4. METHODS ANALYSIS AND DATA VALIDITY

The following section analyses the methods used by USFS and MTFWP as well as commenting the validity of existing data. Grazing management data is presented first, followed by vegetation management data, and finally by elk management data.

4.1 GRAZING MANAGEMENT DATA

The grazing allotment data presented to ERG for evaluation was inconsistent throughout the study area. Some inconsistency is expected when multiple government agencies are managing various portions of a contiguous landscape. However, even within USFS districts the data was inconsistent and scattered. The allotment management plans from the late 1960s were well organized and self-explanatory. The documents often contained useful information such as allotment history, past and current stocking rates, grazing system and rotation schedule, productivity estimates, and utilization reports. AMPs from the late 1990s list grazing prescription, utilization standards, and monitoring requirements. However, range analysis (ecological site information, productivity estimates, designation of primary and secondary range, utilization, and capacity estimates) on which the AMPs are based is not present or referenced in current allotment files. Limited allotment inventory data was made available to ERG in GIS layers, along with some range studies (1991-1993 Elkhorn allotment utilization study). However, changes in methodology from the 1960s inventories to current methods, lack of a defined sampling schedule, and poor or nonexistent methods documentation lead us to believe much of the range inventory information is useful only at the broadest planning scales.

4.2 VEGETATION MANAGEMENT DATA

In both the Forest Plan (1986) and the IRMA (1989) it is stressed that range condition should be maintained or improved (Appendix B). In both these documents it is also stressed that livestock grazing should be compatible with or optimize, elk winter range. Several studies have shown that cattle grazing on elk winter range can be compatible and possibly improve use by elk. The key is balancing cattle use on elk winter range so the primary elk forage species (generally rough fescue on most USFS allotments) is maintained in a productive and vigorous state. Since range condition is a key basis for determining compatibility of livestock management with the Forest Plan and IRMA goals it follows that range condition should be monitored across the landscape in such a way as to provide managers with information to determine changes in range condition. In the following sections ERG will review the methodology of data collected for determining range condition and determine if information collected in the past provides a sound database for determining changes in vegetation condition. We also review the development of the range condition concept, examine the validity of the range condition concept, and make recommendations for measurement of ecological condition in sections 5.2.1, 5.2.2. and 5.3.

4.2.1 Condition and Trend Transects (Parker 3-Step Method)

The general methodology of the Parker 3-Step Condition and Trend Transects are described in Section 1.1.2. Parker (1950) lists the advantages of the method as 1) providing a permanent site for recording changes over time, 2) a classification of condition and apparent trend at the time of record taking, and 3) photo-points to allow a qualitative measure of change over time. Parker and Harris (1959) report on work on National Forest lands that showed fairly consistent results among observers. The consistency of the method between observers was seen as an advantage of the method. Parker and Harris (1959) believed that most of the differences between observers could be attributed to poor technique and were not necessarily related to the method itself. They listed four sources of error:

1. Failure to adhere to the same standards or criteria of plant measurement, i.e., measuring current twig growth on the periphery of the shrub when the rule provides that such should be ignored.
2. Improper plant identification.
3. Poor eyesight or careless observation.
4. Failure to plumb the loop or failure to locate it precisely at each foot mark on the tape.

However, several studies have shown that the loop procedure overestimates actual plant cover (Johnston 1957, Parker 1950, Hutchings and Holmgren 1959). The degree of overestimation appears to be greatest for single-stemmed plants or those with small basal area (Hutchings and Holmgren 1959). Although Parker (1950) indicated that the amount of bias was consistent for all plants and from area to area, other studies indicated that it was not. Johnston (1957) found that loop sampling overestimated actual cover by 1.62 to 8.01 times depending on species and location. Hutchings and Holmgren (1959) found that the loop cover index depended on plant size and number, plant shape, variability of plant size and plant pattern. They indicated that some of these sources of variation could be corrected by appropriate formulas, but others could not. Grieg-Smith (1964), Sharp (1954) and Smith (1962) also stressed that frequency is a non-absolute measurement affected by a number of variables. Thus, the Parker 3-Step Condition and Trend method was criticized early because the ¾ inch loop biased cover estimates and because the frequency measures do not necessarily accurately measure species composition (i.e. a “hit” of a small annual would count as much as a “hit” of a large perennial).

With an understanding of some of the limitations of the Parker 3-Step Condition and Trend method we began a detailed review of the 56 Condition and Trend Transect folders to determine if they could be used for making an assessment of long-term changes. In our review of the Condition and Trend transect data we found a number of problems. For transects C-76 (Table 1.2.2-11) and C-22 (Table 1.2.2-10) we found relatively large changes in composition during two-year time periods. Large changes in species composition in such a short period are unlikely related to livestock management. It is more likely that transect lines were not placed in the same location and the changes in composition were mostly associated with the different placement of the loops. Another concern is that the actual area measured is very small. A 100-foot transect with 100 ¾ inch loops represents a sampled area of only 1.2 square feet. On many sites there were three, 100 foot transects per site, but this would still represent an area of only 3.6 square feet on which to base species composition change. On site C-65 there was a decrease in desirables and an increase in undesirables between 1966 and 1981 (Table 1.2.2-3); however, in 1966 there was only 1 transect measured and in 1981 two transects were included. For site C-7 there was similar composition of desirables in 1957 and 1978, but much higher composition of desirables in 1966 (Table 1.2.2-4). An examination of the data shows no Idaho fescue in 1957 or 1978, but high percentage of Idaho fescue in 1966. This large change in species composition of Idaho fescue seems very unlikely and must be related to other measurement factors. For sites C-51 and C-56 there were increases in undesirables between the 1960 dates and 1970 date with a subsequent decrease in desirables (Tables 1.2.2-5 and 1.2.2-6); however, an examination of the data shows the increase in undesirables is associated with increased sagebrush. The increase in sagebrush is more likely associated with natural successional processes (lack of fire) and not with livestock grazing. For site C-76, an exclosure established in 1962, there was a dramatic change in composition between 1969 and 1976; however, subsequent analysis of the data shows that *Poa*, *Poa pratensis*, and *Koeleria cristata* were recorded as desirables in 1976 instead of intermediate or undesirable, therefore increasing desirable composition. Also, in 1969 only one transect form was available (summary form stated there were two transects) and two transects shown in 1976.

Therefore, after an initial review of 11 matched Condition and Trend Transects we determined that there were too many problems to continue to use this data for analysis of vegetation change. We believe the most significant problems associated with the methodology are the small area being sampled and not being able to locate points in exactly the same place. However, there is also a concern regarding the classification of species and a consistency of classification. Parker (1954) states that his method classifies plant species as desirable, intermediate, and undesirable for livestock grazing; but suggests that there is a correlation between desirable and climax dominants and between undesirables and lower seral species. The USFS Region 1 Handbook (December 1963) defined desirables, intermediates, and undesirables according to successional status except for seeded areas where seeded species would be recorded as desirables. However, Kentucky bluegrass was listed as a desirable and some native species such as mountain big sagebrush, were always classified as invaders. Therefore, determining what the “true” changes in ecological condition associated with the summary data sheets is very difficult.

We believe the photographs taken as part of the Condition and Trend Transects provide an excellent opportunity for a qualitative assessment of plant community change. On a number of sites it was very clear that changes were occurring and many of these sites should be considered as areas for future monitoring.

Replicated ECODATA plot-sampling methods are used to provide intensive, quantitative measurement (Ecosystem Inventory and Analysis Guide, July 1972). ERG located 11 ECODATA plots that were located on the same sites as the Parker 3-Step Condition and Trend transects. In order to compare information from these two methods we would need to either compare each species or group species according to some classification since Parker 3-Step Transect used desirables, intermediates, and least desirables and ECODATA groups are potential natural plant community, high seral, mid seral, and low seral. ERG was not able to do this because we did not receive the ecoplot data forms until late April. We also hypothesize that the comparisons between the Parker 3-Step Condition and Trend transects and ECODATA plots would not be meaningful because the actual sites measured would vary greatly in size. As stated previously, the Parker 3-Step Condition and Trend transects measure only 0.7 square feet/transect and the ECODATA plots use a 0.1 acre plot (4,356 square feet). For some of the sites with photographs from the Parker 3-Step Condition and Trend transects and ECODATA plots, it may be valuable to revisit these areas to determine changes in vegetation composition.

Therefore, we find that long-term sound statistical data on condition and trend is lacking. We hypothesize that many of the Condition and Trend Transects and ECODATA plots could be used as the basis for developing qualitative information on vegetation community change. ERG reviews the development of the range condition concept, examines the validity of the range condition concept, and makes recommendations for measurement of ecological condition in sections 5.2.1, 5.2.2. and 5.3.

4.3 WILDLIFE MANAGEMENT DATA

The survey technique provided by the MTFWP for the Elkhorns is one of several very similar counting methods utilized by the department throughout Montana. It depends on aerial survey with fixed-wing aircraft while elk are on the winter range. For example, Hamlin and Ross (2002) use a PA-18 Super Cub for flights conducted between January and March in the Gravelly Mountains. West of the Continental Divide, Region 2 Biologist Bob Henderson surveyed the Clark Fork winter ranges in a fixed wing aircraft. Most of the game managers using this technique would agree with Hamlin and Ross (2002) in assuming "…our trend flight counts were generally near the total number of elk for the major wintering areas."

The efficacy of this approach in the Elkhorns received at least partial confirmation on February 20-21, 2003, when Arnaud Outfitting, Inc., conducted a helicopter survey as an independent test of the MTFWP flights conducted on February 15 and 19. Their count was 1,239, compared to the MTFWP count of 1,485. Given a general assumption that 15% of the animals present could have been overlooked, the available correspondence suggests agreement that the actual population of elk was somewhere between 1,500 and 1,700. A previous comparison of flights in 1996 was in far less agreement. The minutes of

CRM (1996) report a February flight in which 72 photographs were taken to record 2,088 elk, while a MTFWP flight a day prior counted 2,893.

One point often overlooked in discussions of aerial survey results is the major difference between trend counts and population census. MTFWP trend counts, here and elsewhere in the West, are rarely considered an accurate estimate of the total number of elk present. Rather, they are intended to provide comparisons, one year to the next, of changes in population density and structure. Raedeke et al. (2002) points out that aerial counts, even conducted "… when snow cover improves visibility and elk group size is maximized … should be treated as an index of the population, as it is unlikely that all elk will be counted." Despite the sometimes substantial underestimates of the true population, trend counts provide the majority of information available for management of big game populations. Public policy decisions involving the numbers of hunting licenses and their limitations on age and sex of the proposed harvest are made every year based on trend count data, and in most cases the available information is considered adequate for this purpose.

Aerial trend counts are not the only available technique for assessing population levels of big game, and they are very rarely the most accurate. However, the relatively low cost of the information obtained and the efficiency of the collection method have generally resulted in the acceptance of aerial trend counts as the management tool of choice. As Raedeke et al. (2002) noted, "… when developing elk management plans, biologists invariably are expected to provide estimates of the number of elk in a given population." This expectation has produced a relatively vast amount of literature describing, with increasingly complex mathematics and almost always increasing costs, techniques for producing population estimates. In the following discussion, we have attempted to provide a brief description and appropriate references for alternative methods that might be utilized to describe the elk population in the Elkhorn Mountains. Further expansion and additional information can be found in Lancia et al. (1994) and Raedeke et al. (2002), as well as the specific references cited.

Possibly the most straightforward method for determining big game populations is the ground count or drive, with people on foot spaced at intervals presumed too narrow for an animal to get through without being counted. Annual census of wildlife on the National Bison Range at Moiese, MT has been conducted this way for years. The obvious drawback is that few managers can conveniently assemble, or afford, the number of people provided to the Bison Range at no cost by the University of Montana wildlife biology program. When manpower is available, drive counts work best within fenced areas or open habitats on populations with limited geographic range. Even then, participants are often surprised by the ability of large animals to miraculously appear behind the line of drivers. Other methods that allow assessment of elk population parameters by an observer on the ground include roadside counts, fecal pellet counts, and hunter check-station information. None of these appear to have any potential for estimating animal abundance in an area as large and diverse as the Elkhorns.

In the air, larger sampling areas can be covered in far less time, and some variations on counting techniques from aircraft have been truly innovative. Croon et al. (1968), for example, presented descriptions of an early attempt to detect big game with an infrared scanner. Their results and those of more recent investigators (Garner et al., 1995 and Naugle et al., 1996) were only partially successful, although the technique still appears promising. The problems with infrared are at least two-fold: first, large mammals, and especially those on the winter range, are so well insulated they provide no realistic target. Second, normal mammalian body temperatures occur in a range (90-100F) that is best detected when the infrared detector is cooled with liquid nitrogen (Lyon, 2004).

To convert trend counts into actual census of elk populations it is necessary to determine the relationship between animals counted and the number of animals in the population, or alternatively, the density of animals in the area sampled compared to the total area occupied by the population. Either approach requires a level of statistical rigor that may be difficult to achieve. Lancia et al. (1994) and Buckland et al. (1993) describe several line-transect and strip-transect sampling methods that have proved successful in ground searches for bird nests and in flights over open habitats for antelope. Such methods usually assume the ability to cover an entire study area and require the assumption that 100% of the objects being censused will actually be seen. Both assumptions are normally unrealistic for elk in mountainous terrain.

According to Raedeke et al. (2002), “Many forms of sample area counts to estimate population size have been developed for big game, including elk. An animal density estimate is calculated by counting all the elk within a given area divided by the size of the area sampled, resulting in estimates of elk per square mile.” Presumably, the average population density for a number of sample areas can then be applied to a much larger, but unsampled, area used by the total population. Statistical reliability of such a sampling system requires random selection of sample areas and is still subject to all the vagaries of weather, cover quality, and animal behavior that produce trend counts rather than true census.

Mark and recapture methods for both terrestrial and aquatic populations have been developed, modified, and improved for at least 100 years. The basic method requires that some portion of the census population be marked so subsequent capture of marked and unmarked animals can be used to create a ratio indicative of the total population size. The earliest versions of the Lincoln Index (wildlife) or Petersen Index (fisheries) involved only the two occasions when some animals were marked and released and the subsequent capture to provide the ratio of marked to unmarked. Krebs (1989) provides a method for calculating confidence intervals. This is an essential calculation because very wide confidence intervals can suggest a population estimate of limited utility. Multiple sampling within a marked population can be used to provide estimates of greater reliability, but the statistical implications can sometimes appear overwhelming. Schnabel (1938) describes an extension of mark-recapture using repeated counts in which unmarked animals in each count are marked before release. Jolly (1965) has developed the Jolly-Seber Estimator in which captured individuals are marked with tags specific to the sampling period. Manipulation of collected data provides estimates of the population size, probability of survival, and dilution rate, along with associated confidence intervals. Comprehensive review of capture-recapture techniques is provided by Otis et al. (1978) and White et al. (1982).

Normally, with elk, the marked animals are radio-equipped and the recapture is obtained by observation rather than actually recapturing the animal. The obvious limitation of this method is that unmarked animals remain unmarked for subsequent observations. The advantage is that resightings are much less expensive than capturing and handling animals. The mark-resight procedure, without additional marking, has been tested with known populations of mule deer (Bartmann et al., 1987) used with white-tailed deer (Rice and Harder, 1977) and moose (Bowden and Kufeld, 1995). In 1982, DeSimone and Thompson (1983) calculated the elk population in Crow Creek and the East-side using the modified Petersen estimate of Rice and Harder (1977); DeSimone et al. (1984) calculated the total Elkhorn population from winter range surveys the following year.

As a possible alternative to physical capture and radio-marking of elk, the Washington Department of Fish and Wildlife has tested marking animals by firing paintballs from a helicopter. "Mark-resight estimates of elk numbers were reliable and precise (Myers et al., 1995 and Spencer, 1997). Further refinement of this technique and evaluation of biases could provide a cost-effective and precise procedure for estimating the abundance of elk and other ungulates" (Raedeke et al., 2002).

In the opinion of many wildlife biologists, techniques using sightability models represent the luxury version of census methodology for elk. The models are developed using marked (usually radio-collars) animals, surveying an area containing these animals, and then using information about collared animals that were missed (i.e. activity, group size, habitat, cover, survey conditions) to correct for all animals that were missed. The models are based on forward stepwise logistic regression techniques. Unsworth et al. (1994) have written a manual describing the development and use of sightability methods. Primary advantages of sightability models are the accuracy and statistical precision of results. The disadvantages include the expensive necessity of helicopter rather than fixed-wing flights. In many situations it may also be necessary to capture and radio-equip numbers of elk to develop a locally applicable model.

In the original research for sightability models, Samuel et al. (1987) found that group size and vegetative cover were the most important variables, while other considerations, such as snow cover, were not. Field tests of the method seem to confirm this finding. Hamlin and Ross (2002), testing sightability in the Gravelly Mountains, reported their most common misses were small groups of elk in the timber, and Unsworth et al. (1990) found the most successful sightings on the National Bison Range involved open habitats and large groups of animals. In Colorado, Department of Wildlife (DOW) researchers (Freddy, 1998) combined sightability models and randomly selected quadrant samples on an experimental scale. Tests by Anderson and Lindzey (1996) suggested that cover was the most important variable in the model for moose surveys. This seems to be confirmed by recent work in Minnesota where a new sightability model used on moose revealed a population over twice as large as expected (NAHC, 2004).

Over 60 years ago, (Kelker, 1940) attempted to estimate mule deer populations in Utah through differential harvest loss in the sexes. The approach achieved little popularity, but in recent years several authors have returned to the development of calculation methods for determining population numbers on the basis of mortality rates; Chen et al. (1998) presented a paper using change-in-ratio, index-removal, and removal models for estimating population size. Such methods appear easily applicable to elk populations in which herd structure and harvest rates are commonly measured as part of annual trend counts and check station data collection. Hamlin and Ross (2002) estimated population numbers in the Gravelly's using a calculation based on the hunting mortality rate of radio collared adult cows. Another published field test is included in a very recent and definitive paper describing the calculation methods (Cooper et al., 2003). Rather than attempting to summarize this paper, we have elected to copy the abstract directly from "Ecological Applications".

> *Abstract.* Population assessment modes give managers insight into both the current status of a given population and how that population may respond to management measures. Nearly all of the techniques in both terrestrial and aquatic wildlife management require either an independent estimate of absolute abundance or an index that is consistently proportional to abundance. When neither of these exists, some information can still be mined from the changes in the sex and age ratios within the population over time. When harvesting information about the exploitation rate is highly skewed toward a single sex or age class, the change in these ratios provides information about the exploitation rate and, when combined with absolute numbers removed, also provides information on absolute abundance. Traditional change-in-ratio techniques require independent estimates of other variables in order to be used in a predictive sense for open populations. This paper proposes a new method that combines the synthetic approach of fisheries stock assessment with the information contained in sex and age ratios to allow for the assessment of populations when no estimate of absolute abundance or reliable index of abundance exists. Although estimates of population parameters such as survival rates and fecundity are produced, the primary output of the estimation routine is the current population size and structure and the potential population sizes and structures that may result from future management options. The approach is validated using simulated data and is then applied to data for an elk population in north-central Idaho.