Assessment of habitat fragmentation, roads and weather on elk harvest vulnerability in the upper Bitterroot Valley, Montana
by Clifton Conrad Youmans

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Biological Sciences
Montana State University

Abstract:
Vulnerability of elk (Cervus elaphus) to hunters is widely accepted as the consequence of many variables: habitat fragmentation, road density, number of hunters, season length, elk behavior, hunter behavior, and weather. The importance of each of these variables to elk vulnerability is not well understood. Long-term data from hunter check stations offer a continuous historical record of harvest information and are potentially a valuable source of information on elk vulnerability. This study evaluates long-term check station data from Darby, Montana, with respect to its utility to provide insight into elk vulnerability questions.

Thirty-seven years of elk harvest data obtained at the Darby hunter check station were compiled and analyzed for two hunting districts (HD 250 and HD 270) in the upper Bitterroot Valley. Concurrent information on annual changes in road density, percent of area logged, season length, and number of hunters was also compiled and analyzed. An index of winter severity (IWS) was computed for 15-day intervals across all years based on snow depth and used to examine the influence of weather on elk vulnerability. Several indices were found useful to measure changes in elk vulnerability: hunter success, distribution of the harvest, percent of total harvest occurring opening day, mean and variance of the rate of harvest (number killed/ day). Statistical analysis of variables was severely constrained by problems of autocorrelation (due to time trend) and multicollinearity. Principle components analysis (PCA) of variables was conducted to create independent synthetic variables. Results of graphical and statistical analysis of data from two hunting districts revealed large increases in vulnerability occurred in the mid-sixties concurrent with periods of peak road construction and logging, but resolution of the data was insufficient to detect incremental increases in vulnerability during the most recent decade. The influence of weather on elk vulnerability differed between the two hunting districts. In HD 270, where elk migrate from large tracts of secure habitat to concentrate on highly fragmented, accessible areas, weather accounts for up to 50% of the variation in the harvest. In HD 250, where elk migration is less pronounced and elk are uniformly more accessible, numbers of hunters and road density were more important in determining vulnerability.

ASSESSMENT OF HABITAT FRAGMENTATION, ROADS AND WEATHER ON ELK HARVEST AND ELK VULNERABILITY IN THE UPPER BITTERROOT VALLEY, MONTANA

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Clifton Conrad Youmans

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APPROVAL

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Clifton Conrad Youmans

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Date

Chairperson, Graduate Committee

Approved for the Biology Department

21 May 1992
Date

Robert E Moore
Head, Biology Department

Approved for the College of Graduate Studies

May 22, 1992
Date

Henry L Parsons
Graduate Dean

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Date 15 June, 1992

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ABSTRACT

Vulnerability of elk *(Cervus elaphus)* to hunters is widely accepted as the consequence of many variables: habitat fragmentation, road density, number of hunters, season length, elk behavior, hunter behavior, and weather. The importance of each of these variables to elk vulnerability is not well understood. Long-term data from hunter check stations offer a continuous historical record of harvest information and are potentially a valuable source of information on elk vulnerability. This study evaluates long-term check station data from Darby, Montana, with respect to its utility to provide insight into elk vulnerability questions.

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INTRODUCTION

The term "elk vulnerability" is a fairly new term used in wildlife management to describe the susceptibility of elk *(Cervus elaphus)* to being killed during the hunting season (Lyon and Christensen 1990). It is the antonym of security during the hunting season (Lyon and Christensen 1990). Increased elk vulnerability is the consequence of many factors that cumulatively lower the probability that an elk will survive the hunting season. These factors include (but are not limited to) number of hunters, road density, vegetation, weather, topography, hunter behavior, and elk behavior. Despite a recent shift in emphasis in elk management toward elk vulnerability questions, the factors which increase elk vulnerability are not well understood and remain largely hypothetical (Lyon and Christensen 1990, Christensen et al., 1991). Most elk vulnerability studies have been extremely limited in scope and characterized by small sample size and lack of replication (Thomas 1991). A clear pattern of results does emerge from the current research on elk vulnerability, but none of the studies to date is definitive (Thomas 1991). The current budget status of state and federal wildlife agencies provides little optimism that funding will become available for intensive new field studies on elk vulnerability - at least of scope sufficient to address fairly the research needs enumerated by Thomas (1991). It is unlikely that this situation will change in the near future (Don Childress, Administrator, Wildlife Division, Montana Department of Fish, Wildlife and Parks, pers. comm.).

Lack of data has not deterred development and use of models to address elk vulnerability. Models developed to evaluate elk habitat selection and use (Lyon 1983, Lyon et al. 1984, Wisdom et al. 1986) have been erroneously applied to assess elk vulnerability (Lyon and Christensen 1990). Other models have been developed based on limited research results and questionable assumptions (Youmans and Brussard, 1986). Hillis et al. (1991) developed a model intended to maintain elk security by providing for fewer open roads and larger and more continuous stands of timber. The Hillis model has been incorporated into the management of at least one National Forest to reduce elk vulnerability, but it has not been empirically validated. While the performance of the model may be measured over time, there is a critical need for long-term, site-specific information on the factors that determine elk vulnerability.

The absence of funds to initiate field studies leaves managers dependent upon existing sources of information. Long-term check station data offer a continuous record of harvest information and thus are a potentially valuable source of information on elk vulnerability. Montana Department of Fish, Wildlife and Parks (FWP) check station results and statewide harvest survey data are the primary sources of information on elk harvest trends in Montana. Figure 1 is a flow chart outlining the parameters that might be used in managing elk populations and identifying elk vulnerability trends (Terry Lonner, FWP Research Bureau, pers. comm.). This flow diagram validates FWP's continuing commitment to check station data as a primary source of information for wildlife managers. Most wildlife managers rely heavily on check station data and harvest survey information to make management decisions. Radio telemetry information sometimes augments this data base,

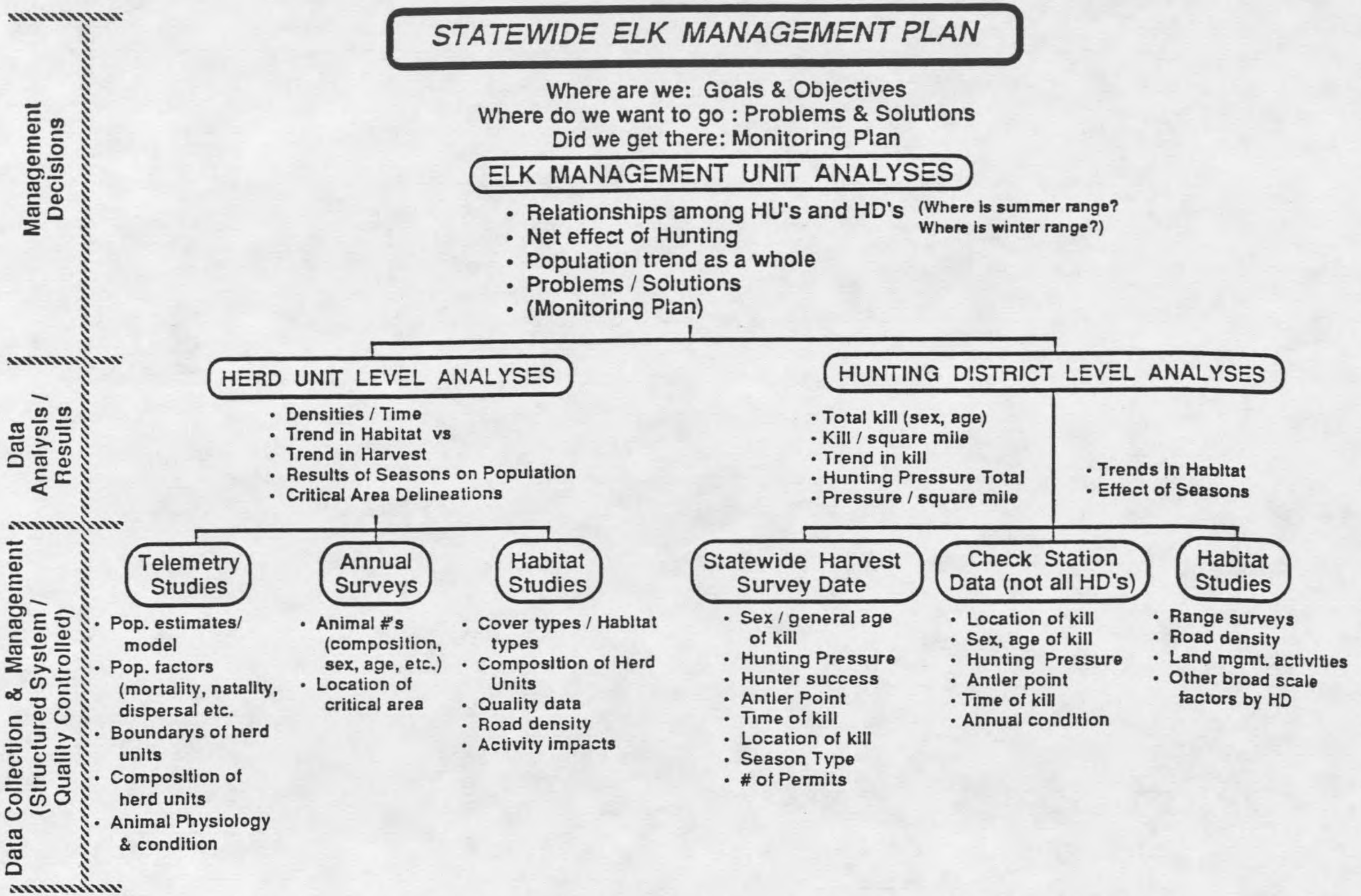

Figure 1. Schematic of proposed data management levels for managing elk populations. Note the role of check station data in hunting district line analysis (Courtesy of Research Technical Service Bureau, Montana Department of Fish, Wildlife and Parks [Unpublished memo by T.W. Lonner]).

but telemetry studies are generally too limited in scope to provide much insight into long-term trends in vulnerability. The primary drawback of habitat studies to address questions of elk vulnerability is that historical information on road construction and timber harvest is typically lacking. Findings obtained from long-term elk ecology research studies provide a more in depth understanding of population processes, but only for a few study areas in the state.

Given the need for information on elk vulnerability and the absence of funds and personnel to initiate new studies, a critical evaluation of long-term check station data is warranted. The data set from the Darby hunter check station spans four decades (1953-1989) and represents a considerable investment in data collection by FWP. The focus of this study was to gain insight into trends in elk vulnerability in the upper Bitterroot through compilation, analysis, and evaluation of Darby check station records coupled with synthesis and analysis of weather, logging and road construction records for the study area.

Objectives

The objective of this study is to address the following basic questions: 1) Can long-term check station data provide insight into trends in elk vulnerability? 2) What kinds of check station data are most useful in assessing trends in elk vulnerability? 3) Which variables related to access, habitat, number of hunters and weather have had the greatest impacts on elk vulnerability? 4) What are the management implications of the study findings?

DESCRIPTION OF STUDY AREA

Study Area

The Bitterroot National Forest comprises about 647,520 ha (1,600,000 ac) and encompasses two mountain ranges which form the east and west sides of the Bitterroot Valley (USDA Forest Service 1987). The Bitterroot Valley floor is about 97 km (60 mi) long and varies in width from 6.4 to 16 km (3-4 mi). Bordering the valley on the west is the Bitterroot Range, which rises about 1524 m (5000 ft) in 3 to 6 km (3-4 mi) from the valley floor. Deep, rocky, glaciated canyons break this front at 2-5 km (1-3 mi) intervals (USDA Forest Service 1987). The Sapphire Mountains lie to the east of the Valley where vertical relief is more gentle, rising about 914 m (3000 ft) from the valley floor in 6-8 km (4-5 mi).

The Bitterroot Valley increases in elevation from north to south and abuts against the Continental Divide at its southern boundary. The portion of the Valley situated south of the town of Darby is typically referred to as the upper Bitterroot. Two hunting districts: (HD 250 and HD 270) encompass the area known as the upper Bitterroot (Fig. 2). HD 270 encompasses approximately 128,694 ha (318,000 ac) of National Forest, and private and state forest lands and extends westward from the crest of the Sapphire Mountains to the East Fork of the Bitterroot River. It is bounded on the north by

Figure 2. Map of the upper Bitterroot Valley depicting boundaries of Hunting District 250 and Hunting District 270. Location of four elk management areas are also depicted within each respective hunting district. Ravalli Co., MT.

the Skalkaho Pass road and on the south by the Continental Divide. Hunting district 250 encompasses approximately 187,376 ha (463,000 ac) of National Forest lands bordered on the west and south by the Bitterroot Mountains and the Montana-Idaho border and extends eastward to abut against HD 270. To the North, HD 250 extends to Tin Cup Creek (directly west of Darby, Montana).

Description of Hunting Districts

HD 250

Hunting District 250 encompasses two management areas, the West Fork and the Triangle Area (Fig. 2). These two management areas were delineated in the 1950s based on topography and what was then known of elk herd movements. The boundary between the West Fork and the Triangle Area is the West Fork of the Bitterroot River. West Fork elevations range from approximately 1490-3048 m (4900-10,000 ft). The terrain is mountainous with 50% of the land area in excess of 2133 m (7000 ft) elevation (USDA Forest Service 1987). Stream bottoms are typically narrow with side slopes rising steeply to narrow ridges. More than half the area's slopes are in excess of 60%, confining most trail and road access to stream bottoms or ridge tops (USDA Forest Service 1987). The area is forested except for a few large meadows in stream headwaters and dry, south-facing slopes. At higher elevations, rock rubble and grassbalds are common. Coniferous forests are dominated by Douglas fir (*Pseudotsuga menziesii*, [Mirbel] Franco.) and ponderosa pine (*Pinus ponderosa*, Dougl.) on the warmer, lower elevation sites and lodgepole pine (*Pinus contorta*, Dougl.) on cooler sites at midslope.

Whitebark pine (*Pinus albicaulis,* Engelm.) is a dominant species at higher elevations.

In the Triangle Area, elevations range from about 1400-2700 m (4800-8831 ft) at Piquett Mountain. Approximately 60% of the area is above 2100 m (7000 ft). Topography is steep and rocky with shallow, sandy-loam soils (USDA Forest Service 1987). Drainage bottoms are narrow with steepened slopes rising to narrow ridges. The area is mostly forested except for peaks in the Piquett Mountain area and ridges in the upper Warm Springs drainage. Lodgepole pine, subalpine fir (*Abies lasiocarpa,* [Hook.] Nutt.) and whitebark pine dominate above 2100 m (7000 ft). At lower elevations, Douglas fir, ponderosa pine , lodgepole pine and Engelmann spruce (*Pinus engelmannii,* Parry) are the major species (USDA Forest Service 1987).

<u>HD 270</u>

Hunting district 270 encompasses two management areas, the East Fork Area and Rye Creek Area (Fig. 2). These two management areas were established at the same time as the West Fork and Triangle Areas, based on geography and elk herd movements. The East Fork and Rye Creek Areas are separated by the Rye Creek-East Fork divide. The dominant landscape feature, the Sapphire Range, forms the eastern boundary of both management areas. Steep, rocky cirque basins and trough walls lie along the crest of this Range. Exposed bedrock and rubble predominate along the Sapphire crest, Whetstone Ridge, and the southern portion bordering the Anaconda-Pintler Wilderness (USDA Forest Service 1987). Slopes are moderately steep with flat or rolling lands comprising a small part of the total land area (Rognrud 1955). Elevations range from 1219 m to 2743 m (4,000-9,000 ft) at Kent Peak. The forested landscape is interspersed with stream-side meadows at lower elevations. Vegetative cover on lower and warmer exposures consists of bunch grasses and bitterbrush (*Purshia tridentata*, Pursh.) association and mountain mahogany (*Cercocarpus ledifolius*, Nutt.) (Rognrud 1955). As elevation increases, Ponderosa pine replaces browse plants. At about 1828 m (6000 ft), Douglas fir replaces Ponderosa pine on southerly exposures. Lodgepole pine replaces Douglas fir on moist sites and above 2133 m (7000 ft). Whitebark pine and subalpine larch (*Larix lyallii*, Parl.) exist above 2438 m (8000 ft).

Human Population Trends

Between 1870 and 1910, the population of the Bitterroot Valley increased from 314 to 11,666 (Montana Historical County Census Data 1910-1970) and then remained relatively stable through 1960 (12,341 in 1960). From 1960 to 1970 the population increased 16% to 14,409. Rapid growth began in the 1970s, with the population increasing 56% to 22,493 in 1980 (U.S. Bureau of the Census 1981). Population growth then slowed, reaching 25,010 by 1990 (11% increase) (U.S. Bureau of the Census 1991). Much of the rapid growth in Ravalli County was due to an influx of people seeking a rural lifestyle in a scenic environment (Sylvester 1981).

Roads

On the Bitterroot National Forest there are approximately 5,632 km (3,500 mi) of roads providing access to about 25% of the Forest (USDA Forest Service 1987). Excluding designated wilderness, eleven roadless areas comprising about 163,903 ha (405,000 ac) remain. (USDA Forest Service 1987). These remaining roadless areas (Fig. 3) are under consideration for future development (USDA Forest Service 1987). Road densities in HD 250 have increased 300% in the past 37 years, from 1.09 km/km^2 (0.68 mi/mi^2) in 1953 to 4.4 km/km^2 (2.74 mi/mi^2) in 1989 on the non-wilderness portion of the Forest. A period of extensive road building occurred from 1965 to 1970, when approximately 25% of existing roads in HD 250 were constructed (Fig. 4).

In HD 270, road densities have increased 350% since 1953 (1.2 -5.56 km/km^2 [0.77-3.52 mi/mi^2] on the non-wilderness portion). Two dramatic peaks in road construction occurred in HD 270: during the 11,700 ha (29,000 ac) Sleeping Child fire in 1961 and the following year when numerous salvage sales were active, and again in 1968-1969. Road construction during these four years accounts for approximately 35% of existing road miles in HD 270 (Fig. 5).

Timber Harvest/ Habitat Changes

Both wildfire and timber harvest have influenced the forest landscape in the upper Bitterroot. Approximately 238,368 ha (589,000 ac) in the Bitterroot Forest are designated as "tentatively suitable" for timber production (USDA Forest Service 1987). Tentatively suitable timber lands include areas