5. COMPARISON WITH OTHER FINDINGS AND MODELS

TASK 5: EVALUATE FINDINGS IN THE ELKHORNS WITH OTHER SIMILAR STUDIES OR MODELS

This section discusses efforts to use landscape modeling to describe pre-settlement conditions in the Elkhorns; uses historic photo sets and the most current data to identify areas of conifer encroachment; analyzes the elk security and hiding cover in the two EHUs; and also compares our finding in the Elkhorns with similar studies. The findings in this section for encroachment and elk security will be used to make vegetative treatment recommendations in Section 7.

5.1 COMPARISONS WITH SIMILAR STUDIES

The literature shows both potential for direct resource use conflicts and mutualistic beneficial relationships between elk and cattle grazing. There is no lack of data concerning food habits and/or speculation about direct competition for space on the landscape (Mackie, 1970; Lonner, 1975; Nelson and Burnell, 1976). Lyon and Ward (1982) tabulated 37 studies conducted between 1911 and 1979 on rangeland interactions between cattle and elk. Nelson (1982) mentions strong diet similarities between cattle and elk, possibly implying direct competition for a limited forage resource.

Other studies suggest that cattle grazing may enhance elk grazing. Anderson and Schertzinger (1975) proposed that appropriate management of cattle could benefit elk winter range. They found that prior cattle grazing stimulated regrowth of grasses, improving elk winter range. Subsequent research supports this thesis. Scotter (1980) wrote, "Available evidence supports the generalization that dual use by livestock and wild ungulates, when properly planned, can benefit both classes of animals." Miller (2002) observed that, "Multiple species utilization of a common resource generally results in more efficient use of the forage resource." Frisina and Keigley (2004) report that grazing management with cattle has improved the vegetation on Mount Haggin Wildlife Management Area and reported the "vegetation in uplands, riparian and meadow habitats is responding favorably in the face of livestock grazing that has occurred under rest-rotation grazing system since 1984."

Elk density mapping, in Section 4, identified the use areas in pastures grazed by cattle in the summer. The North Crow Allotment, operated as a defacto rest-rotation allotment, has dual use occurring in each of the eight pastures, and maintains 99% of its rangeland habitats in "good" and "excellent" ecological condition.

Research has been aimed at documenting the effects of seasonal use on elk and cattle forage quantity and quality. Anderson and Scherzinger (1975) advocated grazing strategies to produce high quality autumn and winter forage for cattle by preventing formation of "wolf" plants and manipulating plant physiology to improve nutritive values. DeSimone et al. (1984) noted a positive response of elk spring grazing to previous cattle grazing in the Elkhorns, and a year later concluded that livestock grazing can be used to improve foraging conditions for elk during the spring season (DeSimone et al., 1986). Accordingly, Baumeister et al. (1996) also suggested that season-specific cattle grazing improves availability and quality of forage for elk. More recently, Short and Knight (2003) found, from research performed in the Blackfoot Clearwater Wildlife Management Area, that 70% utilization of rough fescue by cattle in the fall would best improve forage availability for elk in the spring.

ERG determined that, in spring, elk are congregating in areas grazed by cattle the previous fall. These areas most commonly had high percentages of ecological condition (see Sections 2 and 4 for full discussion on the ecological condition of the rangeland habitats in these areas).

Grover and Thompson (1986) confirmed that elk appeared to react favorably to previous cattle use in their selection of spring feeding sites. They concluded this was "… due to removal of residual vegetation by cattle [and that] … moderate cattle grazing may be a tool the land manager can use to improve spring elk foraging … ." Miller (2002) also noted that, "Those portions of the range used by elk during spring migration are used by cattle as part of their summer range … . Although prior use by elk has potential for negative impact on subsequent cattle use, the continued growth of the vegetation through early summer most likely offsets any impact." Nevertheless, management care is needed. As Hobbs et al. (1996) mentioned, "Heavy winter and spring foraging of grazing allotments by elk can create an adverse situation for cattle." The underlying management recommendation in all these studies is that positive results for elk are possible if grazing management practices are implemented.

Through interviews with local ranchers and allotment managers, ERG was able to identify several problem areas, where upland utilization standards were met before cattle entered the allotment. These areas are in the upper portions of Shep's and Ribedeau pastures of the North Crow Allotment and in the head of Kimber Gulch in the Whitehorse Allotment.

Progressing beyond seasonal management modifications, a number of different authors have developed recommendations for rest-rotation systems. ERG determined that there are three standardized rotational grazing systems in the Elkhorns. DeSimone et al. (1984) found the primary variables influencing elk feeding distribution in the Elkhorns were cattle use, distance from visible road, density of bunchgrass, and distance to cover. Later, DeSimone et al. (1986) reported that "… elk movements from calving ranges to summer range did not appear to be disrupted by introductions of cattle." He concluded that, "The lack of detectable elk response to cattle introductions was likely a function of high overall elk population density, light cattle stocking levels, and high availability of forest cover." These are important observations because they compliment and suggest local modifications to land use planning in the Elkhorns.

In addition to the recognition that dual use can be beneficial to grazing animals, there has been "…an increasing understanding of the role herbivory plays in ecosystem function. Lyon and Christensen (2002) state that grazing, at some nondestructive level, is virtually essential to the continued health and maintenance of grasslands in North America."

5.2 CONIFER ENCROACHMENT

There is an abundance of literature documenting conifer encroachment onto grassland communities across the west. In addition to encroaching on grasslands, there has been a thickening of drier forest types over the

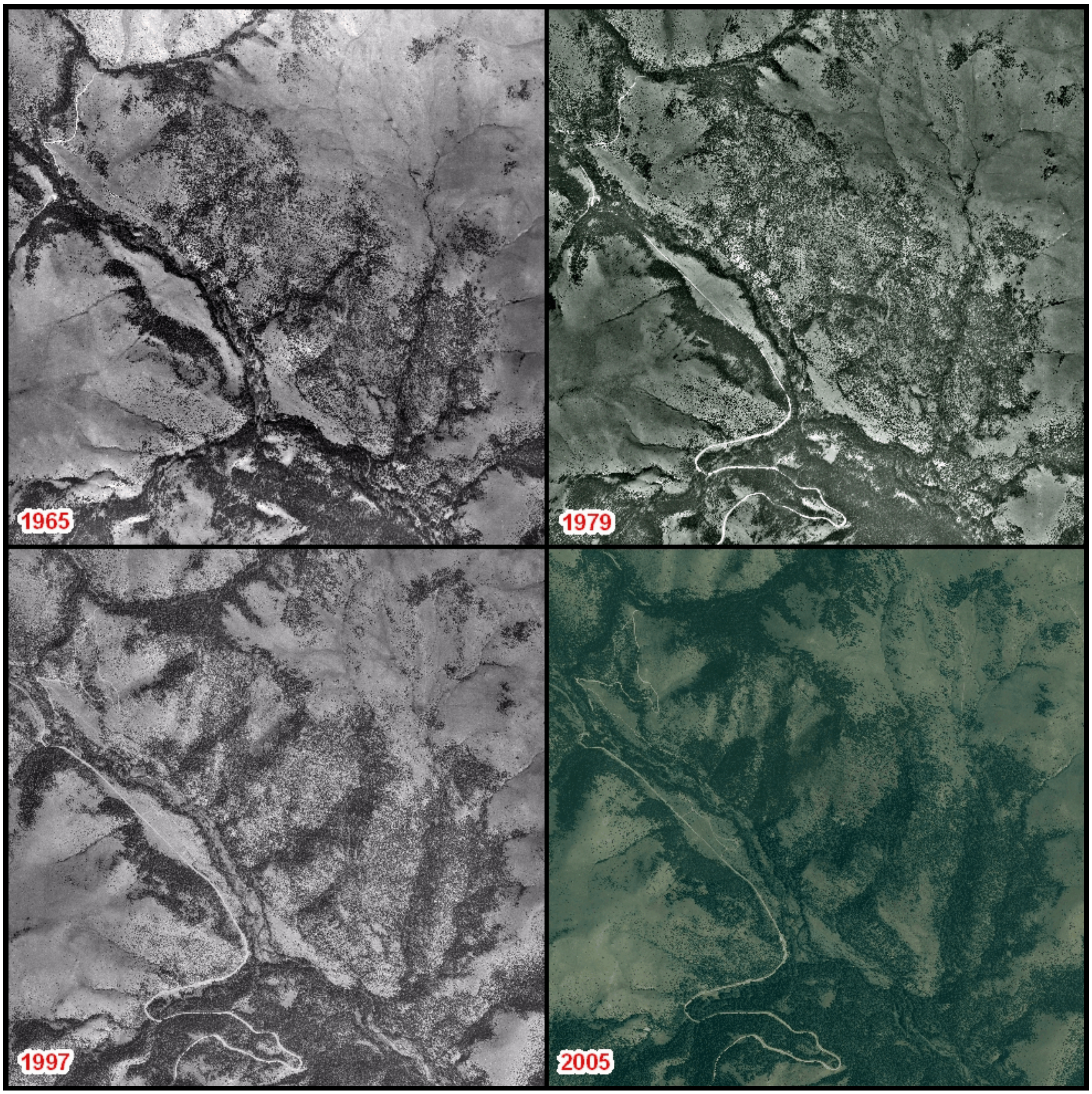

Figure 5.2-1 Forty year aerial photo-set of Crow Creek in the vicinity of Power Gulch.

past 100 years. Figure 5.2-1 above shows both encroachment and forest thickening over the past 40 years. However, literature suggests that encroachment has been occurring since the late 1800s. Arno (1986) in his study just west of Boulder, Montana concluded that:

> "Since 1890 fires have been rare as a result of livestock grazing (which removed the fine fuels), fire suppression, and cessation of ignitions by the Native Americans. Lack of fire allowed extensive areas of Douglas-fir "invasion" now of pole size to become established in former grasslands between 1890 and 1915. Widespread invasion of sapling size trees occurred between 1941 and 1955, when seed crops apparently coincided with unusually favorable moisture conditions."

In this photo-set encroachment has, most likely, been occurring for 50-plus years before the first photo in 1965. In the 1965 photo a difference can be seen in the size classes of timber, with larger trees found on north slopes and appearing as dark stringers in the south facing draws. There are large areas of the 1965 photo covered with less dense and younger trees. Throughout the rest of the photo set these younger less dense stands thicken considerably while encroaching on grasslands. This correlates well with both Arno (1983 and 1986) and Barrett's (2005) results.

Barrett (2005) during his fire history study counted fire scars on core samples from trees in this photo-set. In the northwest corner of the photos (in the bottom of Roberts Creek) Barrett took core samples on old Douglas-firs. Barrett counted seven burn scars between 1571–1878, with fire return intervals ranging from seven to 56 years (mean return interval= 21 years). The last fire in this area was in 1878, over 126 years ago.

5.2.1 Barrett (2005) Encroachment Exercise

ERG compared present day forest cover to results from Barrett's (2005) *Role of Fire in the Elkhorn Mountains*. ERG used the timber polygons from the HNF's TSMRS shapefile which ERG modified via large scale photo interpretation. Polygons were digitized to match the outline of timber stands and the rangeland habitats were broken according to aspect, this was done at a scale of 1:1000 using the 2005 DOQ for photo interpretation.

Barrett (2005) described and mapped four biophysical settings (BpSs): mountain grassland, sagebrush-cool, Douglas-fir interior (xeric-Douglas-fir), and interior west lower subalpine forest. BpSs are the same as potential natural vegetation groups

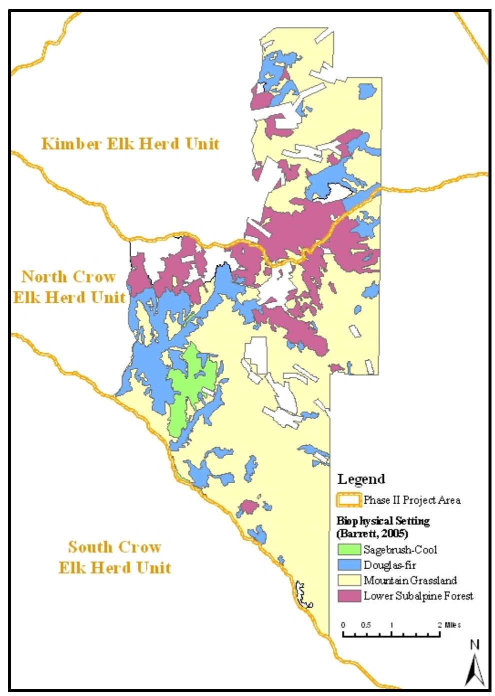

Figure 5.2.1-1 Barrett's BpS clipped to the Phase II project area

(Hann et al., 2005) Barrett's BpSs were used as the starting point for the encroachment analysis (see Figure 5.2.1-1). ERG clipped Barrett's BpSs to the North Crow and Kimber EHUs, next the BpSs were overlaid with ERG's 2005 timber layer (see Figure 5.2.1-2). Encroachment, for this exercise, was defined as areas historically non-forested (mountain grassland and sagebrush-cool BpSs) where timber was currently occupying the site. Figure 5.2.1-3 below presents the areas of encroachment determined from the BpSs encroachment exercise.

ERG determined that a total of 2,924 acres of encroachment have occurred in the area where Barrett's study area overlaps the Elkhorn Vegetation Study's Phase II study area (see Table5.2.1-1).

Barrett's (2005) Fire Regime Condition Class (FRCCs) and BpS types provide an excellent reference point from which historic age classes, historic density and stand structures, and historic forest coverage can be estimated. The three BpSs of most interest on the Elkhorns for addressing the question of forest encroachment are: (1) MGRA1 (mountain grassland) defined as grass-dominated communities where

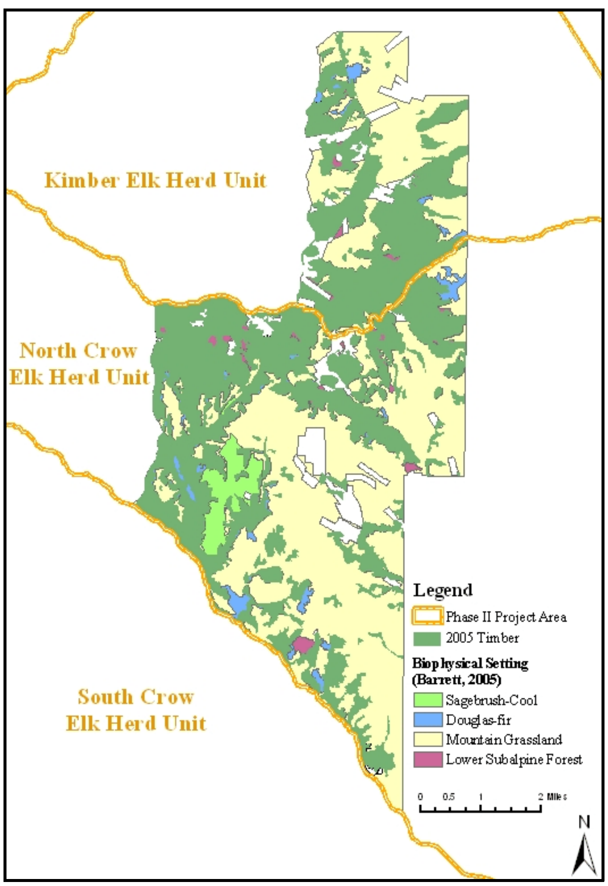

Figure 5.2.1-2 2005 Timber overlayed on Barrett's BpS

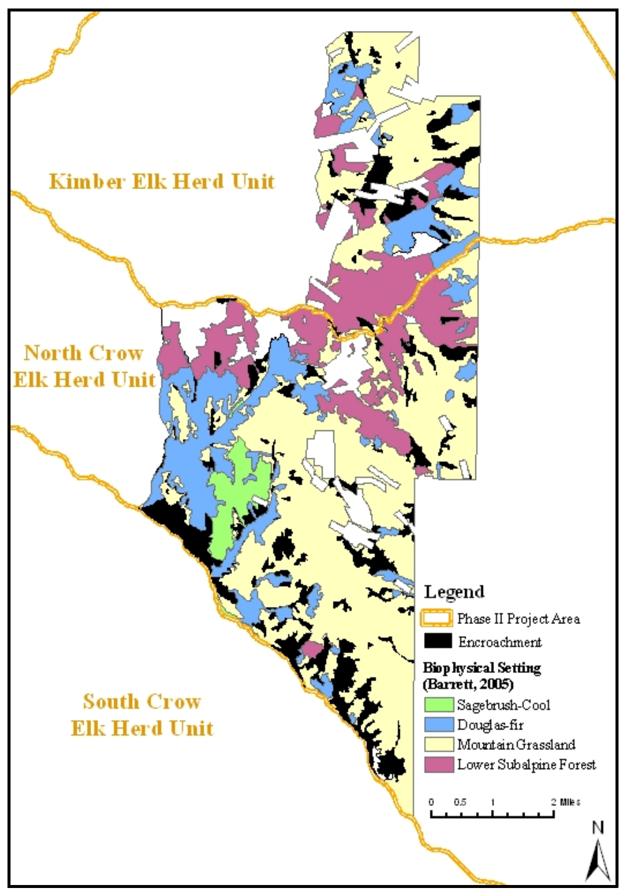

Figure 5.2.1-3 Areas of encroachment

wildfires are frequent; (2) CSAG1 (sagebrush) defined as sagebrush/grassland-dominated communities where wildfires are frequent and lethal (i.e. fires typically kill the sage); and (3) DFIR2 (Douglas-fir-interior), defined as Douglas-fir-dominated communities where wildfires are frequent and generally non-lethal (i.e. fires may kill small and intermediate-sized trees, but large trees often survive). From those BpSs we can describe average historic vegetative communities, as well as identify variation within each.

Grasslands

The high frequency of fires within grasslands doesn't mean that conifers weren't present historically, but it does suggest conifer occurrence would have generally been limited to small patches of young trees, and such occurrences would have been *intermittent* (i.e. trees "came and went" with periodic fires). This assumption is substantiated by looking at 1950's era aerial photos of the Elkhorn's grassland communities. In those photos (recognizing of course that even in the 1950's those photos were taken following several decades of fire exclusion), trees are scattered, uncommon, patchy and very small.

Sagebrush

The historic occurrence of conifers within sagebrush/grassland-dominated was likely similar to grassland-dominated communities. It's been suggested (Arno and Gruell, 1983) that historically, the age class distribution of sagebrush was more varied (i.e. more younger age classes) than what we see today after decades of fire exclusion. The question of historic age class distribution and degree of coverage of sage during pre-fire-suppression periods remains highly controversial.

Douglas-Fir

The high frequency of non-lethal fires suggests Douglas-fir communities were relatively open, single-storied, and forested with fairly large-diameter trees (Arno and Gruell, 1986). While Douglas-fir understories would have developed after wildfires, resulting from the seed bed created by those fires, those small trees would likely have succumbed to the next wildfire. Understory Douglas-fir, therefore, might best be described as small, patchy, and intermittent. It would have been rare to encounter dense, multi-storied stands of Douglas-fir under natural fire return intervals.

Table 5.2.1-1 Encroachment Analysis Results

EHU	Acres of Barrett's Non-Forest Biophysical Setting	Acres of Encroachment in Mountain Grassland	Acres of Encroachment in Sagebrush-Cool	Acres and % of Area Encroached
Kimber	3,185	707	0	707 (22%)
North Crow	10,724	2,131	86	2,217 (21%)
Totals	13,909	2,838	86	2,924 (21%)

5.3 ELK SECURITY ANALYSIS

Changes in conifer coverage, either from tree encroachment due to fire exclusion or prescribed burning intended to reduce encroachment, can affect elk security. Elk security is defined by Lyon and Christensen (2002) as cover that occurs in sufficient quantity to make elk difficult to harvest during the general hunting season. If elk are difficult to harvest, the harvest takes place slowly with some bulls surviving the season. Landscapes with high levels of elk security support much higher levels of hunting recreation then within landscapes with little security (Lonner and Cada, 1979). Because of this relationship between tree encroachment and security an analysis of security was done.

ERG determined elk security two different ways. First elk security was determined following the protocol outlined by Hillis et al. (1991). This method buffered roads which remain open during the hunting season by one half mile and quantified security on timber stands outside of the buffer. The second method is an adaptation of Hillis et al. which also buffered open roads by one half mile in addition to buffering trails and closed roads by 40 feet, thus further fragmenting the landscape.

Both methods used the following GIS layers:

1. A timber layer with timber outlines digitized by ERG, which was intersected with SILC3 to add percent canopy cover. Large scale photo interpretation and ground truthing were used to "clean" the SILC3 data, which classified all parts of the Warm Springs fire as having no canopy closure.

2. A roads layer, supplied by the HNF, and attributed by ERG as open or closed during the hunting season via use of the HNF's travel plan map.

3. A trails layer, supplied by the HNF.

In both cases the buffered roads and trails were used to erase all timber inside the buffer. The remaining timber stands were evaluated for patch size and lineararity. The minimum patch size of 250 acres was classified as elk security. Patches of timber less than 1,200 feet wide were removed, this mainly cut off narrow tails of larger polygons of security. The resulting acres of elk security were related to the total area of the EHUs, and to the area of each EHU within the extended WMU boundary. The extended WMU was created by ERG during Phase I of the Elkhorn Vegetation Study in attempt to remove areas that elk do not frequent from analysis.

Table 5.3-1 Elk Security Analysis for Kimber and North Crow EHUs

EHU	Total Acres	Extended WMU Acres	Hillis et al. (1991) Security	Adapted Hillis Security
Kimber	39,638	(28,488)	12,743 acres	12,157 acres
			32% (45%)	31% (43%)
North Crow	97,373	(39,470)	11,296 acres	9,612 acres
			12% (29%)	10% (24%)

5.4 HIDING COVER ANALYSIS

Hillis et al. (1991) defined security as large patches of non-linear hiding cover away from open roads. They also concluded, however, that no definition of security can encompass all the situations where elk can escape pursuit by hunters. Burcham et al. (1998) for instance, identified situations where elk were able to avoid hunters within posted, private lands, and within small patches of hiding cover that hunters merely overlooked as possible places to pursue elk. Therefore, small patches of hiding cover that are the result of conifer encroachment should not be overlooked as contributing to the overall pattern of security. Consequently, we recommend that when prescribed burns are planned to reduce conifer encroachment, the potential of such small patches of hiding cover be evaluated to determine if some patches might contribute to the landscape pattern of security, and if some should be retained.

5.5 STATE AND TRANSITION MODEL

ERG believes the best model to evaluate the findings in the Elkhorns is the one that is still being developed. The state and transition model for vegetation ecology is becoming the predominant vegetation model across many rangelands in the U.S. The Elkhorn Vegetation Study Final Report (ERG, 2004) developed a review of these updated approaches and excerpts of it are presented below.

Ecosystem planning, assessment, and monitoring of vegetation resources are improved with a prediction of vegetation spatial pattern at the landscape scale. Understanding vegetation factors and processes is a necessary prerequisite to predict future patterns of vegetation in landscapes. Toward that end, there is renewed interest in implementing models of vegetation dynamics to assess the effect of human activities on ecosystems and help manage landscapes. In range science, traditional approaches have proven inadequate for certain types of rangeland. Traditional range management was based on the hypothesis that the replacement of one type of plant cover by another was the most rational and reliable way to detect overgrazing, and grazing value of a range site was determined by the stage of succession represented.

Range ecologists and managers realized the need for determining range condition (rangeland health) on factors other than growing season conditions early in the 20th Century. Smith (1989) reports that both Sampson (1917) and Clements (1920) described changes in vegetation as a result of grazing in terms of successional stages; however, the concept of range condition based on secondary succession was not fully elaborated and put into widespread use until the 1940s (Parker and Woodhead 1944; Humphrey, 1945; Renner, 1948; Dyksterhuis, 1949). Thus, by the 1950s range condition was based on succession stage and defined as the present status of vegetation of a range site in relation to the climax (natural potential) plant community for that site. As such, it was an expression of the relative degree to which the kinds, proportions, and amounts of plants in a plant community resemble that of the climax plant community for the site (SRM, 1999).

Using the secondary succession model as the theoretical basis, range condition has generally been classified into four classes (excellent, good, fair and poor) based on percentage of the current plant composition with the perceived climax community. This was the general procedure of the USFS ECODATA and Parker 3-Step Condition and Trend transects. As disturbance (i.e., livestock grazing) increases the percentage of climax species would decrease (decreasers) and the amount of intermediate species (increasers) and disturbance species (invaders) would increase. Likewise, as disturbance (i.e., livestock grazing) was decreased the dominant climax species would increase and thus condition improved. By the late 1980s, the theoretical basis of the secondary succession model was being questioned as being overly simplistic and not representative of natural events (Laycock, 1989; Smith, 1989; Friedel, 1991). A different theoretical approach is being developed using state-and-transition models and a determination of ecosystem functions as a measure of range condition or health. In 1994, the National Research Council defined rangeland health (condition) as "the degree to which the integrity of the soil and ecological processes of rangeland ecosystems are maintained" and the Task Group on Unity in Concept and Terminology (1995) refined the definition to "the degree to which the integrity of the soil, vegetation, water, and air, as well as the ecological processes of the rangeland ecosystem, are balanced and sustained." Thus, current range condition methodology may consider the current plant composition to a reference plant condition (possibly the historic natural plant community), but also considers a number of other factors (soils, hydrology, energy flow).

For the Elkhorns, a change in range condition methodology could be significant. For example, on some sites where range condition is declining because of increases in Rocky Mountain juniper (*Juniperus scopulorum*) or mountain big sagebrush removal of grazing will not improve range condition. The increase in these species is more associated with a reduction in the fire regime rather than with overgrazing; although, overgrazing by livestock may increase the rate of encroachment. For these sites the state-transition-model would show that a lack a fire would result in a relatively stable state with high coverage of mountain big sagebrush and will not "transition" to a "grassland" without fire (livestock grazing is not the driving factor). Stringham et al. (2001) believe that "state-and-transition models hold great potential to aid in understanding rangeland ecosystems' response to natural and/or management-induced disturbances by providing a framework for organizing and understanding potential ecosystem dynamics." We believe the development of state-and-transition models for ecological sites for the Elkhorn study area would improve the ability of land managers to assess changes and possibly determine treatments to alter states to more desirable communities for area objectives.

5.6 LANDSCAPE MODELING

SIMPPLLE is a modeling system designed by the Rocky Mountain Research Station, a USDA Forestry Sciences Laboratory, in Missoula, Montana, for simulating vegetation patterns and processes at a range of spatial scales. The name SIMPPLLE is the acronym for "SIMulating (vegetation) Patterns and Processes at Landscape scaLEs." Managers can use the SIMPPLLE system to help define and evaluate desired future conditions at landscape scales, to identify what parts of a landscape are more prone to disturbance processes over a given time frame, and to help design and evaluate different strategies for achieving desired future conditions (Chew, 2004). Single or multiple simulations can be run. A single simulation represents one possible outcome to the landscape over time; multiple simulations can show average conditions and the probability that a process will occur on specific areas of the landscape over time. Time steps can be run yearly or in decade steps.

Specifically, SIMPPLLE's purpose is to provide the user with the ability to:

1. Simulate future vegetation changes caused by disturbance processes at multiple landscape scales;
2. Simulate ranges of conditions of plant communities and processes that can be expected for specific landscapes;
3. Simulate how changes in vegetation patterns influence the activity of fire, insect, and disease processes;
4. Simulate management treatment alternatives for their impact on disturbance processes and the attainment of desired conditions defined at landscape scales;
5. Help identify areas that have a high priority for treatments that can help achieve and sustain desired conditions at landscape scales;
6. Simulate impacts over time on a variety of resource objectives that can be defined by a combination of vegetation conditions and spatial attributes; and
7. Provide a basis for identifying the probability of disturbance processes and vegetation conditions (Chew, 2003).

Using SIMPPLLE involves an inventory of attributes assigned to each existing vegetation unit within the landscape being analyzed. This modeling system is designed to be consistent with the existing range of field inventories and satellite imagery used by the USFS. The vegetation attributes that SIMPPLLE uses to describe a unit are a combination of habitat type, dominant species or cover type, size class, structure, and density (Chew, 2004). Vegetation units are plant communities that undergo disturbance processes and reflect vegetation patterns across the landscape. GIS are used to identify the surrounding plant communities or neighbors that influence the patterns and processes of the landscape dynamics as modeled by SIMPPLLE. Knowledge of the pattern and process relationships between the vegetation units comes largely from workshops with experts and previous research (Chew, 2004).

A key feature of SIMPPLLE is that it is spatially explicit. Each vegetation unit has a defined location so that interactions between processes and vegetation patterns are a function of unit and neighboring unit attributes. Probabilities for each disturbance process are calculated for each vegetation unit, including the influence of neighboring units on the probability. Combinations of dominant species, size class, structure, density, and habitat type are used to represent existing vegetation and potential vegetation. Each potential vegetation state stores the knowledge of the disturbance processes and the next vegetation state that can occur (Chew, 2004). Thus, SIMPPLLE models the change in vegetation state for each unit of a landscape, based on how processes change and spread in the vegetation community. While SIMPPLLE is spatially explicit, it is not designed to predict precisely when and where processes will occur. Rather, the objective is to provide a prediction of behavioral trends (Chew, 2004).

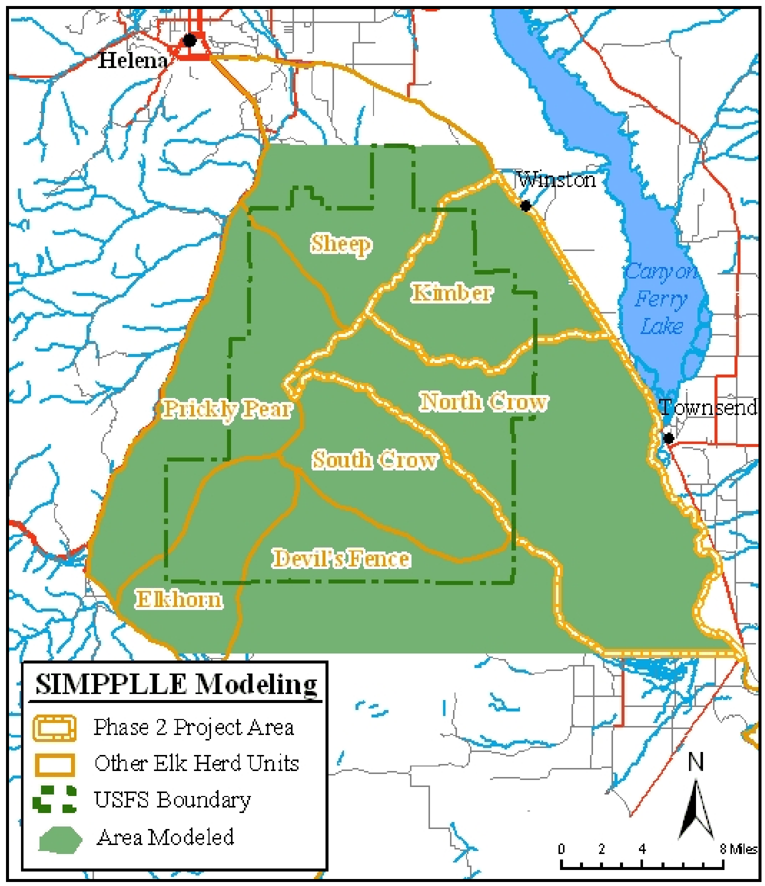

Figure 5.6.1-1 Area modeled with SIMPPLLE

SIMPPLLE also offers the user the ability to access and adjust the behind the scenes "logic". SIMPPLLE offers the user the ability to adjust logic for fire spread, type of fire (i.e. how a fire burns in differing vegetation types), insect and disease logic, and regeneration logic. The user also has the ability to adjust vegetative successive pathways and fire occurrence inputs.

5.6.1 Modeling in the Elkhorns

SIMPPLLE was utilized to model the historical range of variation (HRV) for the Kimber and North Crow EHUs. However, in order to capture landscape scale processes and interactions, ERG modeled the entire WMU plus surrounding areas. North Crow and Kimber EHUs total 137,011 acres; the total area modeled encompassed 360,213 acres (see Figure 5.6.1-1). The 360,213 acres were divided into 31,463 polygons (averaging 11.44 acres/polygon), each of which was attributed for species, canopy coverage, structure, and size class. ERG utilized many data sources while attributing. Satellite Imagery Land Cover Classification (SILC3) and the HNF's TSMRS data sets were used to attribute timber stands (although neither of these datasets did a good job capturing vertical stand structure) and GIS layers from Steve Barrett's *Role of Fire in the Elkhorn Mountains* 2005 study were used to help attribute habitat type groupings. All polygons within the Phase II project area were attributed uniquely in the ownership field in order to track results for the Kimber and North Crow EHUs apart from the rest of the area modeled.

HRV was modeled by simulating the present landscape once for 50 decades with no fire suppression and using historic pathways. Historic pathways remove the effects of white pine blister rust. The results were saved as a new area file. This initial step "resets" the effects of 100+ years of fire suppression on the present landscape toward something more representative of the historic range. The new area file was then modeled 30 times for 50 decades with the final output representing the HRV. These methods for modeling HRV were suggested by creators of the model at the Rocky Mountain Research Station.

A key component of modeling the HRV, is achieving a historic fire regimes and fire return intervals. ERG received adjusted fire spread logic, type of fire logic, and vegetative pathways from the HNF on March 3, 2006. All of these components were tested in single simulations, for 500 years, and the results for acres burned by decade and fire return intervals were compared to SIMPPLLE's default logic. Results from Barrett (2005)were used as a target for adjusting model components, specifically, the historic fire return intervals by BpS. BpSs describe historic vegetative conditions and the factors which influences them, and are further described later in the section. ERG further adjusted fire spread logic until results were closely correlated with Barrett's historic fire return intervals. Table 5.6.1-1 presents results for SIMPPLLE default logic, the HNF's adjusted logic, and for ERG's final adjusted logic; compared to Barrett's (2005) findings. Several polygons were selected within the North Crow allotment, in both mountain grasslands and in xeric Douglas fir cover types, and fire return intervals were tracked between differing logics based on a single simulation for decades 50 through 100. Notice how both SIMPPLLE's defaults and the HNF's logic had to be adjusted in order to approach the historic fire return intervals described by Barrett (2005). Achieving historic fire return intervals, allows the most accurate modeling of HRV.

Table 5.6.1-1 Fire Return Interval Comparison Between Differing SIMPPLLE Logic

Cover Type	Fire Return Interval (years)			
	Barrett, 2005 Historic Range (mean)	SIMPPLLE Defaults	HNF Logic	ERG Logic
Mountain Grassland	0–35 (16)	35	71	25
Xeric Douglas fir	0–35 (17)	60	58	27

Once ERG had finalized all logic adjustments they were saved in a system knowledge file, which was used for all HRV modeling. All results presented were taken from simulations between decades 50 and 100 and the results from 30 simulations were averaged.

5.6.2 SIMPPLLE Results

Modeling HRV, while using the best available science to modify SIMPPLLE's logic, allows the historic landscape to be quantified and visualized instead of just described. The historic range was determined by taking the highest and lowest points and an average during the multiple simulations from decades 50 to 100. Figure 5.6.2-1 shows present quantities of grasslands and shrublands compared to the historic range, including the high end, the low end, and the average. The increased frequency of fires in the historic fire regime resulted in less shrublands historically. HRV modeling shows that shrublands have increased 31% from the HRV average. This correlates well with Barrett's (2005) results that show a nearly 50% expansion in sagebrush coverage since the early 1900s. It is important to note that Barrett's project area overlaps only 16% of the Kimber and North Crow EHUs, ERG's HRV analysis averages results from the entire EHUs.

In addition to tracking changes in cover types, ERG also tracked changes in stand structure within the forest types. Table 5.6.2-1 below shows size, structure, and canopy cover for forested areas within the phase II project area for present and historic conditions. These results show that historically forests were less dense and predominantly single storied. Barrett (2005) states, "After nearly a century of fire exclusion the Douglas-fir forest exhibits the full range of fire exclusion-induced ecological problems: stand infilling, reduced stand biodiversity, reduced diversity of the forest age class mosaic, increased fire severity potential, and tree encroachment into adjacent grasslands and shrublands."

Figure 5.6.2-1 below compares forest structure from HRV to present. The effects of the 1988 Warm Springs fire have resulted in a large amount of seedling/sapling age class at present. Notice that historically there was over twice as much acreage of single storied stands than presently. Even though present day forest structure was underestimated, due to the lack of data (TSMRS and SILC), one can see sharp contrasts between historic and present day forest structure.

Table 5.6.2-1 Forest Size/Structure/Density Comparison for Forested Portions of the Phase II Project Area

Size/Structure Classes	Presently			HRV		
	Percent Canopy Cover			Percent Canopy Cover		
	15–39%	40–69%	70–100%	15–39%	40–69%	70–100%
Seedling/Sapling (<5" dbh)	8.3	22.3	0.2	17.9	9.8	0.0
Pole (5–8.9" dbh)	11.4	0.6	0.0	10.9	0.3	0.0
Pole Two Story	1.6	26.2	0.0	0.7	2.2	0.0
Pole Multi-Story	0.0	1.4	1.7	0.0	0.0	0.0
Medium (9–14.9" dbh)	9.1	0.4	0.4	27.6	10.7	0.0
Medium Two Story	9.1	0.7	0.7	0.0	0.3	0.0
Medium Multi-Story	0.0	2.0	2.0	0.5	0.4	0.0
Large (15–20.9" dbh)	0.6	0.0	0.0	9.2	1.3	0.0
Large Two Story	1.3	0.2	0.2	3.1	2.8	0.0
Large Multi-Story	0.0	0.3	0.3	0.4	0.6	1.2
Totals	**41.5**	**54.3**	**4.2**	**70.5**	**28.3**	**1.2**