheatgrass seedings), home sites and urban expansion, and other non-rangeland uses reduced the quantity of habitat available to Sage-Grouse. Although range improvements and changes in grazing systems have been implemented, changes in grazing, and even the elimination of grazing, cannot completely restore the herbaceous vegetation to these sites (as discussed in Section 2.5.5). This combination of habitat conversion to non-Sage-Grouse habitat and the continuing decline in the quality of remaining habitat has contributed to the downward trend in Sage-Grouse numbers since the 1960s.

2.6.4 A Model of Sage-Grouse Populations - 1850 to 2001

The events discussed in Section 2.6.2 are depicted on a time line in **Figure 11**. The predicted Sage-Grouse population as discussed in Section 2.6.3 is depicted on the graph in **Figure 11**. This represents a model of Sage-Grouse populations from the time just prior to settlement through the present. There is little scientific evidence to support or refute the model for the early part of the time line, but there are indications of Sage-Grouse abundance (or lack thereof) from anecdotal accounts in the personal journals, newspapers, and publications of the period.

McQuivey (2000 and in preparation)[8] reviewed the available documents and provides some insight regarding the fluctuations in grouse numbers. For the latter part of the 20th century, data collected by the NDOW are available from which Sage-Grouse abundance can be estimated.

An historical review of personal journals, newspapers, and publications indicates that prior to settlement and during early settlement by European man, Nevada had low Sage-Grouse populations (McQuivey 2000). This view contrasts with the popular view that the period

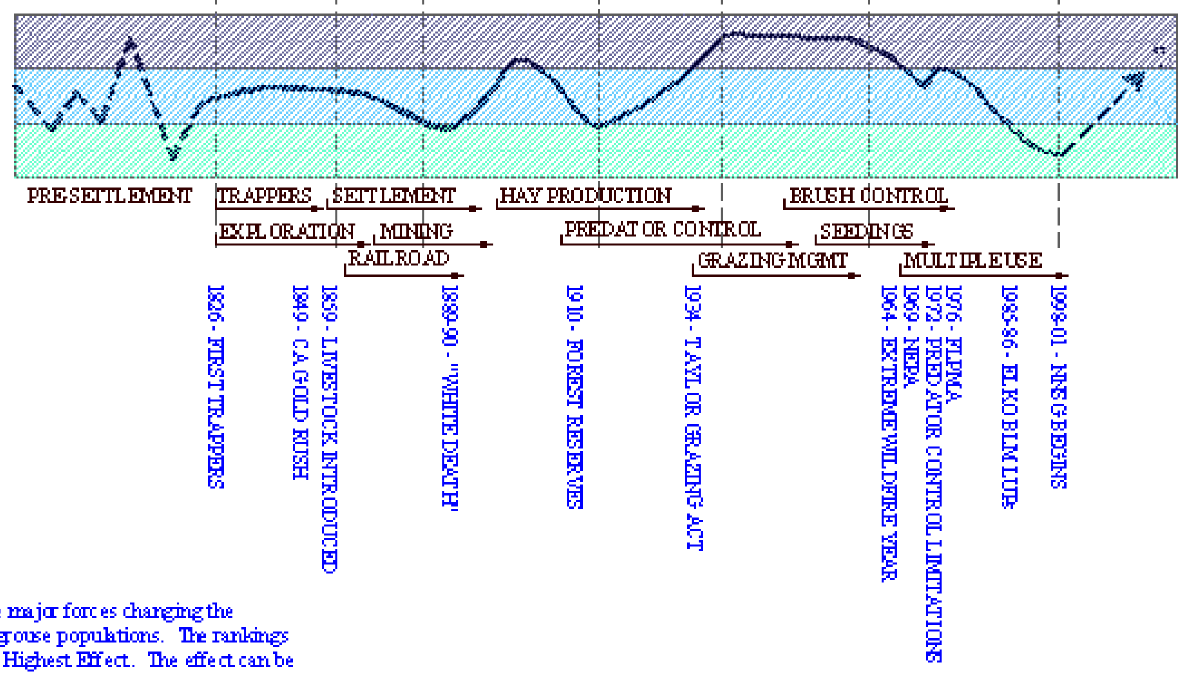
[7] A steady state is defined as a system that has resistance to change from external forces and returns to the original steady-state after being disturbed (e.g., an annual grassland disturbed by wildfire returns to an annual grassland and resists change to a perennial plant community).

[8] Robert McQuivey has been, and continues to, review historic documents in preparation of publishing a history of Nevada wildlife. On September 13, 2000 he presented his preliminary findings as related to sage grouse to the Governor's State Sage Grouse Conservation Plan Team. The history of sage grouse in Nevada is taken from this presentation.

FACTORS [1]

	UP TO 1825	1826-1859	1860-1885	1886-1920	1921-1946	1947-1963	1964-2001	2002
WILD FIRE	4	1	1	1	1	2	3	
FIRE SUPPRESSION	0	0	1	2	3	3	3	
EXOTIC PLANTS	0	0	0	1	2	3	4	
MINING (LOCALLY)	0	0	4	2	2	1	3	
PREDATOR CONTROL	0	0	1	2	3	3	3	
GRAZING	0	0	3	4	3	3	2	
WEATHER	2	2	2	2	2	2	2	

POPULATION LEVEL [2]



FOOTNOTES:

1. The factors listed are considered to be major forces changing the landscape or directly impacting sage grouse populations. The rankings are relative from 0 = No Effect to 4 = Highest Effect. The effect can be positive or negative.

2. Population levels are relative and the population "line" indicates trends, not specific values for any given year. Actual population level for any year could be much higher or lower. The population "line" indicates overall general changes within the specified "ERA".

FIGURE 11

MODEL OF SAGE GROUSE POPULATION TRENDS IN NORTHERN NEVADA

SRK Consulting

prior to settlement was a land of plenty and nature was in balance. Both views are correct. The events leading up to the time of settlement were "random" events in both time and space. The colder and wetter climate limited the number and location of fires, but during the short-term drought cycles, fires did occur. Where the combination of habitats for a given species was available, including Sage-Grouse, local populations were abundant. However, due to the randomness of the fires, these combinations of habitats were relatively rare and most of the landscape was dominated by older sagebrush. The populations of Sage-Grouse across the Great Basin probably fluctuated drastically, depending on the long-term and short-term climate cycles that influence the temporal and spatial distribution of habitats. The references from 1826 to 1860 reviewed by McQuivey support this premise; game, including Sage-Grouse, was scarce (i.e., widely scattered), but when found, "they came into camp loaded" with Sage-Grouse (i.e., locally abundant). Similarly, the description of the habitat varied from sagebrush that was extensive and up to eight feet tall, to grasslands that resembled meadows.

From 1861 to 1885, the references to Sage-Grouse are few, but references to game shipped in from other states are common. Market hunting was occurring outside of Nevada, but there was no indication that game was sufficiently plentiful for market hunting in Nevada. This was also the time of pinyon-juniper harvesting for charcoal and sagebrush for fuel. The sagebrush harvest in the Tuscarora area prompted a reference to the possibility of sagebrush "ultimately becoming extinct." This was a period of locally extirpated Sage-Grouse populations, with other populations widely scattered throughout the state.

The period 1886 to 1920 saw Sage-Grouse populations fluctuate. Hunting seasons varied from one and a half months to eight months in length. Following the winter of "White Death" (1889-90), livestock numbers were drastically reduced, allowing portions of the range to recover, and Sage-Grouse numbers rebounded. By 1900, the grazing levels had increased and mining was on the increase. But in 1906, sheep were numbers were greatly reduced on the forest reserves and wild horses were removed from the forests. Local increases in Sage-Grouse populations occurred as shrubs, grasses and forbs recovered. Habitat quality was probably a factor in fluctuations of yearly populations, with weather being indicated as the proximal cause of Sage-Grouse shortages in 1904 (cold, wet spring) when birds were scarce. This population low occurred only three years after reports of four individuals bagging 96 Sage-Grouse in one day and another party of four bagging 140 Sage-Grouse on another day. The pattern in 1910 was one of regional scarcity and local abundance in the Ely area. A rabies epidemic in 1915 killed more than 30,000 coyotes in an 18-month period, and predator control and poisoning of prey by livestock operators was common. The general trend in Sage-Grouse numbers varied with local environmental conditions.

From 1921 to 1947, seasons were reduced from months to 15 days or less. Sage-Grouse populations were generally increasing during this period, although fluctuations were still common. Passage of the Taylor Grazing Act in 1934 initiated range management, and with it some changes in grazing and then initiation of range improvements. Although these improvements were directed primarily at sustaining the livestock industry, there were also some benefits to wildlife.

Peak Sage-Grouse populations were reported throughout Nevada in the 1950s, and populations remained relatively high through the 1960s. Sage-Grouse populations declined in the 1970s, with some rebound in the late 1980s and early 1990s, followed by a decline to lower levels in the mid 1990s. The century ended with a slight upturn in Sage-Grouse numbers, but the overall trend from 1950 to 2000 has been downward. Predator control was greatly reduced after the banning of chemical poisons in 1972. The combination of less predator control and continued decline in habitat quality (winter and spring habitat) has resulted in less recruitment to the Sage-Grouse populations and more influence from weather events.

Mr. McQuivey reviewed 211 journals, diaries, and letters, 171 newspapers from 79 different communities in Nevada (primarily covering the period 1859 to 1900), state statutes from 1861 to 1947, and other sources of information. Although these sources are primarily anecdotal in nature, they provide the only written record available. The NNSG Sage-Grouse pod developed a model of Sage-Grouse populations

(**Figure 11**), independent of Mr. McQuivey's work, based on historic events and how these events would have impacted Sage-Grouse habitat or Sage-Grouse survival. The model is general in nature, assuming that events and activities occurred throughout the county, except where noted. The model should not be interpreted as providing a specific population level of Sage-Grouse in the state or Elko County for any given year, but provides the general trend over periods of time. For example, since the 1900s there are State Fish Commission records that indicate specific years when Sage-Grouse populations were extremely low (e.g., 1912-13, 1926-27, 1936). These represent variations from the general trend, but do not negate that a general trend was occurring. Indeed, these short-term but drastic changes in population lend credence to the model and the interpretation that weather was a major factor in determining population levels when habitat conditions were poor and predator control was intensively practiced.

The earliest scientific survey of Nevada occurred in 1867. Ornithologist Robert Ridgeway, part of the survey team for the exploration of the 40th Parallel, chronicled wildlife species as the team traveled from San Francisco, California to the Wasatch Mountains, east of Salt Lake City, Utah. His description of the sagebrush vegetation is that of an extensive community covering the valley floors and foothills "farther than the eye can reach" (Ridgeway 1877). The sagebrush was generally about three feet or less in height, occasionally taller, and uniform in its density over large expanses. This indicates a relatively long period of time since the last fire. Ridgeway (1877) summarizes his observations of Sage-Grouse as follows: "Although this large and well-known grouse was met with throughout the sage-brush country between the Sierra Nevada and the Wasatch, we saw it so seldom that little was learned of its habits, particularly during the breeding season. It came under our notice only late in summer and during the autumn, when it was found to be abundant in certain localities, but by no means uniformly distributed." These observations support the contention that the species was locally abundant where quality habitat was available, but regionally rare due to large expanses of low quality, or only one seasonal habitat.

There is general correspondence between the habitat based model (**Figure 11**) and the historic accounts. Differences are primarily related to specifics for a given locality (e.g., the population in Austin, Nevada may have been high in a given year when the prediction for the Elko area may have been low), but these may have been due to the timing of events related to mining or livestock grazing activities, which varied in time throughout the state. One important factor that was not included, except for 1889-90, was weather. Many of the severe annual fluctuations may have been due to the influence of weather when habitat quality was below optimum.

However, by arriving at similar indices of population levels from two independent methods lends some credence to the general. More importantly, the model integrates the major factors affecting Sage-Grouse, providing some understanding as to why Sage-Grouse numbers were high in the 1950s when livestock numbers were also high. The correlation is due to events that preceded the population highs by decades, setting up the future habitat, and due to other factors acting at the time of the population highs (e.g., predator control). The model also indicates that habitat quality and quantity are generally the underlying basis for Sage-Grouse population trends.[9] If this is truly the case, then habitat management is the key to bringing back healthy, sustainable populations of Sage-Grouse. The following conservation strategy is first and foremost a strategy for managing habitats.

[9]However, because the model is based on an estimate of habitat conditions resulting from these other factors, some circular reasoning is involved when concluding that habitat is the driving force.

3 CONSERVATION STRATEGY

The preceding sections of this document have provided the necessary background information for understanding sagebrush and Sage-Grouse ecology. In this section, the ecological basis for managing the sagebrush ecosystem, with emphasis on Sage-Grouse, is presented. This is followed by the goals (the desired outcomes), objectives (measurable and with time frames), and strategies (specific steps required to reach the objectives).

3.1 Ecological Basis for Management Strategies

In the absence of noxious weeds and other invasive annual species, the traditional successional models of range ecology (e.g., Clements 1916, Sampson 1919, and Dyksterhuis 1949) may be the appropriate models on which to base the management of the habitats. The Clemensian model of succession assumed that the stages of secondary succession on improving rangelands were the reverse of stages or processes of degradation and that these successional stages were the same for all sites at all times for a given range site.[10] Laycock (1991) discussed the concepts of ecological thresholds and steady states of vegetation that occur when certain thresholds are crossed. The type of disturbance and the plant community in place at the time of the disturbance interact to determine the state or transition that occurs as a result of the disturbance. When the combination of factors result in a threshold being crossed, a new steady state is created. Reversing the trend when a threshold has been crossed requires more than just removing the disturbance. For example, as discussed above, the presettlement fire regime created a cycle of:

grassland ↔ grassland-shrubs ↔ shrub-grassland ↔ shrubland.

Interjecting fire at any stage of the cycle abruptly reversed the cycle (e.g., set back succession) to an earlier stage, or in the case of the grassland stage, perpetuated the grassland for a longer period of time. The introduction of intensive livestock grazing resulted in stress on the understory species, creating a threshold and the potential for a new steady state:

grassland ↔ grassland-shrubs ↔ shrub-grassland ▬► shrubland.

The dominance of shrubs and loss of understory species creates a steady state of sagebrush dominance with eventual changes in the soil and seed bank that prevent reversal of the situation with the removal of livestock. Additional inputs of energy and plant material are needed to change the steady state to some other state once a threshold has been crossed. The shrub-dominated rangelands are susceptible to intense wildfires that are likely to cause the plant community to cross another threshold and convert to annual grasslands. The shrubland community is also open to establishment of pinyon-juniper, resulting in conversion from shrubland to woodland.

The introduction of annual grasses, such as cheatgrass, and invasive plants (weeds) such as leafy spurge or the knapweeds provides the potential for many new pathways and thresholds, and therefore new steady states that are dominated by these undesirable species. The successful management of the current landscape requires some knowledge of which state exists on the site, whether or not a threshold has been crossed to achieve the existing state, how the proposed management action will influence the existing state, and what preemptive actions should be taken to prevent undesirable states from occurring.

State and transition models for the six primary ecological range sites that comprise the majority of Sage-Grouse habitat have been developed by the Natural Resource Conservation Service (NRCS), and are included as **Appendix F**. These models are untested, but are based on current ecological knowledge of the plant communities within the planning area. Part of the adaptive management incorporated into this strategy will be to test the models and make

[10]This is a simplistic overview; a close examination of Clement's work indicates that the type of disturbance and the plant community present at the time of the disturbance could influence the subsequent stages of succession. However, the end points of these different successional paths were always the climax community.

revisions based on the field results. The models represent a hypothesis for what we expect to occur as a result of our management actions. If our hypothesis is correct, the model will not be modified significantly. If the hypothesis is not supported by the field results, then the new data will be incorporated into the model and tested (i.e., we will proceed based on current, albeit imperfect knowledge, and learn from our mistakes and our successes).

The discussion of the state and transition model is not meant to imply that the models are the basis for the management strategies provided below. Rather, the model is useful in that it causes one to be aware that not all sites will respond similarly to the same treatment, that the same range site at two different locations may not respond similarly to the same treatment, and that the same treatment conducted under different conditions on the same range site at two different locations may not get similar results. The model is useful in facilitating an understanding of the range site, current condition (including vegetation composition and soil seed bank), and potential response to any proposed treatment (i.e., that "one size does not fit all"). The models represent hypotheses for what we expect to occur as a result of management actions designed to reduce sagebrush densities and improve Sage-Grouse habitat quality.

Fortunately, Sage-Grouse are a landscape scale species that use a variety of habitats, including riparian zones. Therefore, management of the landscape must include consideration of other habitats and must be based on the understanding that what occurs on the uplands affects the riparian habitat, and management of the riparian habitat affects the upland habitat.

3.2 Goals

A goal is a statement of what we envision for the future. The goal of this strategy is to manage watersheds, basins, or subbasins in a manner that restores or enhances (as appropriate) the ecological processes necessary to maintain proper functioning ecosystems inclusive of the Sage-Grouse. These processes include, but are not limited to: soil building, nutrient and energy cycling, water retention and cycling, maintenance of complex trophic pathways, and establishment of vegetation disturbance regimes that emulate presettlement disturbances in function and interval. Through these processes the plant, animal, and habitat diversity of the rangelands can be perpetuated for generations to follow.

The goal also includes statements of the desired outcomes, which are specific to individual resources. Based on the preliminary evaluation of the watershed conditions in the planning area, the following are examples of goals that may be developed for one or more watersheds:

- Sage-Grouse. Improve juvenile recruitment for local populations. Fall harvest data indicates that juvenile recruitment is insufficient to replace annual adult losses. Improvement of juvenile recruitment should halt the decline in Sage-Grouse populations and with sufficient improvement, population increases are anticipated.

- Sage-Grouse. Restore Sage-Grouse habitat on areas currently occupied by annual grasslands and encroached upon by pinyon-juniper. Annual grasslands do not provide habitat for Sage-Grouse, and by occupying sites of one or more seasonal habitats for Sage-Grouse, these annual grasslands may prevent local populations of Sage-Grouse from establishing or increasing. Encroachment of sagebrush range sites by pinyon-juniper woodlands not only eliminates the occupied acreage as Sage-Grouse habitat, but Sage-Grouse may avoid sagebrush or riparian areas in proximity to pinyon-juniper stands because the woodlands include raptor perching habitat. Reestablishment of sagebrush on these range sites will increase the quantity of habitat over that which exists today.

- Vegetation/wildlife. Improve the macro diversity of habitats, and therefore the diversity of plants and wildlife. Creation of a mosaic of plant community transition stages on the landscape results in a variety of habitats and niches (for plants and animals) that do not exist when the land is dominated by one age class or condition of sagebrush.

- Vegetation/wildlife. Increase numbers or distribution of special status species where appropriate. Special status species will be included in all watershed plans where any special status species exist, or have the potential to exist, on the range sites being managed.

- Vegetation. Maintain high levels of productivity and diversity of perennial herbaceous plants to reduce the risk of establishment by exotic, invasive species.

- Livestock. Improve forage quality and quantity within the managed basins. Implement vegetation treatments and grazing systems that provide flexibility and promote vegetation diversity.

- Recreation. Improve recreational opportunities by increasing watershed values. Increases in plant and wildlife diversity, water quality and quantity, and range condition will improve the recreational opportunities over conditions which exist today.

- Mining. Maintain opportunities for mining and the short- and long-term habitat changes created by mining. Increasing the quantity of habitat for special status species and other wildlife will reduce pressure on mining operations that desire to mine in existing habitats for these species. Active land management provides opportunity for effective mitigation of unavoidable impacts.

- Fuels Management. Combine vegetation, wildlife habitat, and livestock forage treatments with fire management goals to achieve fuel breaks on the landscape. These fuel breaks/habitats will have a spatial and temporal component that will provide for a variety of land uses.

3.3 Objectives

The objectives are statements that provide measurable quantities or units of the desired outcomes. The objectives listed below are general objectives applicable to this Strategy. The measurable amounts (e.g., acres of annual grassland to be rehabilitated) and the time frames for achieving the objectives will be specific to each watershed plan. For example, pinyon-juniper encroachment is not an issue for all watersheds, and where encroachment is an issue it varies in magnitude among watersheds. Therefore, the specifics of how much to treat and over what time frame the treatments will occur has to be related to specific watershed/landscape goals.

The objective of this Strategy is to implement a watershed analysis process on the watersheds within the planning area by initiating the assessment of three watersheds each year and development of a watershed plan for each watershed within one and one-half years of the initiation of the process.

The watershed assessment will follow the process developed by BLM, US Geological Survey, NRCS, and Agricultural Research Service *Interpreting indicators of Rangeland Health* (BLM Technical Reference 1734-6, 2000), BLM's *Process for Assessing Proper Functioning Condition* (BLM TR 1737-9, 1993), the interagency Federal Guide for Watershed Analysis: *Ecosystem Analysis at the Watershed Scale*, and may be supplemented by other assessment methodologies as determined by the watershed assessment team. The assessment will include watershed-level quantification of the factors affecting Sage-Grouse that were identified and discussed in Section 2.5. Specific objectives will be identified for each watershed based on the results of the assessment. These objectives will include Sage-Grouse habitat objectives as well as more general watershed objectives, such as:

- Rehabilitate annual grasslands to perennial plant communities capable of supporting diverse land uses.
- Create a mosaic of vegetation age classes on the landscape to meet the needs of Sage-Grouse and to allow for natural watershed functions and processes.
- Restore the sagebrush-herb community on range sites currently encroached upon by pinyon-juniper woodlands.
- Improve water quality and quantity within the managed basin.
- Manage uplands and riparian vegetation to improve systems at risk and restore

non-functioning systems to proper functioning condition.

3.4 Management Strategies

Management strategies are the specific actions necessary to achieve the stated objectives. The management strategies will be specific to each watershed and based on the assessment of each watershed. However, the preliminary evaluation of vegetation and issues for the planning area resulted in some general management strategies which are presented below. The vegetation treatments described below are not the only strategies to be implemented, but at this point in the planning, the need for vegetation management has been identified for each watershed and PMU. As stated above, the assessment results will be used to identify and/or develop other strategies specific to the watershed issues within each watershed.

Several of the management strategies discussed below are presented in the context of creating a mosaic of age classes of sagebrush on the landscape. For each strategy presented below, there are constraints which must be understood before treatments are applied. Although each of the four brush treatments will achieve similar results, there are significant ecological differences among the treatments. These differences must also be understood to ensure that the specific watershed management goals are achieved. A full discussion of the constraints and ecological factors of each treatment are presented in a summary at the end of this section. Other strategies, such as focused predator control, changes in livestock grazing systems, and greenstripping may also be implemented as necessary.

The vegetation treatments are intended to perpetuate the sagebrush plant community through periodic disturbance to provide the various successional stages associated with this plant community, from grass-forbs through shrub dominance, on a spatial and temporal scale that meets the overall objectives of the watershed. To be effective, the treatments need to be distributed in time and space. Treatments should be spaced in time to create at least four age classes (realizing that there is really a continuum of change, rather than four distinct conditions). The age classes should be five to 15 years apart as determined by the site potential, existing condition of the vegetation, and the specific watershed goals (to be determined during the watershed analysis). In general, the target should be to treat at least 20 percent of the acreage of the suitable range sites within the watershed within a treatment period (five to 15 year interval) and treat the entire acreage of suitable sites over 40 or more years, but probably not to exceed 60 years, as determined in the watershed assessment. Individual treatments should be at least 100 acres in size, but not exceed 400 acres, until some adaptive management feedback has been obtained and evaluated. A guideline that can be used at the pasture level within a watershed is: 1) for small pastures (i.e., less than 1,000 acres), no more than half of the pasture acreage in sagebrush range sites should be treated in any one time interval, and treatments should be no less than one quarter of the total pasture acreage; 2) for large pastures (i.e., greater than 1,000 acres), the treatment within any one time interval should not exceed one quarter of the total acreage of sagebrush range sites and individual treatments should not exceed 400 acres. Once the mosaic has been created, the interval can be shortened or lengthened, as appropriate, but the current condition of most sagebrush habitat in Elko County dictates an accelerated time frame to avoid the need to seed following the treatments.

The size of the treatment should take into consideration that treatment of a 400-acre “treatment block” does not mean all vegetation within the area will be treated. The “treatment” includes leaving sagebrush, either as strips, patches, or buffers (as needed for sediment control), and the shape of the treated area should be irregular so as not to resemble blocks. Thus a 400-acre treatment area that has the objective of thinning sagebrush density by 50 percent may result in the removal of 50 percent of the sagebrush plants on 70 percent of the area, leaving more than one-half of the pre-treatment sagebrush plants within the entire 400-acre treatment area.

The distinction between sagebrush control (i.e., eradication) and sagebrush thinning (i.e., opening a closed stand of sagebrush) must be understood. In the past, sagebrush control removed many acres of habitat and converted the land to grasslands. The size of these projects and the level of sagebrush control achieved prevented sagebrush from reestablishing on the sites for many years. The strategy proposed herein is not to create large expanses of shrubless areas, but rather create large expanses of herb-shrublands. This can be accomplished by controlling or prescribing the degree of sagebrush removal.

3.4.1 Prescribed Burning

This treatment is recommended for mountain big sagebrush and Wyoming big sagebrush sites in precipitation zones with ten or more inches of precipitation annually. Prescribed burning may also be used for restoration of some annual grasslands or areas of pinyon-juniper encroachment; however, the following discussion focuses on using prescribed fire as a means of rehabilitating existing stands of sagebrush. Prescribed burning can also be used to reestablish aspen stands within the watershed, but such use would be established in the watershed analysis and watershed management plans.

Prior to settlement, fire and climate interacted to determine the vegetation on the landscape. Since settlement, man, domestic animals, and introduced species (especially invasive plants) have been added to the equation. Fire and climate remain the major factors, but the other factors also influence the outcome when fire occurs under various climatic conditions. Because many of these outcomes have not achieved desired land use objectives, fire has become viewed as being destructive. However, desired land use objectives can be achieved by the judicial use of fire under the appropriate conditions. The timing and intensity of the fire, as well as the size of the fire are important factors in achieving desired outcomes.

Timing is a combination of season of year as well as site conditions. Burning at the “correct time” but under the wrong conditions will not achieve the desired outcome. Spring or fall burning can be just as intense and detrimental as late summer wildfires if conditions at the time of burn are not monitored. Fall moisture can be sporadic, and when insufficient moisture is received, burning must be delayed until spring conditions are evaluated, or until the following year. Fall moisture allows dormant perennial grasses to “greenup” with some regrowth at the root collar. The increased fuel moisture is sufficient to protect the root collar from the detrimental effects of fire, allowing the stubble (dried material from the current year’s growth) to burn without killing the plant. Spring burning can accomplish the same results; however, spring moisture conditions may prevent access to the sites when the proper burn window is available. “Burning on snow” or winter burning, is recommended for extremely dense stands of sagebrush. The blanket of snow protects the seed reservoir, soil organic matter, and herbaceous plants from the intense heat generated when burning dense stands of sagebrush. Winter burning requires that the shrub crowns be relatively close and that sufficient wind is present to spread the fire. This may be the most successful method for treating Basin big sagebrush (*Artemisia tridentate* ssp. *tridentata*) due to the extreme fuel loading that can occur in the loamy bottoms where this species is found.

The established root system of the perennial plants can benefit from the nutrients that are recycled in the process of burning, generating vigorous and nutritious forage in the spring. As discussed above, the new growth when nutrients are abundant is tender and palatable to wildlife and livestock. The regrowth following prescribed burning has lower lignin content and higher nutrient levels than that found in older ungrazed plants. Carbon accumulation (i.e., high lignin content) occurs in older, “wolfy” plants that are nutrient stressed. Thinning the stand of sagebrush to create openings for herbaceous vegetation increases nutrient cycling by allowing the carbon and other nutrients to return to the soil as litter or dung by the end of the growing season. Without thinning of the sagebrush, herbaceous plants are out competed by the sagebrush and the carbon and nutrients become tied up in the woody plants, unavailable for other plants. Thinning reverses the trend and the increased soil organic material increases soil water capacity, soil microbial activity, and soil productivity.

In addition to the conditions under which the prescribed burn is conducted, the manner in which the burn is ignited can also be used to achieve a desired outcome. To achieve a low intensity prescribed burn (referred to as a “cool” fire), the key is to prevent an extensive united fire front (the wall of flame advancing the fire) and long fire runs (the distance from the ignition point to the end of fuel, measured parallel to the wind direction). The fire front is controlled by using spot ignitions; spacing the ignitions along the fire line to prevent the ignition points from converging. This type of ignition disperses the fire front and prevents mass heating ahead of the flames. Limiting the fire run is accomplished by creating a backfire at the downwind side of the treatment area to create a fuel break known as a blackline. The width of this break is determined by the fuel loading and burn prescription, but for most low intensity burns, twenty feet of complete blackline is likely to be sufficient. The rest of the treatment area is burned by igniting a series of spaced lines of spot ignitions, with the lines running perpendicular to the wind direction. The ignition lines should be spaced at 100- to 200-foot intervals. The fire ignition lines should be started in sequence, starting at the blackline (downwind) side of the treatment area and not igniting each successive line until after the preceding line has burned one-half of the spacing interval. This method of burning limits the intensity of the fire and significantly reduces the potential for the burn to escape the prescribed perimeter. As with all prescribed burns, a complete fuel break or foam line should be established around the perimeter prior to any ignition. The site specific burn plans for each treatment area will include specific measures for containing the fire within the prescribed treatment area.

The sagebrush plants that remain after the treatment are released from competition and will not be nutrient stressed. The plants switch from the production of fiber and carbon-based compounds to the production of nitrogen based reproductive parts. The consequences for Sage-Grouse are two-fold. First, the plants improve as winter forage and contribute to the assimilation of energy and protein needed for the breeding season. Second, abundant seed production occurs to establish the next stand of sagebrush that will eventually provide nesting, early brood, and winter habitat. The overall effect is to improve the quality of one seasonal habitat and set the dynamics for perpetuation of the site as future habitat for other seasonal uses.

The stands that are treated will provide the grassland and grassland-shrub habitats needed by a variety of animal species (see **Appendix G** - Sagebrush Obligate Species) and increase forage for herbivores (wild and domestic) where forage was previously less abundant. When included in a mosaic of other Sage-Grouse habitats, livestock grazing generally will graze the treated areas first. This allows spring growth of herbaceous plants found in nesting habitat to grow without grazing while Sage-Grouse are on the nest. Depending on the grazing system, sufficient residual growth and/or stubble height will be maintained in the untreated areas (i.e., the nesting habitat) because the livestock are removed from the pasture after grazing the treatments or lightly grazing the untreated areas. In areas where the pre-treatment understory of herbaceous plants is relatively high, the existing herbaceous plants will be released. These plants have existing root systems and protection from grazing is not required (provided the treated area is under a grazing system). The normal pasture grazing system can be maintained.

In areas where the herbaceous understory is determined to be insufficient to properly dominate the site within one to three years after treatment, seeding following the fire with the appropriate seed mix is an option that should be determined prior to the prescribed burn. Due to the charred stems of sagebrush (skeletons) that should remain standing if the fire intensity is controlled, broadcast seeding or aerial seeding may be the only method of seeding available. Plants that can establish by broadcast seeding and that do not require a soil cover should be considered for the seed mix. Without seeding, invasive species may establish on the site. Post-treatment grazing management may be required under these conditions to allow the seeded species to establish prior to grazing.

3.4.2 Herbicide Application

Herbicide application for purposes other than sagebrush thinning, such as control of annual grasses, control of invasive noxious weeds, or control of other undesirable plant species may be incorporated into the specific watershed management plans, as appropriate. However, for this Strategy, herbicide application is only being discussed as a means of rehabilitating existing stands of sagebrush.

The use of tebuthiron for control of sagebrush is not a new practice. This selective herbicide has been used for years. However, in the past the goal was usually to achieve a very high rate of mortality of sagebrush. To rehabilitate the rangelands, complete shrub removal is not the desired goal. As with the prescribed burning discussed above, the goal is to open up a stand to allow perennial grasses and forbs to reestablish. The degree of sagebrush mortality depends on the rate of application, the amount of rainfall after application, and the amount of clay and organic material in the soil. NRCS has developed an information sheet for tebuthiron (**Appendix H**), which provides specific application rates for various levels of soil organic matter and desired level of canopy cover reduction. When applied properly, tebuthiuron will not kill herbaceous plants.

To achieve a herb-shrub community through the application of tebuthiron, one can choose from two different options. The first option is a uniform application at the recommended rate to achieve a desired level of thinning. This will result in the vegetation within the treated area appearing somewhat uniform: shrubs widely spaced with grasses and forbs dominant. A rate sufficient for a 75 percent reduction in shrub cover is recommended for this option. The second option is to apply the herbicide in a less uniform manner, but at a slightly higher rate. This will result in patches of shrubs being distributed throughout the treatment area and less shrub cover between patches. Both options will provide the desired results for Sage-Grouse; opening of the stand and providing a new generation of sagebrush. The only difference for Sage-Grouse is that the shrubs that are released using the uniform application option are likely to provide higher quality forage than those shrubs that are left in patches (depending on the size of the patches). However, the patches provide loafing cover for the birds following a feeding period. The patch option may be more conducive to creating openings in the sagebrush as habitat for wildlife species that nest in grasslands and prefer little or no shrub canopy at the nesting sites.

Leaving strips of sagebrush perpendicular to the prevailing winds will create natural snow “fence” to increase the capture of winter moisture, facilitating seedling establishment of grasses, forbs, and shrubs. Establishing natural “snow fences” should be considered at the lower elevation sites where moisture is a potential limiting factor. The strips will create some visual contrasts with the surrounding landscape for several years, requiring careful consideration of the moisture requirements when in visually sensitive areas.

3.4.3 Aerating

Aeration consists of rolling a large drum across the treatment area to crush or break the brush. The drum has blades spaced around it to achieve some imprinting of the vegetation into the soil. The weight of the drum can be changed by varying the amount of water used to fill the drum. The less weight the lower the impact on the vegetation. The drum acts to crush or break the stem of the woody plants, but does not have much impact on herbaceous plants. The blades push some of the material into the soil, enhancing levels of soil organic material. Reported herbaceous plant response to this treatment has been favorable.

As with the application of herbicides, the aerator can be used to create a uniform vegetation community or to create patches of sagebrush within the treated area. The aerator can also be operated in a manner that will create natural “snow fences.” A one-pass aeration and seeding operation can be accomplished where necessary by mounting a broadcast seeder directly on the aerator or on the tractor used to pull the aerator. This is recommended for sites where the sagebrush is of such high cover that the herbaceous understory is depleted. The litter created by this method provides protection from grazing for emerging seedlings.

3.4.4 Disking

Disking is a mechanical control method of some annuals or invasive noxious weeds which may be appropriate. Use of this tool for these purposes should be considered at the watershed management plan level. Disking is only being discussed below as a means of rehabilitating existing stands of sagebrush.

Disking, like the application of herbicides, has a relatively long history of use for brush control. Where intensive disking has been conducted, sagebrush eradication has been achieved. However, where disking was conducted “improperly” or purposely conducted less intensively, the control of brush was less “successful.” As stated for the other treatments, the purpose of disking is to thin the stand of sagebrush, not eradicate the sagebrush. Disking is conducted with a rangeland disk, of which there are many versions. Whichever equipment is used, the level of disking should be minimal, and the pattern of disking should be such that unplowed rows of sagebrush remain as “leave strips." The leave strips should not be more than six feet wide and spaced at approximately 60-foot intervals. Patches can be left to provide cover for Sage-Grouse, and nesting habitat for other bird species. Jackrabbits are also likely to inhabit these patches and feed on the treatment areas.

Disking is limited to soils that do not have a lot of cobble or boulders and to landscapes that are not very steep. This treatment is the most invasive of the treatments so far discussed, and the potential for undesired results is high. Established understory vegetation is generally uprooted and an initial decline in herbaceous cover may occur with this treatment. Soil disturbance increases the potential for invasive species to establish and for greater water or wind erosion. However, this treatment also incorporates organic material into the soil and may create a favorable seedbed for desired species. Therefore, it is necessary to have a good understanding of the site potential, current site conditions, and surrounding vegetation before implementing this treatment.

As with aerating, disking and broadcast seeding can be achieved, where appropriate, in a one-pass operation by mounting a broadcast seeder on the disk unit or the tractor.

3.4.5 Seeding

Seeding can be used for restoration of degraded rangelands, for rehabilitation of older, decadent stands of sagebrush, to reestablish grasses and forbs on range sites previously occupied by pinyon-juniper, and for burned area rehabilitation. Seeding will most often be used in conjunction with some other treatment that is designed to prepare a suitable seedbed or to remove competing or undesirable vegetation.

The seed mix to be used will be selected to meet the objectives of the watershed management plan and will consist of species that are adapted to the specific sites to be seeded. In keeping with the overall goal of the Strategy and the Northeast Great Basin Standards and Guidelines to restore or maintain natural processes of the watershed, native species will be selected over non-native species whenever the two species are equally adapted to the site and have similar establishment characteristics. In some instances, the selection of species may be a result of the type of seeding method available because one species has a higher establishment rate when a specific method of seeding (e.g., broadcast seeding vs. drill seeding) is used. Two exceptions to the preference for native species should be noted. Greenstrips, discussed below, have a specific purpose, and a combination of native and exotic species may be used to achieve these specific purposes. The other exception is burned area rehabilitation. Currently, establishment of native species in areas of low precipitation that have been subject to intense fires and/or had little herbaceous understory preceding the fire, has met with limited success. Until seeding techniques, seedbed preparation methods, and plant materials have been sufficiently developed for these arid sites, adapted exotic species are recommended for site stabilization and noxious weed control. The use of some exotic species has been shown to provide for long-term reestablishment of native grass and shrub species. However, as new technology or plant cultivars develop, the dependence on exotic species should be eliminated.

Each seeding of sagebrush range sites should be designed to provide for the establishment of plant communities that will provide the structure and diversity of plants to support a variety of wildlife species over time. This can be accomplished in one of two ways. On sites with relatively high potential (i.e., deeper soils with water holding capacity, higher precipitation zones, and topographic diversity) that have either burned or have a depleted herbaceous understory, a seed mix of a few grasses and forbs may be the most appropriate. Seeding following a wildfire or after one of the sagebrush thinning treatments is designed to supplement the natural processes that lead to plant species diversity. The simple plant community thus created will become more diverse with time as native species suited to the site establish (i.e., achieve diversity from the "bottom up" approach). Stabilization of the site to prevent erosion or the establishment of invasive or noxious weeds should be a first priority. A diverse plant community cannot be developed where soils are eroded or where invasive or noxious weeds dominate the site. Conversely, diversity may be achieved by the "top down" approach. Using a diverse seed mix on a site with a variety of microsites will allow many of the species in the mix to establish where the conditions for each species are favorable.

On rangelands with low potential (i.e., poor soils, low precipitation zones, low topographic diversity), a simple seed mix is generally the most effective. These sites do not have the potential for a highly diverse community; therefore using a seed mix with eight or more species is not cost effective.

The use of shrubs in the seed mix should be carefully considered. On sites where sagebrush thinning is part of the treatment, sagebrush seed will be produced on site and need not be included in the seed mix. Generally, seeding in combination with a sagebrush thinning treatment will be designed to increase grasses and forbs, not shrubs. The objective is to allow the shrubs to establish over time and create nesting and early brood habitat where a healthy component of herbaceous plants has already established. On sites that are restored after years of dominance by either annual grasses or pinyon-juniper, the soils may be lacking the mycorrhizae necessary for sagebrush establishment. For these sites, a second overseeding with sagebrush (with or without supplemental species) five or more years after the initial seeding may be both more cost effective and more successful than seeding immediately after the removal of the annual grasslands. The objective of overseeding is not to establish sagebrush uniformly over the entire seeding, but rather to create patches of sagebrush throughout the entire seeding. This prevents the single age class monoculture of sagebrush from developing and creates variable fuel loading to keep wildfires from burning large acreages.

This same concept should be considered for burned area rehabilitation. Large burned areas that supported sagebrush at the time of the fire should be spot seeded with sagebrush as a second seeding (i.e., overseeding) effort the first fall/winter after the fire, or have sagebrush seed loaded into the drill seeder or aerial seeder intermittently (e.g., every fourth load) to create strips or patches of sagebrush within the burned area. These plants will mature quickly in the absence of dense herbaceous competition and start the natural progression of sagebrush establishment and age class creation over a 30- to 40-year period. This should result in a variety of Sage-Grouse seasonal habitats developing within the burned area, rather than having one large age class develop that only provides one seasonal habitat at any given time.

The other factors to consider when seeding sagebrush are the cost and the conditions needed for establishment. Seeding intermittently reduces the overall cost, allowing more burns to be seeded with some sagebrush seed. Establishing small patches over many burned areas may have greater benefit than completely seeding only a few burns. In addition, conditions suitable for sagebrush germination <u>and</u> establishment do not occur every year (Perryman et al. 2001, Maier et al., 2001). Therefore, intermittent seeding should be planned as a two-phase effort. The first phase should be during the fall or winter following the burn. If unsuccessful, a second seeding two or three years later may be more successful. During periods of extended drought, sagebrush seeding should not be conducted because the chances of successful establishment are extremely low during dry springs.

Where Sage-Grouse habitat, or potential habitat, and mule deer crucial winter range overlap, careful consideration of restoration and fire rehabilitation seed mixes is necessary. Currently, prostrate forage kochia (*Kochia prostrata*) is recommended for mule deer crucial winter range. This species provides forage for mule deer, pronghorn antelope, and livestock, but has not been shown to be of value to Sage-Grouse or other species of the sagebrush ecosystem. Prostrate forage kochia is an aggressive species that establishes easily in some of the lower precipitation zones and has demonstrated the ability to compete favorably with cheatgrass. While there is no doubt that this species provides important forage for mule deer and can be effective in greenstrips (see below), not much is known about how this species interacts with native vegetation over the long term. Where kochia and sagebrush can be successfully established on the same sites, will kochia prevent sagebrush from reaching the cover percentages required for Sage-Grouse seasonal habitats? Will the presence of kochia extend the fire interval in sagebrush stands, leading to depletion of the native herbaceous plants? Will kochia demonstrate the long-term environmental adaptations that we now observe for cheatgrass? Without answers to these and other questions, some caution should be exercised when using kochia in Sage-Grouse/deer habitats. Where mule deer crucial winter range does not overlap with Sage-Grouse habitat, kochia could be included in the seed mix to restore mule deer habitat values. Where the two species' habitats overlap, restoration of sagebrush and other native shrubs should be the management goal.

3.4.6 Greenstripping

Greenstrips are linear seedings (strips) of plant species that have some resistance and tolerance to fire. Fire resistance means the plants are less likely to burn than other plants. For most greenstrip species, this means that they retain fuel moisture, and therefore a green appearance later into the summer than many of the cool season grasses and forbs common to the Great Basin. Fire tolerance indicates that a plant recovers following a fire. The plant may have adaptations to protect growing points, resprout from root nodules, or have seed that requires exposure to heat or altered soil chemistry to germinate. The concept of greenstripping is to provide a strip of fire resistant, fire tolerant species at a strategic location to either prevent the fire from spreading from one side of the greenstrip to the other side, or to slow the spread of the fire to allow suppression crews to arrive, or to provide fire suppression crews with a fuel break from which to anchor their suppression efforts.

Another factor to be considered when planning a greenstrip is palatability of the greenstrip species to livestock and wildlife. While these species may be fire resistant, they do eventually dry out and become potential fuel. Grazing the greenstrip late in the growing season reduces the amount of standing fuel within the greenstrip during fire season, increasing the effectiveness of the greenstrip. Greenstrips can be used wherever there are habitats or facilities that need some protection from unplanned, dry season fires.

There is some indication that by breaking the fire cycle, cheatgrass loses some vigor and seed production decreases, resulting in increased effectiveness of control efforts. These grasslands are highly flammable and fire dependent communities. By breaking large areas into smaller areas, an ignition in one block can be maintained within the block, rather than re-burning the entire annual grassland. Greenstrips are one method commonly used in annual grasslands to break up the grassland into smaller blocks.

The greenstrips must be planned with the “end in mind.” Breaking up large annual grassland into future management units should consider the landscape features and surrounding vegetation. The greenstrips can be positioned on the landscape where they are less visible, or where they would be protected from prevailing winds. The leeward side of a ridge away from a road or other major observation point would achieve both of these objectives. The snow accumulation on the leeward side of the ridge would also favor establishment and functionality of the greenstrip. The management units created by the greenstrips should be irregular in shape to allow the eventual vegetation mosaic to mimic natural vegetation communities. Using soil map unit boundaries as the greenstrip boundary will help achieve this affect. Greenstripping with the topographic contours is also effective.

Greenstrips can also be used to reduce the risk of fire spreading from an annual grassland to sagebrush habitats or other desired plant communities. The greenstrip is normally placed at the contact zone between the annual grassland and the sagebrush habitat. The reduction in fuel within the greenstrip slows the fire and reduces the fire intensity, giving suppression crews an opportunity to keep the fire from the sagebrush habitats. Greenstrips may also be appropriate to break up extensive areas of sagebrush. These extensive stands are vulnerable to wildfires, especially when they are decadent, in which case the intensity of the fires is generally quite high and the potential for annual grasses to become established following wildfire is high. This use of greenstrips should be considered in watersheds that are not at the top of the priority list for watershed plan development. The greenstrips would help maintain the sagebrush resource until watershed plans can be developed.

The watershed assessment and watershed management planning would determine the applicability of greenstrips, as well as the specific plant species to be used in establishing greenstrips. Some cultivars of crested wheatgrass, prostrate forage kochia, an upland cultivar of western yarrow, and some exotic forbs are effective and commonly used species. Research to develop cultivars of native species is ongoing, with some promising preliminary results. As native species cultivars are developed, they should be used wherever suitable to reduce the visual and ecological impacts of greenstripping.

Greenstrips, while providing benefits for restoration and fire suppression activities, can also be viewed as fragmenting habitats (i.e., breaking up large blocks of habitats into smaller parcels). Therefore, some thought needs to be given to the placement of greenstrips on the landscape. Here are some guidelines to consider:

- Plan greenstrips to complement existing features. Roads can be considered fuel breaks and are more effective if a greenstrip is placed adjacent to the road. The presence of the road also reduces the width of the greenstrip necessary to achieve effective results. The greenstrip should include both sides of the road, with two-thirds of the greenstrip width on the upwind side (for the prevailing winds) and one-third of the width on the downwind side. Other features that can be used in combination with greenstrips are fences, transmission lines, and drainage features. The added benefit of greenstrips along fences and transmission lines is that wooden fence posts and power poles are less likely to be burned, reducing costs of wildfire rehabilitation. Greeenstrips along ephemeral or intermittent drainages may reduce soil erosion and incision of the drainages by maintaining vegetation adjacent to the drainages. However, the greenstrip should not be placed in the drainage itself.

- Plan greenstrips in sagebrush communities to coincide with the long-term plans for the watershed. At the outset, a desired mosaic can be mapped and greenstrips can be used to break up the large expanses of sagebrush along the edges of the blocks of the mosaic. The greenstrips thus function as fuel breaks and can eventually be used as the fire line to control prescribed burns.

- Use the minimum width necessary. Greenstrips will present visual contrasts with adjacent vegetation and may create potential predator traps for prey species crossing the greenstrip. Visual contrasts have been previously discussed. A greenstrip created to break up a continuous block of sagebrush creates a strip with minimal cover between the resulting sagebrush blocks. Small mammals, birds, and reptiles crossing these strips will be vulnerable to predation.

- Where the visual contrast between exotic fire resistant species and native perennial species is undesirable, opt for removing shrubs from native perennial vegetation to create a greenstrip that will reduce the contrast by consisting of the native grasses and forbs.

- Existing and planned transmission line corridors and fence lines should receive high priority for greenstrips. Transmission lines may result in habitat fragmentation and rather than create more fragmentation by creating separate greenstrips, the two features can be combined. As mentioned above, greenstrips may reduce the loss of wooden poles and fence poles to wildfires. In addition, prey species are already scarce along transmission lines due to the increased predator use of the poles for hunting perches; therefore, planting non-habitat (i.e., a greenstrip) where animals are less abundant has less impact. Transmission lines and fence lines generally have access points for maintenance, which can be used as access for fire suppression crews. As new transmission lines or fences are constructed, the greenstrip can be created as part of the reclamation requirements for construction disturbance.

3.4.7 "Brownstrips"

"Brownstrip" is a new termed coined by the NNSG to differentiate between a greenstrip created with non-native species that are fire tolerant and fire resistant (i.e., retain greenness longer into the growing season) from fuel breaks that have reduced shrub abundance (either devoid of shrubs or very widely spaced shrubs) and occupied by native perennial herbaceous species that are brown or tan when cured at the end of the growing season. Brownstrips are an alternative to eradicating existing native perennial vegetation and seeding fire resistant or fire tolerant species. While not as effective as planting fire resistant species, this practice is more cost effective, and at lower precipitation zones, may have higher potential for success than a seeding.

Brownstrips can be created in a number of ways, including brush mowing, aerating, disking, prescribed fire, herbicide, and through prescription grazing. The choice of technique will depend on terrain, rockiness of the soil, and current condition of the vegetation. The brownstrip is a tool for breaking up large contiguous tracts of sagebrush to limit the size of wildfires that may start in these intact habitats. The intent of the brownstrip is to release the herbaceous understory and reduce the woody (long-term) fuels. Grazing brownstrips is strongly recommended due to the lower fire resistance of these types of fuel breaks. These open areas, when grazed, reduce the standing fuel to a level that is insufficient to carry a fire.

Brownstrips are recommended along fence lines, roads, and power lines until watershed plans are completed. The power lines and fence lines can be created by aerial application of herbicide (tebuthiron). An 80-foot swath along fence lines (using the fence line as the center line) or roads (one side of the road), and two 80-foot swaths along power lines (one on either side of the power line) is recommended. This would create approximately 10 acres of brownstrip per linear mile of road or fence line and 20 acres of brownstrip per linear mile of power line.

Any of the native vegetation treatment to achieve the sagebrush succession, Sage-Grouse habitat, fuels management, and livestock objectives stated above will be brownstrips during the herbaceous phase of the plant succession. These treatment areas do not necessarily need to be "strips", but can be any shape as long as they serve to break the contiguous woody fuels on the landscape.

3.4.7 Chaining, Woodcutting, and Wood Harvesting

Chaining consists of dragging an anchor chain across the landscape between two bulldozers. The chain breaks or uproots shrub and tree vegetation and rolls over herbaceous vegetation. The technique is commonly used in pinyon-juniper woodlands. As with disking, soil disturbance occurs and the opportunity is created for invasive species to become established. In the semi-arid and arid regions of the Great Basin, woody material does not decay readily; therefore the rate of incorporation of organic material into the soil can be quite slow.

When applied to areas with established understory vegetation, the herbaceous plants can be released. However, where understories are meager, chaining should be followed with seeding. The litter that is left after chaining does not provide much in the way of Sage-Grouse habitat, but the downed trees can provide habitat for a variety of other species. Burning the down litter or slash would generally favor Sage-Grouse if sagebrush and herbaceous plants are expected to establish on the site.

As with the sagebrush ecosystem, the pinyon-juniper woodlands have a complement of wildlife species, some of which may be considered obligates. Therefore, conversion of pinyon-juniper to sagebrush needs to be accomplished while still providing the necessary habitat requirements for the pinyon-juniper obligates. This can generally be accomplished by identifying the woodland sites and the rangeland sites during the watershed assessment. Managing the pinyon-juniper on the woodland sites, through appropriate management strategies as proposed herein for sagebrush, would result in healthier woodland sites and maintenance of the associated fauna and flora.

Where markets exist, woodcutting for fence posts and firewood may be appropriate alternatives to chaining. Although some of the organic material is removed from the site, the slash that is left decays more readily than tree trunks. Soil disturbance is often less after woodcutting than after chaining. Woodcutting may not result in the complete removal of pinyon-juniper, because smaller diameter trees are passed over. The combination of woodcutting and chaining may provide the best overall treatment of pinyon-juniper. An area planned for pinyon-juniper removal could be opened up for commercial or non-commercial woodcutting for two or three years and the residual trees could be chained at the end of that period. This would allow for harvest of the useable wood fiber and reduce the amount of slash left after chaining.

Other uses of the pinyon-juniper biomass should be considered. An industry that can be sustained by removing these woodlands and using the biomass, while providing for the renewal of these woodlands over time, would benefit rural economies and make use of a potentially valuable resource, rather than on-site burning or chaining. An industry solution would generate income, rather than require funding like the burning and chaining options. A wood pellet or wood cube factory, wood-fueled power plant, or other wood products industry needs to be considered and developed where appropriate.

Normal woodland harvest operations generally leave the seedlings and saplings of the woodland species. Therefore, the stock necessary to regenerate the woodland is likely to be in place. Where Sage-Grouse or other watershed values require a longer interval before the pinyon-juniper woodland reestablishes, prescribed burning after the removal of the mature trees may be a cost-effective means of removing the seedlings.

3.4.8 Grazing

Grazing can be a tool to achieve land use objectives or it can be an impact that detracts from achieving land use objectives. As discussed in Section 2.5.5, herbivory is not the issue, it is the timing, intensity, and duration of herbivory that needs to be managed.

3.4.8.1 Grazing As A Tool

Sagebrush thinning can be achieved through livestock grazing. Winter feeding of hay on upland sites concentrates the livestock in a relatively small area, resulting in breakage of shrubs and thinning of the sagebrush stand. In order to implement this practice, pathways need to be established within the dense sagebrush to allow vehicle access during winter for hay distribution. An aerator, disk, or brush hog (brush mower) can be used to create the access. In addition to thinning the sagebrush, residual hay and concentrated dung provide organic material that can be incorporated into the soil, improving the nutrient levels and water holding capacity of the soil. Trampling of the cow pies promotes rapid breakdown and incorporation of the manure into the soils. This technique is only applicable to lands with moderate to level topography that exists close to hay production areas.

Winter feeding on uplands is also likely to improve water quality. Currently, many operators use the aftermath on hayfields as fall and winter forage. Prior to hard frost, this practice provides fertilization of the meadows. Soil organisms remain active and contribute to the incorporation of this material into the soil. But once the ground is frozen, soil organisms either cease functioning or function at a greatly reduced rate. The urine and manure build up on the soil surface and are washed into the creeks and streams during the spring runoff. By feeding on the uplands when the ground is frozen, these impacts to water quality can be reduced.

Winter feeding on the uplands should be rotated among sites, both within and between years. Continuous feeding at the same site throughout the winter is likely to cause sagebrush eradication. Annual use of the same area is also likely to cause impacts to herbaceous plants through hoof action, eliminating the potential increase in herbaceous vegetation production resulting from the initial thinning. Therefore, several areas should be established for winter feeding and a site rotation system implemented. Or, the treatment can be applied to a new site each year to accomplish additional acreage of habitat management.

Moderate livestock grazing of meadows has also been shown to improve Sage-Grouse forage and to make meadows more attractive to Sage-Grouse than ungrazed meadows (Neel 1980, Evans 1985, Klebenow 1985). Utilization that reduces rank growth, but leaves clumps of tall grass distributed throughout the meadow, creates optimum habitat conditions for Sage-Grouse and leaves sufficient stubble of grass to replace root reserves. The stubble also serves to trap sediment during high flows (e.g., spring runoff), improving the meadow, stream channel morphology, and water quality. Extreme use or abuse of the meadow results in degradation of the meadow, stream channel morphology, and water quality.

Grazing can also be used to improve the effectiveness of greenstrips. Even though the species used to create greenstrips are relatively fire tolerant, they still provide some fuel during high fire danger conditions. Grazing the greenstrips during the growing season reduces the amount of fuel available. Herding and placement of mineral supplements are techniques that can facilitate grazing of greenstrips.

This same concept can be used on upland sites to reduce fine fuels and decrease the potential for the spread of wildfires. However, this only applies to stands of sagebrush that are open and need the fine fuels to carry the fire, and to grasslands created by the treatments discussed above. Most of the existing sagebrush communities have sagebrush cover values that are too high to make grazing an effective tool. These communities need to be managed before grazing will be an effective tool. Repetitive early spring "flash grazing" in cheatgrass-dominated sites may be used to reduce cheatgrass over time.

3.4.8.2 Grazing As A Land Use

As discussed in Section 2.5.5, livestock grazing can be a compatible land use of the sagebrush ecosystem. However, changes in livestock management are necessary to maintain ecosystem sustainability and sustainability of the livestock industry.

One necessary change is in the manner in which range condition is determined. The current method involves determining if the existing vegetation resembles the desired plant community. The desired plant community is related to a seral stage of plant community succession. However, the current system appears to be based on the linear successional models that inappropriately assume that removal of a stressor will allow the community to proceed to the next climax condition or return to a lower seral stage. As discussed in Section 2.5.5, when Wyoming sagebrush reaches approximately 10 to 12 percent canopy cover and mountain big sagebrush reaches approximately 15 percent canopy cover, herbaceous vegetation cover begins to decline, and species richness decreases with additional increases in sagebrush canopy cover, <u>with</u> <u>or</u> <u>without</u> livestock grazing (Winward 2000).

When sagebrush cover reaches 20 to 25 percent, most rangeland sites will be classified as being in poor to fair condition because of the lack of herbaceous species, especially forbs. There is probably no growing season grazing system that can reverse this trend (but see Section 3.4.8.1 for winter feeding benefits). The sagebrush canopy must be reduced to achieve the desired condition because succession, or plant-plant interactions, is driving the system, not livestock grazing impacts.

If range condition is to remain the standard for making adjustments to livestock grazing operations, then the assumptions of linear successional models and livestock grazing as the major stressor must be modified. The concept of range condition must be modified to recognize that perturbations to the vegetation are necessary to achieve the desired plant community.

Another necessary change is to adjust grazing systems (timing, intensity, and duration) to the specific vegetation communities being grazed. As the landscape is modified to create a mosaic of vegetation communities and transitional stages, current grazing systems may need modification to reach the land use goals. Some modifications that may be incorporated are:

- Creation of additional pastures to allow rotation or deferment systems;
- Changes in the timing of grazing within a pasture to accommodate carbohydrate cycles or seed production;
- Changes in the duration of grazing within a pasture to achieve riparian objectives;
- Modification of an existing rotation system to achieve long-term aspen management objectives; and
- Other modifications which are appropriate to reach specific objectives.

However, these types of changes, when necessary, need to be implemented in a manner that minimizes the impact to the livestock operator; the operation must remain viable.

As the landscape is managed, and monitoring or research provides new information, the adaptive management process will provide for additional information and techniques to be incorporated into the goals, objectives, and strategies for conserving the sagebrush ecosystem.

In Section 2.5.5, the focus was on grazing with cow-calf pairs. Consideration should be given to using winter ranges in other parts of Nevada (or adjacent states), rather than over-wintering in Elko County. This would reduce the amount of hay production necessary under the current system, or provide Elko County ranchers with a cash crop by selling the hay they currently use for winter feeding. If the meadows are not used for hay production, they would be available for late season grazing or emergency grazing during drought or after a wildfire on other parts of the allotment. Late summer grazing of large meadows can be used to relieve hot season pressure on riparian habitats in smaller drainages.

The topography in much of Elko County is suited to yearling steer or sheep grazing. Changes in class of livestock may be effective where riparian issues are the major obstacle to reaching watershed objectives. As mentioned previously, herding and high-intensity, short-duration grazing may also be techniques employed to reach some land use goals.

As with the other management strategies, a change in grazing, if necessary, will be identified during the watershed assessment. The change would have to be related to achievement of a specific objective. Changes in grazing on public lands are made through the allotment evaluation process with respect to the Standards and Guidelines for Rangeland Health. The NNSG will make recommendations to the agencies based on the watershed assessment and watershed plans, but the NNSG also recognizes that implementation of any recommendation regarding grazing is subject to the agency process, schedules, and time frames. Any change in grazing management would be implemented through issuance of a grazing decision and/or agreement, in order to progress toward attainment of Standards and LUP objectives, or site specific watershed objectives determined to be consistent with Standards and Guidelines or LUP objectives.

3.4.9 Predator Control

As discussed in Section 2.3.3 and 2.5.8, predation has been identified as one factor affecting Sage-Grouse populations, primarily through impacts to nest success and early chick survival. Therefore, predator control programs that focus on areas that have been identified as nesting or early brood habitat should be considered in the watershed management plans.

Specific predators need to be identified as the offending animals prior to initiating any predator control program. In addition, the contribution that each predator species makes to the ecosystem needs to be considered to avoid creating additional problems as a result of predator control. Although there may be evidence that predators are impacting Sage-Grouse populations, these same predators may be controlling ground squirrel, poisonous snake, or jackrabbit populations. Wholesale extermination of predators is not compatible with the ecosystem management concept.

An example of a focused predator control program would be related to the concern with nest predation by ravens and/or crows using power transmission lines as perches from which to search for nests. The placement of chicken eggs injected with a corvicide (i.e., a poison specific to ravens, crows, and magpies) along segments of a transmission line route that pass through Sage-Grouse nesting habitat at the beginning of the Sage-Grouse breeding season is one means of achieving focused predator control. This would target the primary avian nest predators in areas where Sage-Grouse nesting occurs, and at a time when the action would provide immediate results. This technique could also be used along fence lines. Livestock winter feed lots are another area where corvids concentrate in the late winter and could be used to focus a predator control effort.

3.4.10 Land Exchanges

Land exchanges can be used to address two of the major factors affecting Sage-Grouse: habitat fragmentation and changing land uses.

Utility corridors, primarily transmission lines and distribution lines, which traverse Sage-Grouse habitats create physical and psychological barriers for Sage-Grouse that result in habitat fragmentation. Planning corridors for future utility needs would be one means of avoiding or minimizing this type of impact. Elko County already has an abundance of utility lines in existence. Based on an incomplete data base, approximately 550 miles of major transmission lines traverse the county. Routes for future lines should be adjacent to existing road or utility corridors, rather than in non-fragmented habitats. Planning, including creation of a utility corridor parallel to the railroad, state or interstate highways within the "checkerboard" land status area should be initiated. The planning for such corridors should include discussions with the utility companies to identify potential long-term needs and where transmission line corridors may be needed to meet these needs. Such a corridor could be created through a series of land exchanges to create a public land corridor designated for such utility activities. Outside of the checkerboard lands, utility corridors should be designated in the public land management and county land use plans. These corridors should be identified by examining a variety of resources in addition to potential Sage-Grouse habitat. Corridors identified through this process would reduce costs of permitting (and costs of utilities to the end users), such as condemnation procedure costs and environmental permitting costs, and provide utility companies with direction for their planning process. This would replace the more reactionary process that is currently in place.

As with habitat fragmentation, there is an opportunity to plan for land exchanges that would accommodate growth around existing communities, rather than create new intrusions into non-fragmented or undeveloped areas due solely to the current availability and distribution of private lands. Although the current trend in the County population is stable or decreasing, the appeal of rural lifestyles will continue to attract those wishing to leave highly urbanized areas. Therefore, it is likely that additional development into these undeveloped areas will continue and some form of planning for such development is recommended. Such planning provides for the future population increases while maintaining the integrity of the natural resources to support the needs of the population.

3.5 The Watershed Planning Process

The 42 sub-basins in Elko County presented too large a task to undertake as individual planning units. Therefore, sub-basins were combined into 19 major watersheds (**Figure 12**). Each major watershed will be the subject of a watershed assessment and subsequent watershed plan. The 19 major watersheds include many more acres of land to actively manage than can be treated with existing funding and manpower. Therefore, the first task was to develop criteria to prioritize the watersheds or sub-basins. The following criteria were developed:

- Land status - percentage of the watershed in public ownership, level of landowner cooperation, and number of permittees.
- Management systems currently in place.
- Sage-Grouse population distribution and population trend.
- Fire history - percentage of watershed recently burned, percentage of watershed in need of restoration/rehabilitation, percentage of watershed currently supporting sagebrush communities.
- Other issues - other special status species present, water quality, degree of disturbance (noxious weed infestations, annual grasslands, pinyon-juniper encroachment), etc.
- Sage-Grouse population management unit - percentage of PMU within the watershed.
- Population Management Unit - priority ranking of the PMU based on the State Conservation Strategy

A matrix for assigning values to each criterion was developed and is included as **Appendix I**. The Rock Creek Watershed, Little Humboldt Watershed, and the Upper Humboldt Watershed were ranked as the top three watersheds. The planning worksheets for the watershed assessments are also included in **Appendix I**.

The formal watershed assessment will be conducted by an inter-disciplinary team of specialists and interested parties (e.g., citizens, representatives of organizations, etc.). Appropriate skill levels would be represented or recruited. The watershed assessment/planning team will use the assessment to identify specific management strategies to be implanted to improve the functionality of the watershed. These projects will focus on improving the indicators of rangeland, riparian, and Sage-Grouse habitat health, with the eventual goal of achieving a fully functional watershed.

The watershed assessment will also be useful in evaluating public and private land management actions that have been previously implemented. These actions, such as specific range improvements or management strategies, will be

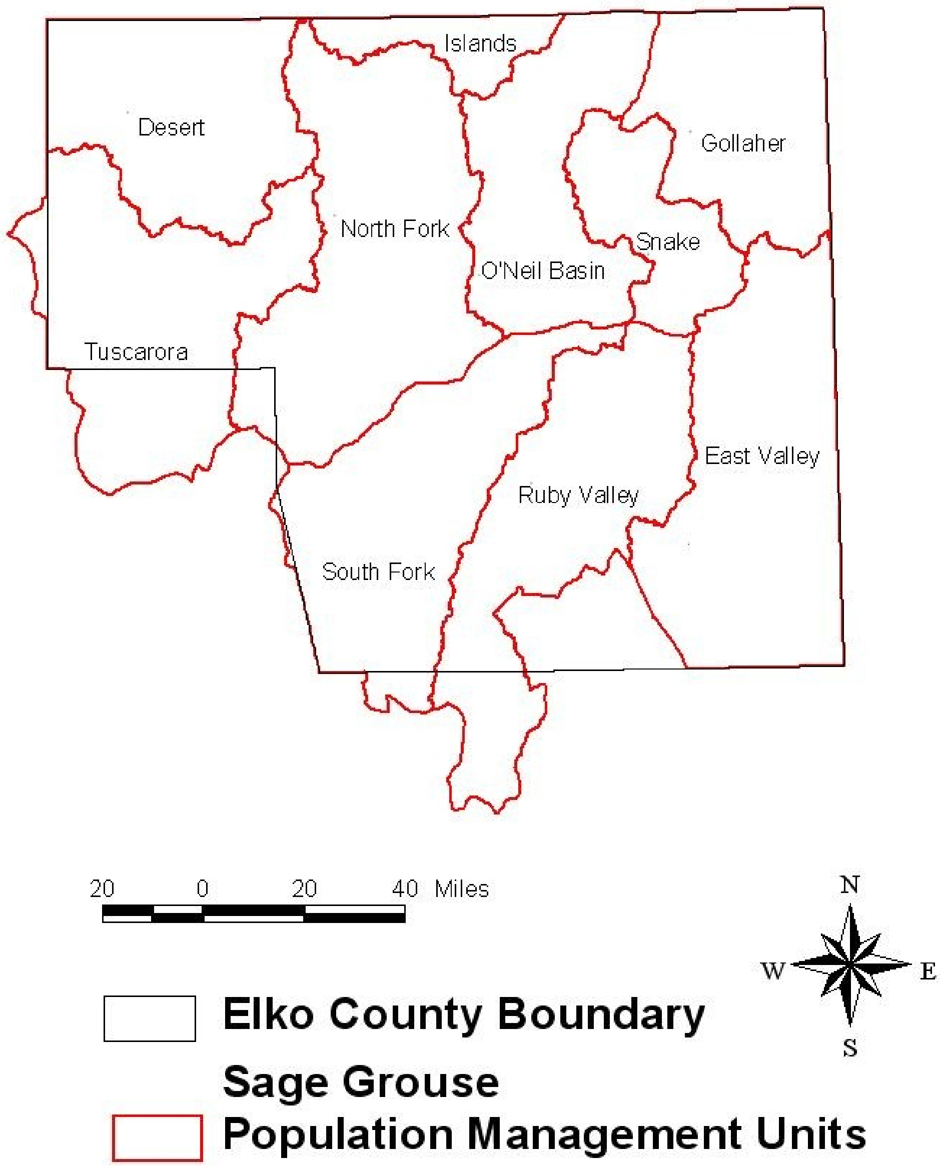


Figure 12: Major Watershed (Sub-basin) Boundaries

evaluated in the context of the overall functionality of the watershed and also with respect to Sage-Grouse habitat guidelines.

This approach, while not focused only on Sage-Grouse, will improve overall watershed conditions, which should increase the potential for improving Sage-Grouse populations, provide for other sagebrush obligates, improve water quality and quantity, and increase water, nutrient, and energy cycling. Due to the importance of Sage-Grouse in this process, each management action will be evaluated as to its overall affect to Sage-Grouse population dynamics and habitat parameters.

The watershed assessment will combine the methodology included in *Interpreting Indicators of Rangeland Health*, USDI and USDA Technical Reference 1734-6 (2000) and *Ecosystem Analysis at the Watershed Scale* (Federal Guide for Watershed Analysis). The watershed team will also have the opportunity to add variables to the assessment process, as appropriate to the specific watershed. The initial watershed assessment may identify specific field measurements that are required before a specific management action can be planned (e.g., fuel loading, plant community composition, existence of a seed bank, etc.). These types of activities will be identified during the assessment process and a schedule for obtaining the needed information will be developed and implemented.

The team will use the watershed assessment to identify the issues and management opportunities within the watershed. The assessment would include general vegetation mapping (distribution and acreage of existing plant communities), condition rating of existing plant communities (proper functioning condition assessment of uplands and riparian communities as well as refinement of the restoration ["r-values"]), identification of the ecological range sites and soil mapping units, and other information related to grazing, wildlife habitats, special status species, cultural and historic values, etc. This information will be organized into a data base compatible with GIS.

The product of the watershed assessment will be a report that summarizes the existing data and watershed condition, including quantity and quality of Sage-Grouse habitats. "Watershed analysis provides understanding of the watershed context that is essential to guide project planning and decision making. Watershed analysis is not a decision-making process, and a watershed analysis report is not a decision document, a planning document requiring NEPA review, or a regulatory prescriptive document. Watershed analysis contributes, however, to efficiently meeting land management and regulatory requirements at the watershed scale" (*Ecosystem Analysis at the Watershed Scale*, 1995). The assessment will be used to set goals and objectives for the specific watershed management plan, based on the issues identified in the assessment. These goals will be consistent with the goals of this Strategy. The goals are the characteristics of a functioning watershed, the vision of success. The objectives are the specific targets that need to be met to reach the goal. The objectives are related to the issues identified in the watershed assessment. The management strategies are the actions than need to be implemented to fulfill the objectives. There may be several management strategies associated with each objective. A schedule for implementing the actions identified in the watershed management plan will be included as part of the plan.

This process will be conducted in cooperation with the federal and state agencies, private landowners, and interested parties that have either the legal authority or the interest to participate. The watershed assessment and the watershed plan will help coordinate and prioritize federal and private land management activities. For example, if the watershed assessment identifies the need for fuel loading reduction, the watershed plan would include a project with management strategies appropriate to produce Sage-Grouse habitat in conjunction with the reduction in fuel. Such a project could be included in the annual work plan/budget process for the appropriate land management agency. Once included in this process, the project would be implemented based on agency priorities and funding availability. In addition, NNSG could apply for grants or partner with other organizations to provide matching funds for the project, increasing the probability of meeting the agency priority and budgetary constraints.

The NNSG will act as the project proponent with responsibility for project proposal development, and compliance with applicable laws, regulations, and policy. There may be opportunity to combine actions already planned by the land management agency with the watershed plan actions, where these actions are mutually beneficial. In such cases, the public land management agency may be the lead for all or portions of the project with regard to planning, compliance, and implementation.

The watershed plan will also identify the appropriate variables to monitor to determine if the objectives are being met. These will include both quantifiable (e.g., acres treated, numbers of birds, etc.) and systematic (e.g., proper functioning condition monitoring, water quality monitoring) variables. The schedule for conducting the monitoring will also be included in the plan. The watershed plan will have an implementation schedule with an approved budget, as well as identified funding source(s).

The next step would be plan implementation. This may involve contract work, agency actions, or private landowner actions, but the responsibility for each action will be clearly identified in the plan. Implementation of the plan will also include monitoring of the response variables mentioned above. Evaluation of the monitoring results will be used to determine the appropriateness of the management strategies and the need to modify the management strategies that do not achieve the desired results.

Within each watershed, the watershed management plan will consider sagebrush habitats that are currently intact, annual grasslands, and pinyon-juniper encroachment as the three major Sage-Grouse habitat issues. These issues are individually discussed below.

3.5.1 Existing Sagebrush Habitats

For watersheds that have sagebrush communities, riparian vegetation, and native perennial vegetation that is considered non-Sage-Grouse habitat (e.g., conifer forests), the potential of these vegetation communities as Sage-Grouse habitat will be determined based on range site potential and existing vegetation. The goals for the watershed will be reviewed to determine the long-term vegetation management objectives. In other words, a determination will be made whether all potential sagebrush range sites be managed as appropriate for Sage-Grouse or managed for other uses. Where vegetation treatment is necessary to meet watershed or Sage-Grouse habitat needs, the NRCS soil survey data will be used to identify the range sites present. The transition/state of each area to be treated will be determined in order to select site specific goals and appropriate treatments. An implementation schedule for conducting the treatments and monitoring will be developed. The plan will be subjected to the necessary agency approval process (i.e., NEPA), followed by implementation if plan modification is not required through the approval process. Monitoring will be conducted as provided for in the monitoring schedule.

Grazing of treated areas will be evaluated on a case by case basis. Where a rest-rotation system is in place, timing of the treatment can be coordinated with the grazing system. Applying treatments following the year of early season use would allow two growing seasons (the normal year of rest and the growing season rest of the year scheduled for late use) without affecting the livestock operation. This would be preferable for sagebrush stands with minimal understory or where seeding is part of the treatment. For stands that have a good understory component, the treatment may be scheduled following the year of rest to take advantage of seed production. The existing perennial plants would not need two years of non-grazing following the treatment, and the scheduled late season use the year following treatment would allow seedlings to establish without grazing pressure. Alternatively, the treatment of areas with a good understory component could follow the late season use. Seed production would be greater than following the early season use, but less than when the treatment is applied following the season of rest.

On areas with a deferred-rotation system, the treatments would be scheduled to follow the year of early season use, providing spring rest the year following the treatment. If seeding is included as part of the treatment, adjustments in the grazing system may be necessary. Where rest-rotation or deferred-rotation systems are not in place, timing of the treatments will be coordinated with the grazing operation to the extent possible. Closure of a pasture would be the last option.

3.5.2 Annual Grasslands

Rehabilitation of annual grasslands will be based on the best available science and techniques available. NRCS soil survey and range site data will be used to determine the appropriate plant materials to be seeded. Field inspections will be conducted to determine if any desirable perennials, noxious weeds, or undesirable species are present prior to any treatment, and the treatment will be modified to address any of these plant species issues. Once the appropriate treatment is determined, the standards for evaluating the treatment and variables to monitor will be determined. The necessary permitting/approval will be obtained, and an implementation schedule will be developed. The monitoring schedule will also be developed prior to treatment.

As with the sagebrush communities, treatments will be coordinated with the existing grazing system where practicable. However, conversion of annual grasslands to perennial vegetation will require seeding, and some period of non-grazing will be necessary to allow seedlings to establish. Appropriate criteria will be used to determine when livestock grazing may be resumed, and monitoring will be implemented to determine when the criteria have been met. Temporary fencing may be used where the seeding is only a portion of a pasture, to minimize impacts to the livestock operation. Temporary, non-renewable grazing permits may also be used to provide alternate forage when entire pastures must be closed.

For large areas of rehabilitation (i.e., > 300 acres), sagebrush should be seeded in patches scattered throughout the treatment area. These patches, when mature, will serve as the seed source for expansion of the sagebrush. Ultimately, this gradual conversion over time will result in a mosaic of sagebrush age classes throughout the treated area. For small areas, seeding the entire area with sagebrush or seeding in patches is appropriate.

The rehabilitation or restoration of annual grasslands is not likely to be a "one-treatment" project. Controlling the cheatgrass is one step, establishing a desired plant community is another, and both of these processes may require the integrated use of several tools. This process may also take a number of years to allow the various steps to proceed to a point where the next step can be conducted.

3.5.3 Pinyon-Juniper Encroachment Areas

Rehabilitation of pinyon-juniper encroachment areas will be based on the best science and techniques available. NRCS soil survey and range site data will be used to distinguish the woodland sites from range sites. Range sites will be considered for rehabilitation to sagebrush-grasslands, and the woodland sites will be managed as woodlands. The soil surveys and range site data will also be used to determine the appropriate plant materials to be seeded. Field inspections will be conducted to determine if any desirable perennials, noxious weeds, or undesirable species are present prior to any treatment, and the treatment will be modified to address any of these plant species issues. The transition/state of each area to be treated will be determined in order to select site specific goals and appropriate treatments. Once the appropriate treatment is determined, the standards for evaluating the treatment and variables to monitor will be determined. The necessary permitting/approval will be obtained and an implementation schedule will be developed. The monitoring schedule will also be developed prior to treatment.

As described above for annual grasslands, treatments in areas of pinyon-juniper encroachment will be coordinated with the existing grazing system where practicable. However, conversion of pinyon-juniper to shrub-herb vegetation will require seeding, and some period of non-grazing will be necessary to allow seedlings to establish. Appropriate criteria will be established to determine when livestock grazing may be resumed and monitoring will be implemented to determine when the criteria have been met.

Many of the pinyon-juniper sites occur on mountain sides and alluvial fans where soil erosion must be addressed. Treatments and seeding methods will be selected to reduce erosion, and sediment basins or sediment barriers will be used to protect drainages as necessary. Buffer zones of vegetation may be left in place adjacent to drainages for sediment control, or alternatively, the areas adjacent to drainages may be treated first to establish more soil cover prior to treating the larger area.

Erosion control will also be a factor in determining the size of the area to be treated.

Where permitted by agency policy, wooded areas scheduled for treatments will be opened to Christmas tree cutting or greenwood cutting prior to treatment. On areas where chaining is conducted, post-treatment wood cutting would also be allowed, as per agency policy, providing that the removal of firewood or posts does not conflict with the vegetation establishment.

Potential for biomass utilization as an alternative fuel or other wood fiber products should also be considered. This type of industry would have economic benefits to rural communities. However, careful planning is required to determine the allowable annual harvest to sustain the industry while maintaining the woodland values over time.

3.5.4 Other Habitats/Issues

The watershed management plan will include management of other plant communities in addition to sagebrush, annual grasslands, and pinyon-juniper. The riparian vegetation, including aspen woodlands along streams and in upland sites, are examples of other plant communities or management zones that must be considered. These are beyond the scope of this Strategy, but are appropriate for the watershed management plans. The management strategies to be developed for each of these habitats or plant communities will be based on the best available science, ecological hypotheses, and past experience. These will be documented in the watershed management plan.

3.5.5 Sagebrush-Obligate Species

In addition to Sage-Grouse, 20 other species have been identified as either sagebrush-obligates or sagebrush-dependent, and the management strategies discussed above will be evaluated in terms of their short- and long-term impacts to these species. A literature review relative to the habitat requirements of these species was conducted by the Biological Resources Research Center, University of Nevada-Reno and is included as **Appendix G**. For most of the species, the habitat requirements are not well documented, but the potential impacts of continuing under the current management and implementing any of the four sagebrush treatment strategies discussed above were evaluated.

The current management consists of continued livestock grazing with little active vegetation manipulation[11]. Basically, this is a strategy that will favor the creation or maintenance of sagebrush in dense, uniform stands with limited understory vegetation - “old growth” sagebrush. Rehabilitation of areas burned by wildfires is the primary means of creating young stands of sagebrush, where conditions are favorable.

The sagebrush management strategies include prescribed burning, herbicide application, aeration, and disking. Seeding may be used in conjunction with any of these treatments, but is not discussed as a separate treatment. These treatments are designed to create herb-dominated communities immediately after treatment. Wyoming big sagebrush is anticipated to begin establishing within one or two years following treatment, but may require up to 10 years. Between 10 and 20 years after the treatment, sagebrush should be well established on the site, but probably not exceeding 10 - 12 percent canopy cover. Herbaceous vegetation is expected to be abundant. During years 20 and 30 following treatment, sagebrush should begin to dominate the site and herbaceous cover would begin to decline. After 30 years, sagebrush would be dominant and herbaceous vegetation would be limited. A similar scenario would occur for mountain big sagebrush sites, but the time frames are likely to be approximately half the time outlined for Wyoming big sagebrush. The current vegetation and anticipated vegetation following treatment were compared to the habitat requirements for each of the sagebrush obligate species to determine when a site would provide suitable habitat for each species. The results of the evaluation are provided in **Table 4**. Impacts to the other obligate species would be considered on a case by case basis through the permitting process for public land actions. Monitoring of species responses to the treatments over time will add to the information

[11]This is a gross simplification, the BLM, USFS, and private landowners are currently involved in limited active vegetation management, but cumulatively this accounts for less than one percent of the planning area each year.

Table 4: Predicted Species Response[1] to Habitat Treatments[2]

Species	Pre-treatment	Immediately Post-treatment	10-years Post-treatment	20-years Post-treatment	30-years Post-Treatment	40-years Post-treatment
Black Rosy Finch	breeding - not present; winter - low	breeding - not present; winter - moderate to high	breeding - not present; winter - moderate	breeding - not present; winter - low	breeding - not present; winter - low	breeding - not present; winter - low to not present
Black-Throated Sparrow	breeding - not present; winter - low	breeding - low; winter - moderate to high	breeding - moderate; winter - moderate to high	breeding - moderate; winter - moderate	breeding - low to moderate; winter - low to moderate	breeding - not present to low; winter - low
Brewer's Sparrow	breeding - moderate to high; winter - moderate	breeding - not present; winter - moderate	breeding - not present; winter - moderate	breeding - low to moderate; winter - moderate	breeding - moderate to high; winter - moderate	breeding - high; winter - moderate
Burrowing Owl	breeding - not present; winter - migrant	breeding - moderate to high; winter - migrant	breeding - moderate to high; winter - migrant	breeding - low to moderate; winter - migrant	breeding - low; winter - migrant	breeding - not present; winter - migrant
Calliope Hummingbird	breeding - not present; winter - migrant	breeding - not present, but may feed; winter - migrant	breeding - not present, but may feed; winter - migrant	breeding - not present, but may feed; winter - migrant	breeding - not present; winter - migrant	breeding - not present; winter - migrant
Ferruginous Hawk	foraging habitat - low	foraging habitat - moderate to high	foraging habitat - moderate to high	foraging habitat - moderate to high	foraging habitat - moderate to high	foraging habitat - low to moderate
Gray Flycatcher	breeding - not present to low; winter - migrant	breeding - not present; winter - migrant	breeding - not present to low; winter - migrant	breeding - low to moderate; winter - migrant	breeding -moderate; winter - migrant	breeding - moderate; winter - migrant
Green-Tailed Towhee	breeding - moderate; winter - migrant	breeding - not present; winter - migrant	breeding - not present; winter - migrant	breeding - low to moderate; winter - migrant	breeding - low to moderate; winter - migrant	breeding - moderate; winter - migrant
Kit Fox	low	moderate	moderate to high	moderate to high	moderate to high	moderate
Loggerhead Shrike	breeding - moderate; winter - low or migrant	breeding - not present; winter - low or migrant	breeding - low; winter - low or migrant	breeding - low to moderate; winter - low or migrant	breeding - moderate; winter - low or migrant	breeding - moderate; winter - low or migrant
Prairie Falcon	foraging habitat - low	foraging habitat - moderate	foraging habitat - moderate to high	foraging habitat - moderate	foraging habitat - low to moderate	foraging habitat - low
Pronghorn Antelope	not present	high	high	moderate to high	moderate	low
Pygmy Rabbit	moderate to high	not present	not present	low	low	moderate to high
Sage Sparrow	breeding - high; winter - migrant	breeding - not present; winter - migrant	breeding - not present; winter - migrant	breeding - not present to low; winter - migrant	breeding - low; winter - migrant	breeding - moderate to high; winter - migrant
Sage Thrasher	breeding - high; winter - migrant	breeding - not present; winter migrant	breeding - not present; winter - migrant	breeding - not present to low;	breeding - low to moderate; winter -	breeding - moderate to high; winter - migrant

				winter - migrant	migrant	
Sagebrush Lizard	moderate	not present	not present	low to moderate	moderate	moderate to high
Sagebrush Vole	not present to low	not present to low	low to moderate	moderate to high	high	moderate
Swainson's Hawk	foraging habitat - low	foraging habitat - moderate to high	foraging habitat - high	foraging habitat - moderate to high	foraging habitat - moderate	foraging habitat - low
Vesper Sparrow	breeding - not present; winter - migrant	breeding - moderate to high; winter - migrant	breeding - high; winter - migrant	breeding - moderate to high; winter - migrant	breeding - low to moderate; winter - migrant	breeding - low; winter - migrant
White-Tailed Jackrabbit	not present	moderate to high	high	moderate to high	moderate	low
Number of species for which habitat is optimum	4	6	8	7	4	5

[1]Response is in terms of relative population. High populations would be limited to optimum habitat quality; Moderate population levels would be associated with good habitat quality; Low population levels would be associated with poor habitat quality; and Not Present would be associated with unsuitable habitat quality.
[2]Treatments consist of shrub thinning or removal from a pre-treatment condition of >25% sagebrush shrub canopy cover, < 10% perennial grass basal cover, and < 5% forb cover (desirable perennial and annual). Immediately Post-treatment would consist of a grass-forb community with little or no sagebrush. 10-years Post-treatment would consist of a grass-forb community with less than 10% shrub canopy cover. 20-years Post-treatment would consist of sagebrush-herbaceous community with 10-15% shrub canopy cover. 30-years Post-treatment would consist of a sagebrush-herbaceous community with 15-20% shrub canopy cover. 4-years Post-treatment would consist of a sagebrush dominated community with 20-25% shrub canopy cover.

about the habitat requirements of these species, and to the development of habitat management strategies specific to these species.

3.6 Monitoring and Evaluation

There are three levels of monitoring that will be implemented. The first is monitoring of the watershed plan implementation schedule. This level of monitoring is to identify that the watershed plans are being implemented on schedule to achieve the desired goals of the watershed plan. The NNSG will undertake this monitoring role to ensure that planned actions are implemented and that plan implementation activities are reported to all parties involved.

The second level of monitoring is to monitor the goals and objectives of the watershed plan. If a goal is to increase juvenile recruitment, then there must be monitoring of population data to determine if the ratio of young to adults has increased and that the population has increased. For each goal and objective of the watershed plan, specific monitoring will be developed and the responsibility for conducting the monitoring will determined.

The third level of monitoring is the project-specific level. For example, if a vegetation treatment is implemented, the treatment will have specific objectives (e.g., percentage of shrubs to be removed, increase the amount of forbs desired by Sage-Grouse, reduce soil erosion, etc.). Each watershed management plan will specify the monitoring for each action included in the plan. The variables to be monitored, the schedule for conducting the monitoring, and the standards for success, will be included in the monitoring section. Emphasis will be placed on existing monitoring efforts; however, additional monitoring specific to each watershed plan is anticipated.

The schedule for reporting progress on the implemented actions will be based on the anticipated time for measurable changes to occur. However, a reporting schedule of every two or three years is anticipated. The monitoring reports will provide a brief description of the action taken, the variables selected for monitoring, the standards for success, and the desired outcome of the action/treatment. The actual field data will be included in appendices, and the report will include a summary of the data and data analysis. A discussion of the monitoring results in relation to the standards for success and the desired outcome of the action/treatment will also be included. If progress toward the desired outcome is adequate, no modification will be made to the action/treatment, and monitoring will be continued. The monitoring information will be made available to other watershed planning groups to promote additional successful actions/treatments.

If the progress toward the desired outcome is inadequate, then the desired outcome, the action/treatment, the scientific basis for the action/treatment (i.e., hypothesis), the monitoring variables, and monitoring methods will all be reviewed as part of the adaptive management process. Based on the evaluation, changes to one or more of these items will be made. The information gained from the evaluation will be provided to other watershed planning groups to avoid repetition of the same situation in other watersheds.

3.7 On-Going Efforts

Actions to benefit Sage-Grouse and Sage-Grouse habitats will be ongoing during the watershed assessment process. The BLM, USFS, and private landowners will continue to operate under their LUPs or ranch plan while the assessments are being completed. NDOW will also continue efforts to monitor the bird populations during this period. As stated previously, the land management agencies have included Sage-Grouse as a Sensitive Species, thereby affording it protection and consideration in the actions undertaken by these agencies. For example, the Proposed Multiple Use Decision for the Squaw Valley Allotment in the Rock Creek Watershed has specific actions for enhancing Sage-Grouse habitats, both upland and riparian habitats that can be implemented as soon as the Final Multiple Use Decision is issued. The watershed assessment can be used to determine where these actions can be implemented, but there is no reason that the BLM cannot move forward without the assessment being completed. **Appendix J** includes a summary of the activities that will be ongoing by the agencies.

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