The relationships between disturbances in stock camps and the occurrence of spotted knapweed (Centaurea maculosa) in the Selway-Bitterroot Wilderness in Montana and Idaho
by Gary Martin Milner

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Earth Sciences
Montana State University

Abstract:
The purpose of this study was to determine if disturbances and vegetation characteristics in stock camps influence the occurrence of spotted knapweed (Centaurea maculosa). Disturbance levels (light, moderate, heavy or extreme) were determined by using site impact worksheets provided by the United States Forest Service.

Disturbance variables on the site impact worksheets were also examined. These included, vegetation loss, mineral soil increase, tree damage, root exposure, development, cleanliness, social trails, and barren area of the camp. Vegetation characteristics examined were bare ground, moss, forbs, grass, litter, rock, trees and canopy cover. The percent cover for these variables were estimated using 2 X 2 meter quadrats located along twenty-four meter transects which radiated out from the center of the camps.

Six of the thirty camps sampled contained spotted knapweed. No association was found between spotted knapweed and the disturbance levels of the camps. No strong relationship was found between spotted knapweed and any of the measured vegetation variables. There were no significant differences in density levels of spotted knapweed in the horse or human areas of the camps. An association did exist, however, between spotted knapweed and the development variable on the site impact worksheet. All six camps containing spotted knapweed were open canopied, between 1524 and 1829 meters in elevation and were located in areas of high visitor use.

THE RELATIONSHIPS BETWEEN DISTURBANCES IN STOCK CAMPS AND THE OCCURRENCE OF SPOTTED KNAPWEED (Centaurea maculosa) IN THE SELWAY-BITTERROOT WILDERNESS IN MONTANA AND IDAHO

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Gary Milner

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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ABSTRACT

The purpose of this study was to determine if disturbances and vegetation characteristics in stock camps influence the occurrence of spotted knapweed (Centaurea maculosa). Disturbance levels (light, moderate, heavy or extreme) were determined by using site impact worksheets provided by the United States Forest Service. Disturbance variables on the site impact worksheets were also examined. These included, vegetation loss, mineral soil increase, tree damage, root exposure, development, cleanliness, social trails, and barren area of the camp. Vegetation characteristics examined were bare ground, moss, forbs, grass, litter, rock, trees and canopy cover. The percent cover for these variables were estimated using 2 X 2 meter quadrats located along twenty-four meter transects which radiated out from the center of the camps.

Six of the thirty camps sampled contained spotted knapweed. No association was found between spotted knapweed and the disturbance levels of the camps. No strong relationship was found between spotted knapweed and any of the measured vegetation variables. There were no significant differences in density levels of spotted knapweed in the horse or human areas of the camps. An association did exist, however, between spotted knapweed and the development variable on the site impact worksheet. All six camps containing spotted knapweed were open canopied, between 1524 and 1829 meters in elevation and were located in areas of high visitor use.

CHAPTER 1

INTRODUCTION

The Wilderness Act of 1964 designated a series of wilderness areas that would be "managed to preserve natural conditions." These areas provide an opportunity for native ecosystems to function relatively independent of human activity. The occurrence of exotic plant species can disrupt this function by altering natural processes and providing evidence of human impacts within these lands (Noxious Weed Management 1991). Centaurea maculosa, commonly named spotted knapweed, is an example of one such exotic plant species. This introduced species now occupies thousands of hectares in the Selway-Bitterroot Wilderness Area in Montana and Idaho (Kummerow 1992). Stockcamps may play a role in the introduction of spotted knapweed in wilderness areas. The purpose of this study was to determine if the disturbances in stock camps in a wilderness setting influence the abundance of spotted knapweed.

Weeds can be legally classified as noxious pests. The Montana Department of Agriculture defines a noxious weed as any introduced or established exotic plant species in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities (Montana Department of Agriculture 1991). Currently the state of Idaho has thirty-three weeds classified as noxious (Wheeler 1991). Montana

has fifteen such species (Montana Department of Agriculture 1991). In both states spotted knapweed is classified as noxious.

Plants have been designated noxious because of their effects on commodity oriented land uses such as farming and ranching. However, the definition is also appropriate for wilderness areas where these species have the potential to disrupt and alter natural and complete ecosystems (Noxious Weed Management Projects 1993). Given that primary functions of designated wilderness areas are to ensure the integrity of natural ecosystem processes and to preserve natural species diversity, a more complete understanding is needed of the roles that outdoor recreationists play in the spreading of noxious weeds.

Stockcamps are one component of recreational activity that may contribute to weed establishment through habitat disturbance and plant/seed dispersal. As stated by Bedunah, "disturbance is always a significant factor in the spread of exotic species" (Bedunah p. 8, 1992). Stockcamp disturbances include damaged trees, exposed roots, and soil exposure. Camps may also be centers for seed/plant dispersal, because alien species can be carried by pack and saddle stock as seed in feces, in supplemental feed or on the fur and hooves (Cole 1989). If established, plants may spread out from these centers to more remote parts of the wilderness (Noxious Weed Management 1991). By examining the roles that stockcamp disturbances have in noxious weed establishment, we may in the

future prevent or attenuate the spread of exotics in wilderness settings.

The primary goals of this research were to: (1) further our understanding of the relation between spotted knapweed and stockcamp disturbance characteristics; (2) furnish baseline data which can be used to determine ecological changes related to noxious weeds; (3) determine if differences exist between spotted knapweed levels in the horse and human areas of the camps; and (4) determine the relationship between spotted knapweed and recorded vegetation variables. The results of this research may help resource managers find ways, whether through regulation or education, to prevent the spread of non-native plant species and to manage wilderness areas so that natural conditions are maintained.

Background Literature Review

Noxious weeds such as spotted knapweed have received extensive study in the agricultural West. The research has largely focused on their negative effects on livestock and crop production (Bedunah 1992). Non-agricultural areas such as forested lands have received limited attention. The following sections will summarize the general history, biology and environmental factors associated with spotted knapweed.

History of Spotted Knapweed in the United States

Exotic weeds such as spotted knapweed were originally transported to North America from Europe and Eurasia during colonization and periods of early settlement (Noxious Weed Trust Fund 1992). For the past century successive waves of these weeds have moved across the Western landscape, each disrupting natural plant communities and in some cases the animals that depend on them. Millions of acres have been affected, particularly along roads and other disturbed sites (O'Loughlin1992).

Spotted knapweed is a native plant from the steppes of Europe (Eddleman and Romo 1988). This plant, along with other species of knapweed, was first introduced to North America near the beginning of the twentieth century as contaminants in Turkistan alfalfa seed (Groh 1940). Having no natural enemies to keep its populations in check on the North American continent (Chicoine 1984), spotted knapweed spread across much of the western United States.

The plant was documented in Gallatin County, Montana in 1927. It presently occurs in all 56 Montana counties (Lacey et al. 1992). Agricultural development, road construction, off-road disturbances and other forms of land disturbance have contributed to the spread of spotted knapweed (Noxious Weed Trust Fund 1992). Today's landscape features help facilitate exotic weed migrations. Modern transportation systems allow for increased dispersal and enable weeds to colonize areas previously unaffected by exotics

(Forcella 1991). Examples of these dispersal patterns will be discussed later. The rapid spread of several species in the knapweed genus through the West has been a concern since the early 1960's as their potential impacts on agricultural production began to be realized (Table 1).

Table 1. Total area infested by spotted knapweed in nine western states as of 1988 (adapted from Lacey 1989).

STATE	ACRES	HECTARES
Colorado	2500	1000
Idaho	2,293,000	917,200
Montana	4,721,060	1,888,424
N. Dakota	0	0
Oregon	3000	1200
S. Dakota	2500	1000
Utah	500	200
Washington	29,070	11628
Wyoming	100	40
Total	7,051,730	2,820,692

Habit

Centaurea maculosa is a member of the Asteraceae or Composite family. Over 500 species make up the genus (Chicoine 1984). Spotted knapweed is a biennial or a short lived perennial

forb with a stout branched taproot. The plant can have one or more stems which may be branched to about one meter high. Generally the plant remains in a rosette stage during the first year. Basal leaves are up to six inches (15 cm) long with blades narrowly elliptic to oblanceolate. The flowers are showy purple or occasionally white in color and are solitary at the end of branches (Whitson et al. 1992). Spotted knapweed can be distinguished from other knapweed species by the black tipped bracts subtending each flower head (Lacey et al. 1992) (Figure 1).

Dispersal Mechanisms and Reproduction

Spotted knapweed seeds can be transported over long distances and have the ability to lie dormant for several years. The plant reproduces only by seed (Story 1992). Seed production of spotted knapweed averages 1000 per plant in Montana (Chicoine 1984). Studies by French and Lacy (1983) suggest seeds may remain viable in the seed bank for up to five years. Davis et al. (1993) found that seeds may remain viable for up to eight years. Even after extensive control of spotted knapweed has occurred on an infested site, there may still be a sizable portion of viable seeds left in the seed bank (Mooers 1982). In rural and urban settings large scale movement of spotted knapweed is accomplished in a variety of ways. For example, farm machinery such as combines and hay balers may spread weed seeds from field to field or along right-of-

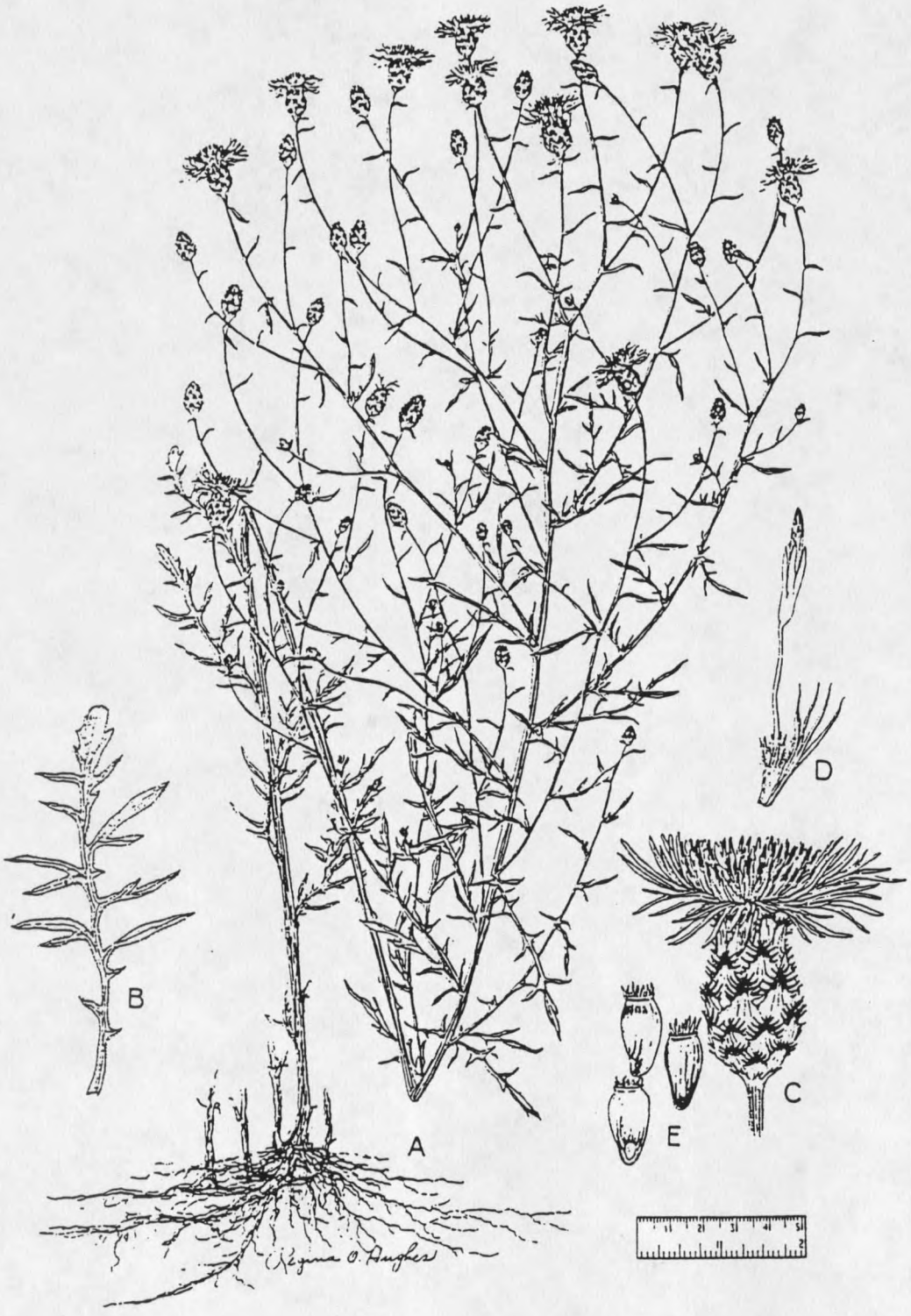


Figure 1. Centaurea maculosa L. Spotted Knapweed. A; Habit. B; leaf C; flower head. D; disk flower. E; achenes. Source: United States Department of Agriculture 1971.

ways as they travel on roadways (Montana Department of Agriculture 1986). Motorized vehicles also contribute to the spread of spotted knapweed as plants can be caught in their undercarriage (Lacey et al. 1992). Infestations of spotted knapweed along roadways, parking lots, loading areas, or vacant lots serve as source points where motor vehicles may pick up the weed and transport it to new locations (Mass 1989). Research in Glacier National Park has shown that primary roads help facilitate the migration of spotted knapweed into adjacent native grasslands (Tyser and Worely 1992).

In wilderness areas, spotted knapweed may be initially transported to trailheads by motor vehicles or livestock trailers. However, as the use of motorized vehicles is prohibited within wilderness boundaries, other vectors of transport are needed to assist successful colonization of spotted knapweed deep within wilderness areas. Saddle and pack animals are a significant source of non-native vegetation in backcountry areas. Seeds from species such as spotted knapweed which infest farms and ranches may be transported into wilderness areas in hay used for pack stock feed (Marion et al. 1985). Spotted knapweed may also find its way into wilderness settings by means of pack animal manure. Seeds consumed by animals prior to entering wilderness areas can be transported many miles. These seeds may then germinate after excretion by the animals far within wilderness boundaries (Dale and Weaver 1974; Marion et al.1985; Montana Department of Agriculture 1986).

Once established in wilderness areas there are a variety of dispersal agents which help to spread exotics such as spotted knapweed. The seeds may be transported along trails to campsites or to other locations where favorable conditions exist for germination. Seeds can be carried some distance from the parent plant by becoming attached to humans or pack stock as they pass along trails (Marion et al. 1985; Watson and Renney 1974). Movement of exotic vegetation along trail corridors has been documented in Rocky Mountain National Park of Colorado (Benninger-Truax et al. 1992) and in the Bob Marshall Wilderness area of Montana (Marion et al. 1985). Seeds may also adhere to damp tarp or tent bottoms and be transported from one camp to another (Marion et al.1985).

Natural dispersal methods are also important in backcountry areas. Populations and individual plants of spotted knapweed expand their territory through peripheral enlargement (Watson and Renney 1974). Roughly two to three weeks after maturity, the bracts of the plant open due to dehydration. This process loosens the achenes in the seed head. Seed dispersal is accomplished by means of a flicking motion when the plant is disturbed. This flicking motion distributes the seeds up to one meter from the parent plant.

It has been suggested that species in the Centaurea genus use allelopathy to maintain density levels (Chiocione 1984). Allelopathy is any harmful effect that one plant causes another by the production of chemicals that spread into the environment. However, work by

Kelsey and Bedunah (1989) suggests that allelopathy is not a significant ecological factor which contributes to the spread of spotted knapweed. Harvey and Nowierski (1989) have found that spotted knapweed depletes the soil of valuable nutrients such as phosphorus, thus depriving surrounding plants with the nourishment they need to survive.

Environmental Factors Affecting Spotted Knapweed Distribution

Spotted knapweed possess the ability to adapt to, colonize and reproduce under a wide range of environmental conditions. That the plant is now found in every major habitat type west of the Continental Divide in Montana is proof of its adaptability to a broad spectrum of environments (Mooers and Willard 1989).

A 1985 study aimed at predicting spotted knapweed migrations in Montana found that the plant can tolerate a variety of annual precipitation levels (Chicoine et al. 1985). Eighty-one percent of the study sites occurred in areas with precipitation ranging from 31 to 76 cm (12 to 30 inches) per year. Plants have been found in precipitation zones ranging from 20 to 203 cm (8 to 80 inches) annually (Lacey et al. 1992). During a wet year Schirman (1981) found that more flowers appear on each plant stem and more seeds develop within the flowers. Schirman also observed that seedlings emerging in April had a high rate of survival, with most of the plants flowering the next year, while seedlings which emerged

after mid May had a low rate of survival and fewer flowering stems. Thus precipitation patterns may influence when the plant flowers and the number of seeds produced by each plant (Schirman 1981).

Spotted knapweed is also well adapted to a wide range of elevations. The species has been documented at elevations of 579 meters (1,900 ft.) to above 3048 m (10,000 ft.) (Lacey et al. 1992). The same 1985 study on weed migration trends in Montana found ninety percent of the study site infestations between 610 and 1829 meters (2,000 and 6,000 feet).

The optimum temperatures for germination of spotted knapweed seeds are between 10^0 and 28^0 C (50^o and 82^o F) (Chicoine 1984) . The plant seems most adapted to areas with 90 to 120 frost free days (Chicoine et al. 1986). The seeds of spotted knapweed are able to germinate equally well under a 0 to 100 percent canopy cover. However, after germination has occurred limited light restricts growth (Losensky 1987).

Soil moisture appears to be an important environmental factor for spotted knapweed germination. Optimum germination rates as reported by Spears et al. (1980) occurred when soil moisture content was between 55% and 70%. Germination rates decreased with soil moisture content above 70% and no seedling emerged when soil moisture content was below 55%. Soil type does not play a major role in regulating spotted knapweed populations (Schirman 1984).

Habitat Types Where Spotted Knapweed Occurs

Spotted knapweed can be found in a wide variety of habitat types and occupies every major habitat type west of the Continental Divide in Montana (Mooers and Willard 1989). In broad terms, the success of spotted knapweed is correlated with the amount of disturbance and the amount of moisture in the environment. Mooers (1986) found that as sites became more disturbed or drier, the average distance between spotted knapweed plants decreased. Mooers' study identified shrub, grass, ponderosa pine, and Douglas-fir series habitat types as the most favorable for spotted knapweed success.

Grassland and shrub habitat types often exhibit areas of bare soil, even in undisturbed conditions (Mueggler and Stewwart 1980). These areas with bare soil offer spotted knapweed the opportunity to invade certain habitat types under natural conditions (Morris and Bedunah 1984).

In Montana, the ponderosa pine series is usually the first forest zone above the grasslands (Pfister et al. 1977). This species can endure dryer environments and is usually the belt of climax vegetation separating grasslands from climax Douglas fir (Pseudotsuga menziesii) forests. In the mountains of Montana, stands of ponderosa pine are fairly open with tree regeneration relatively sparse. Areas of bare soil are often found in this series,

especially those with grass understories (Pfister et al. 1977). These areas of bare soil give spotted knapweed the chance to invade.

The Douglas-fir series is also susceptible to invasion by spotted knapweed. This series typically spans a wide range of environmental gradients from dry, exposed southern slopes to the more lush north facing slopes (Mooers 1986). Bare soil occurs less often in these habitat types (Pfister et al. 1977), thus providing spotted knapweed little room for colonizing unless disturbance levels are relatively high.

Habitat types wetter than the Douglas-fir series require a more intense disturbance level for spotted knapweed to thrive as there is little bare soil present for the invading plant. While Watson and Renney's (1974) work shows that spotted knapweed seed production is greater in moist environments such as irrigated fields, Mooers' (1986) research indicates that the plant could not displace the native vegetation found in Douglas-fir or wetter forest types. Several reasons why spotted knapweed cannot displace native vegetation found in these sites are possible (Mooers 1986). First, many of the forest understory plants that spotted knapweed competes with are not preferred by cattle. Hence, selective grazing would not be an advantage for spotted knapweed. Second, native plants have evolved advantages for these environments, unlike spotted knapweed. One example of this advantage may be that native species may retain more vigor than spotted knapweed under the low light conditions typically found in forest settings (Mooers 1986).

Harvey and Forcella also arrived at similar conclusions in a 1983 study. Their report suggests that in western Montana, primary concern regarding introduced weed control should be aimed at the ponderosa pine and grassland vegetation series (Harvey and Forcella 1983).

Forest Service studies on the Lolo, Bitterroot, and Flathead National Forests indicate that the plant is capable of occupying a wide range of habitat types (Losensky 1987). The habitat types identified by the Forest Service which are at the greatest risk of spotted knapweed invasion on the three forests are: ponderosa pine and/or Douglas-fir bunchgrass types , Douglas-fir/snowberry (Psme/Syal), Douglas-fir/ninebark-pinegrass (Psme/Phma-Caru), and scree types.

Spotted Knapweed in Wilderness Settings

Only recently have spotted knapweed and other exotics generated much concern outside the agricultural realm. The threat which non-natives pose to biodiversity in wilderness settings is now recognized (Noxious Weed Management 1991). Management policies on these public lands call for the removal of exotics to the extent feasible in order to preserve plant communities in their natural state (Westman 1990).

Several studies suggest that exotics are on the increase in both Yellowstone and Glacier National Parks. As of 1986, surveys in Yellowstone Park indicated the presence of at least eighty-five

species of non-native plants within park boundaries (Exotic Vegetation Management Plan 1986). A 1991 survey listed 135 exotics in the Park, including spotted knapweed (Whipple 1991). Numbers of exotics are also on the rise in Glacier National Park. In 1993 Lesica et al. (1993) reported thirty-nine additions to Park flora. Fourteen of these were exotic weeds, including spotted knapweed. Work by Tyser and Worley (1991) in Glacier National Park indicates that roadside populations of spotted knapweed monitored since 1984 are now invading adjacent grasslands. The study also states that spotted knapweed is capable of decreasing diversity and cover of native communities.

National forests and wilderness areas are also prone to the spread of spotted knapweed. A 1993 Final Environmental Impact Statement concerning noxious weeds on the Flathead National Forest in Montana listed 108 sites infested with noxious weeds in the Bob Marshall Wilderness. Forty of these sites were infested with spotted knapweed (Flathead National Forest 1993).

Similarly, the Lolo National Forest in Montana is also implementing plans to combat noxious weeds. A 1991 Final Environmental Impact Statement reported 225,000 acres (90,000 ha) already infested with spotted knapweed and 43,135 (17,254 ha) acres at risk (Lolo National Forest 1991). Concerning spotted knapweed Spoon et al. (1983) reported that by the year 1998, 220 elk could be lost annually due to lost forage production attributed to spotted knapweed. Among the National Parks and Forests in the

western United States, the Bitterroot National Forest may have the highest number of acres infested or at risk by the weed. Currently located throughout the forest there are 274,000 acres (109,600 ha) infested by the plant and another 711,311 acres (284,524 ha) at risk of being infested (Losensky1987). Management plans which focus on containment and prevention of the plant rather than eradication are currently recommended.

CHAPTER TWO

STUDY AREA and METHODS

Study Area

Site Selection

The Selway-Bitterroot wilderness area was chosen as a study site due to its heavy infestation of spotted knapweed. The plant is considered "out of control" in the counties located within the Bitterroot National Forest (Losensky 1987). By examining spotted knapweed infested sites, it may be possible to prevent their spread in areas which are susceptible to, but not currently infested.

The Selway-Bitterroot Wilderness Area includes portions of four National Forests in the states of Idaho and Montana; the Clearwater, Lolo, Nez Perce, and Bitterroot. It is the second largest wilderness in the lower forty-eight states classified under the Wilderness Act of 1964 (Finklin 1983). This study focused on the Bitterroot National Forest section of the wilderness area (Figure 2). The total area of wilderness is 512, 211 acres (204,884 ha), which includes 852 miles (1371 km) of wilderness trails (Bitterroot National Forest 1992). Three ranger districts administer the

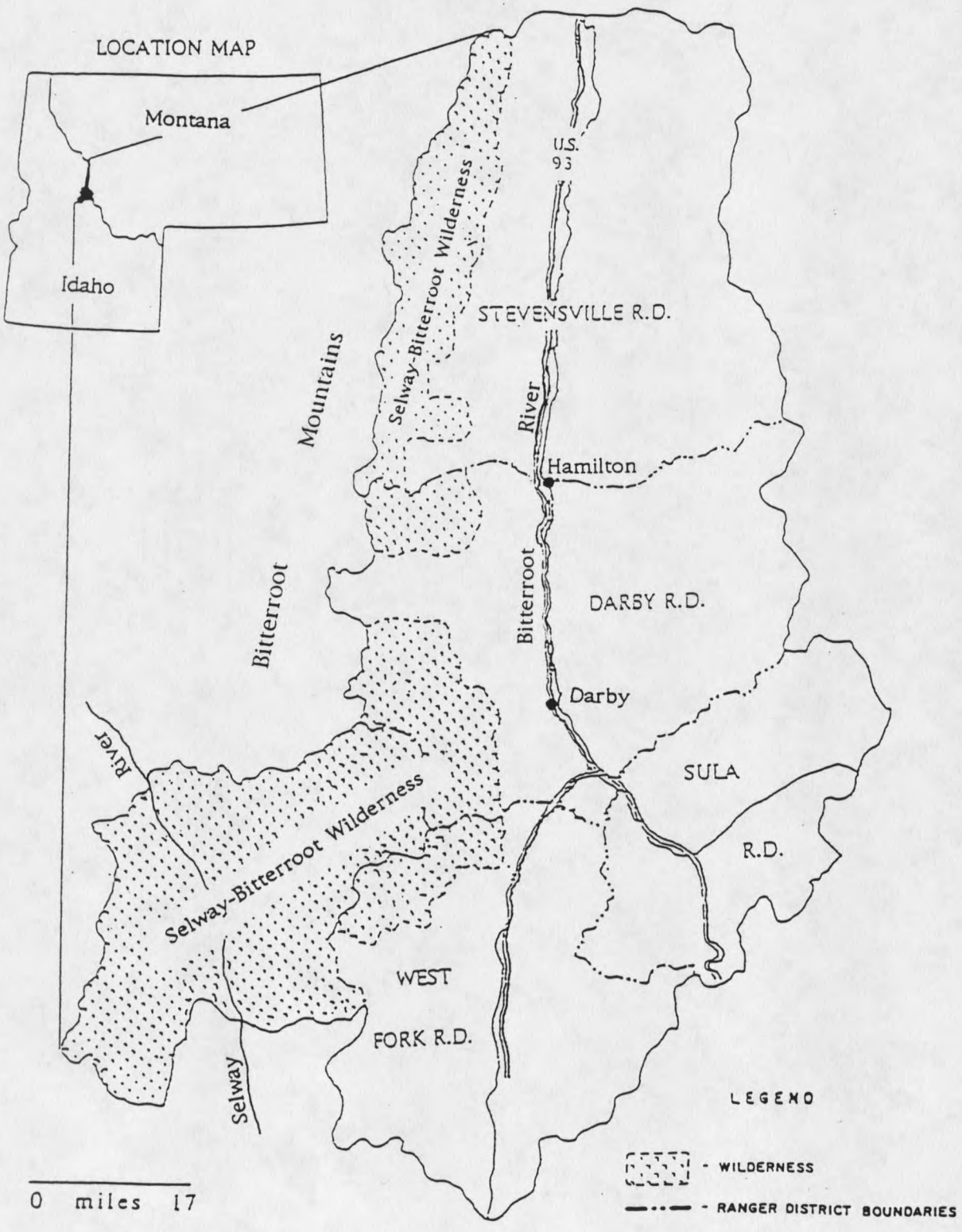


Figure 2. Map of study site - the Selway-Bitterroot wilderness area on the Bitterroot National Forest in Montana and Idaho.

wilderness on the Bitterroot National Forest. These are the Darby, Stevensville, and West Fork ranger districts. The north-south trending Bitterroot mountains form the backbone of the wilderness area. Ridges and peaks generally exceed 2,130 m (7000 feet) in elevation, and many summits surpass 2,740 m (9,000 feet) (Arno and Hammerly 1984). Lower elevations along the Selway River on the western boundary of the wilderness are approximately 550 m (1,800 feet) (Finklin 1983).

The east slope of the Bitterroot range rises above the west side of the Bitterroot valley. The rocks which make up the majority of the range belong to the Bitterroot lobe of the Idaho batholith, which formed during late Cretaceous time (Lackschewitz 1991). The batholith is largely composed of faintly gneissic granite rocks. Soils in the Bitterroot range are typically very shallow. Soil horizon development does occur but generally at lower elevations (Lackschewitz 1991).

Major drainages are aligned east to west and are approximately parallel to each other. These valleys were heavily glaciated during the Pleistocene epoch and are now formed in the classic U- shape. Most of the streams begin as cirque lakes within glacial amphitheaters (Bradley 1981).

The generalized climate of the Selway-Bitterroot wilderness varies between a north-Pacific coastal type and a continental type (Finklin 1983). As Pacific air masses move eastward they are forced over the Cascade range and mountains of northern Idaho. This

forced ascent results in orographic precipitation for those regions, leaving the air mass with reduced levels of moisture as it moves eastward. Thus much of the wilderness area lies in a rain shadow (Lackschewitz 1991). Annual precipitation (snowfall water and rain content) varies greatly over the area and is greatly dependent on elevation and topography. Near the Selway river in Idaho approximately 1000 mm (40 inches) fall along the western portion of the wilderness boundary. Moving eastward and southward this amount decreases to near 625 mm (25 inches) at the southern wilderness boundary. Precipitation levels range between 1500 to 1800 mm (60 and 70 inches) or more in the Bitterroot mountains and in the northwestern mountain area (Finklin 1983). Lower elevations receive moderate amounts of snowfall while snow depth may reach 1.5 to 3 m (5 to 10 feet) in the subalpine zones (Lackschewitz 1991).

Temperature is also affected by topography and elevation. Near 600 m (2000 feet) along the Selway River, monthly mean temperatures range from about -2° C (28° F) in January to 21° C (69° F) in July. Conversely temperatures on mountain tops at approximately 2135 m (7000 feet) range from about -8° C (18° F) in January to 15° C (59° F) in July (Finklin 1983).

Within the area, vegetation can be classified into various zones which generally correspond to elevation. Starting in the lower elevations ponderosa pine (Pinus ponderosa) is the predominant tree in drier locations (Finklin 1983). Gaining altitude most of the

mountain landscape is within the Douglas-fir (Pseudotsuga menziesii), grand fir (Abies grandis) or subalpine fir (Abies lasiocarpa) habitat types with native vegetation predominating. Extensive bands of lodgepole pines (Pinus contorta) occur at middle and upper elevations as a result of past fires (Lackschewitz 1991). At the highest forested elevations white-bark pine (Pinus albicaulis) and alpine larch (Larix lyalli) dominate.

Methods

This study required quantifying both vegetative characteristics and impact levels in stockcamps. Collecting data on vegetation composition and structure in the camps was accomplished by sampling along transects which radiated from camp centers. Existing opportunity classes and worksheets provided by the Forest Service were used to classify campsites into four discrete categories of impact levels. Stockcamp positions were determined by consulting with the recreation coordinator of the Selway-Bitterroot Wilderness area and pinpointing their locations on 1:24,000 scale topographical maps of the wilderness area. These camps were chosen because their locations were known by the Forest Service and maps showing the approximate locations of the stockcamps enabled me to locate them in a time efficient manner. Thirty camps were surveyed between early June and late August of 1993. Figures 3 and 4 show

the locations of the campsites in the Northern and Southern sections of the wilderness area respectively.

Determining Impact Levels

Opportunity Classes. One method for estimating disturbance levels is to use existing Forest Service classifications known as opportunity classes. These classifications divide the wilderness into four different zones of management according to the amount of use they have received and are expected to receive (Table 2). As visitor numbers increase, so does the opportunity class number. For example, areas designated as class one or two are locations which are not frequented by recreationists and have little if any human modifications to the natural resource. These areas would include remote parts of the wilderness, usually where maintained trails are not provided. Locations deemed a three or four are well used, and are often associated with trails, trailheads, lakes or airfields. These areas are frequented often by visitors and many sites located in these zones are substantially affected by the actions of users. These designations provide managers with a framework for managing towards desired future conditions in the wilderness (Selway-Bitterroot Wilderness 1992). The amount of use certain areas receive may influence the density levels of spotted knapweed. The relationship between spotted knapweed and opportunity classes will be discussed in chapter four.

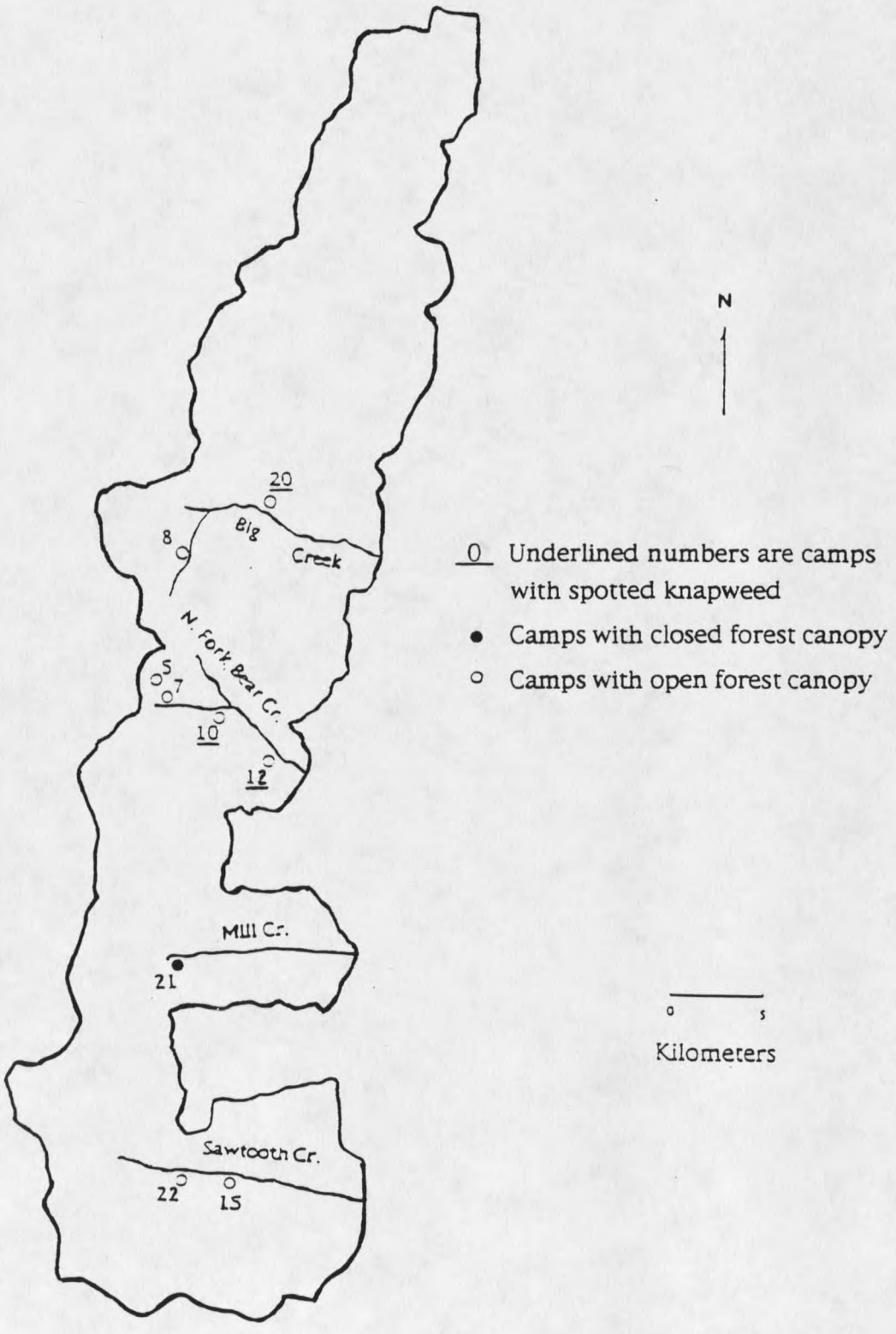


Figure 3. Map of Northern section of the study site showing the locations of camps sampled.

Figure 4. Map of Southern section of study site showing the locations of the camps sampled.

	Opportunity Class 1	Opportunity Class 2	Opportunity Class 3	Opportunity Class 4
Resource Setting	Unmodified natural environment	Unmodified natural environment	Unmodified natural environment	Predominatly unmodified natural environment
Ecological conditions	Not measurable affected by users actions	Some sites slightly affected by users actions	Some sites moderately affected by users actions	Many sites substantially affectedby users actions
Social Setting	Outstanding opportunity for isolation and solitude.	High opportunity for isolation and solitude.	HIgh opportunity for isolation and solitide	Moderate to low opportunities for isolation and solitude
Interparty contacts at the campsites	Non -existent	Very low	Low	Moderately frequent

Table 2. Resource and social setting aspects of each of the four opportunity classes. Source: Selway-Bitterroot Wilderness General Management Direction.

Determining Impact Levels in Individual Campsites. Disturbance levels at individual campsites were determined by using the Selway-Bitterroot Wilderness - Site Impacts Worksheet (SIW) (Appendix A). These worksheets were adapted from previous worksheets developed by Cole (1989) for use in the Bob Marshall Wilderness Complex to monitor impacts in backcountry campsites. The 1993 editions were also employed by wilderness rangers working on all four of the National Forests in the Selway-Bitterroot Wilderness Area. The forms, and variations of these forms, provide general site descriptions and legal locations of the campsites. These worksheets are used by resource personnel in many places throughout the United States to monitor changes in site characteristics over time. Photographs taken yearly are also used to monitor these changes. Use of the SIW in this study thus made particular sense because it is employed by resource managers throughout the region.

Impact level classes on the SIW range over four impact classes as defined by the Forest Service: light 18 -27, moderate 28 - 36, heavy 37 - 45, and extreme 46- 54. To ascertain which class was appropriate for each camp, eight variables regarding site conditions were evaluated (Table 3). Ratings for each variable were multiplied by weighting factors (Table 4) that were assigned by Forest Service personnel. Types of impacts that are remedied easily receive the lowest weighting of 1. Impacts that are contained or that could recover with less use receive a 2. The heaviest weight, 3, applies

Table 3. Eight variables used on the S.I.W. to calculate the impact index for the campsites. Source: the Selway Bitterroot Wilderness Site Impact Worksheet.

Variable	Definitions
Vegetation loss	Estimated difference between on-site and off-site coverage
Mineral soil increase	Estimated difference between on-site and off-site coverage
Tree damage	Total number of damaged trees in the campsite
Root exposure	Total number of trees with exposed roots caused by erosion or trampling by stock or humans
Development	Number and type of facilities found within the camp
Cleanliness	Amount of trash, fire scars, or manure in the site.
Social trail	Number of trails leading in and out of the camp.
Barren area estimate	The total barren area within the campsite. Area is considered barren if ninety percent or more of the vegetation is absent.

to impacts that are difficult to restore or are long lasting. Summation of these eight products produced the impact index number which fell into one of the four categories. To insure that impact levels were

Table 4. Eight variables and weights used to calculate the impact index for campsites. Source: the Selway Bitterroot Wilderness Site Impact Worksheet

Variable	Weight
vegetation loss	2
mineral soil increase	3
tree damage	3
root exposure	3
development	1
cleanliness	1
social trails	2
barren area	3

determined consistent with other Forest Service personnel I attended a four day Wilderness ranger training seminar before fieldwork began. The training provided instructions on the proper procedures for inventorying campsites and completing the SIW.

Vegetation Sampling

To understand how spotted knapweed related to the vegetation characteristics and human impacts in all thirty campsites it was important to have a methodology that gave an accurate representation of the area and was time efficient. This was accomplished by modifying field methods used in determining impact levels in the Eagle Cap Wilderness Area of northeastern Oregon (Cole 1983). This method involves establishing a center point of the campsite and taking measurements along sixteen transects radiating out from this point. Vegetation characteristics are then estimated in one by one meter quadrats located along the transects. I modified this technique by using eight transects and two by two meter quadrats, which proved to be time efficient. This sampling approach never failed to capture spotted knapweed when it was present, even at low frequencies, in the camps.

When the impact level had been determined, the center of the "horse" and "human" areas within the camps were located. This was done to determine if any significant difference existed between spotted knapweed densities in either of the areas. To establish the horse areas, I looked for horse manure, exposed roots, bare mineral soil, tree damage from tethers, and other evidence that indicated the presence of horses. In determining the human area, fire rings, fire scars, and excavated tent pads were used. Wilderness rangers who

had experience with particular camps also provided information as to the whereabouts of these areas within the camps.

From the center of each of these areas, eight twenty-four meter transects were run. To determine the bearing of the first transect a random number table was used. Transects then proceeded every forty-five degrees in a clockwise direction until reaching the first transect. The halfway point between the horse center and the human center was marked with my backpack. This represented the transition zone between the horse and human areas. If the centers of the two areas were less than twenty-four meters apart, transects from the center of horse area ran into the human area and vice-a-versa. This occurred in twenty-four of the thirty camps sampled. By marking the boundary between the two areas, it was possible to make sure I recorded spotted knapweed plants that were found in the horse area even if the transect began in the human area and vice-a-versa.

Along each of the twenty-four meter transects, 2 X 2 meter quadrats were located two meters apart. The horse and human areas each had forty-eight quadrats for a total of ninety-six sampling areas within each camp. This procedure was followed unless natural landscape features such as rivers or cliffs prevented transects from running the full twenty-four meters. Natural barriers prevented transects from running the full twenty-four meters in fifteen of the thirty campsites (Figure 5).

In each 2 X 2 meter quadrat, vegetation data were recorded for three height levels. In level one, from ground level to fifty centimeters, I recorded percent cover of bare ground, moss, forbs, grass, litter, rock, trees, and spotted knapweed. Frequency and density levels for spotted knapweed, when found, were also recorded in level one. Frequency was defined as the number of quadrats containing spotted knapweed. Density was defined as the actual number of spotted knapweed plants per quadrat. Total cover for all variables in level one always added up to one-hundred percent.

Level two ranged in height from fifty-one centimeters to three meters. Percent cover for broadleaf and coniferous trees and bushes was recorded for level two.

Level three included all heights above three meters. Percent cover for both broadleaf and coniferous trees were measured in this level. Percent cover for both levels two and three ranged from zero to one-hundred percent. Coverage for all variables in each level was determined by visual estimate. The data form used to record vegetative data for individual transects is shown in Appendix B.

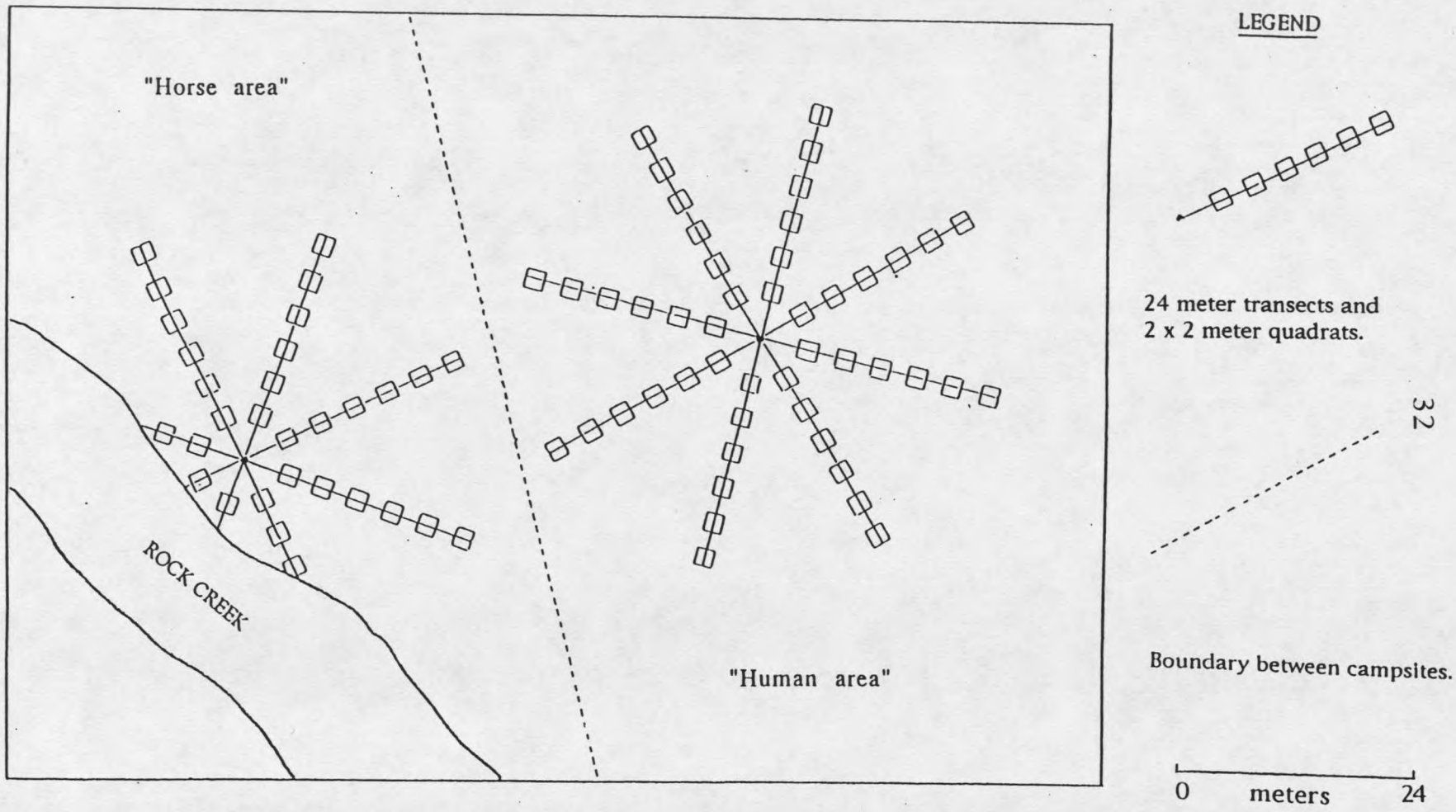


Figure 5. Diagram showing vegetation sampling methods.

CHAPTER THREE

DATA

This chapter presents data documenting the physical site characteristics of the camps inventoried. A total of thirty stockcamps were sampled between early June and late August of 1993. Table 5 shows the location, elevation, distance from trail head, opportunity classes and forest characteristics (closed forest or open forest) for the camps. Only six of the thirty camps contained spotted knapweed. Camps where spotted knapweed occurred are denoted with an asterisk (*). Several factors seem to influence the presence or absence of spotted knapweed and will be discussed in the following chapters.

Table 6 shows the overall impact index for the camps and the ratings for the eight variables used to determine this index. Camps with the weed are denoted by an asterisk (*). All of the camps fell into moderate, heavy or extreme impact categories with no light impact sites encountered. The relationship that these eight variables play regarding the abundance of spotted knapweed will be examined in the following chapter. Copies of data recorded are available from Andrew Marcus of the Earth Sciences Department and Bruce Maxwell of the Plant and Soil and Environmental Science

Department, both of Montana State University. This includes all vegetation and impact data recorded and is available as field notes and on computer disk.

Table 5. Location, elevation, distance from trail head, forest cover, opportunity class designation and average density of spotted knapweed per quadrat for the camps sampled. Camps with spotted knapweed are denoted by an asterisk*.

No.	Location	Elev. (ft.)	Miles from trail head	Forest cover	Opp. class	Avg. den. per quadrat
	Moderately Impacted Campsites					
1 *	T3N, R22W, S28	5120	5.5	open	4	2.30
2 *	T30N, R14E, S4	5900	8.25	open	3	.05
3.	T4N, R23W, S16	6500	3	open	3	0
4.	T4N, R23W, S34	5700	10.25	open	4	0
5.	T8N, R22W, S29	7720	8	open	1	0
6.	T2N, R16E, S11	7560	11.25	open	3	0
7.	T8N, R22W, S29	7720	8	open	1	0
8.	T8N, R22W, S4	5520	7.5	open	1	0
9.	T28N, R15E, S18	4720	5.25	closed	2	0
	Heavily Impacted Campsites					
10*	T8N, R22W, S34	5440	4.75	open	4	.01
11*	T3N, R22W, S33	5440	6.25	open	4	.64
12*	T8N, R22W, S2	5040	3	open	4	.69
13.	T1N, R23W, S13	6680	4	closed	2	0
14.	T2N, R23W, S1	5720	9	closed	4	0
15.	T5N, R22W, S4	5460	7.5	open	3	0
16.	T28N, R13E, S33	4700	4.5	open	2	0
17.	T2N, R22W, S22	6200	5.25	closed	2	0
18.	T28N, R15E, S19	6100	3.25	closed	2	0
19.	T30N, R15E. S24	6080	6.5	closed	2	0
	Extremely Impacted Campsites					
20*	T9N, R22W, S36	5080	5.75	open	4	.15
21.	T6N, R22W, S5	5720	7.5	closed	2	0
22.	T5N, R22W, S5	5600	8.5	closed	3	0
23.	T4N. R23W, S16	6520	2.75	closed	3	0
24.	T4N, R22W, S33	4600	4.5	closed	4	0
25.	T3N, R23W, S12	6300	10	open	4	0
26.	T30N, R14E, S4	6080	8.5	closed	2	0
27.	T3N, R16E, S6	7000	13.25	closed	3	0
28.	T4N, R22W, S32	4600	5.5	closed	4	0
29.	T3N, R23W, S9	6200	12	open	2	0
30.	T2N, R22W S3	7300	5.5	closed	3	0

Moderately Impacted Campsites

Camp No.	veg. loss	mineral soil	tree damage	root exposure	devel.	cleanliness	social trails	barren area	overall
1*	1	1	2	2	3	3	2	2	33
2*	1	1	2	2	2	3	2	2	32
3	2	2	2	2	1	1	2	2	34
4	1	2	2	2	3	2	2	2	40
5	1	2	2	2	1	3	1	2	31
6	1	2	2	2	1	3	1	2	32
7	1	1	2	2	1	2	2	2	30
8	1	2	2	2	1	2	1	2	31
9	1	2	2	2	3	3	2	2	36

Heavily Impacted Campsites

Camp No.	veg. loss	mineral soil	tree damage	root exposure	devel.	cleanliness	social trails	barren area	overall
10*	2	2	2	2	2	3	2	3	37
11*	2	2	3	2	3	3	3	2	43
12*	2	2	3	2	3	2	2	3	37
13	2	3	2	2	3	1	2	3	42
14	3	3	2	2	1	3	2	3	44
15	2	1	2	2	3	2	2	3	37
16	1	1	2	2	2	2	2	3	44
17	2	2	3	2	3	2	2	3	43
18	3	2	2	2	3	2	1	3	40
19	3	1	2	3	3	3	2	3	43

Table 6. Overall impact index of the camps and ratings for the eight variables used to determine the index.

Extremely Impacted Campsites

Camp No.	veg. loss	mineral soil	tree damage	root exposure	devel.	cleanliness	social trails	barren area	overall
20*	2	2	2	3	3	3	2	3	46
21	3	3	2	3	3	2	3	3	48
22	3	3	2	2	3	3	3	3	48
23	3	3	2	3	2	2	3	3	49
24	3	1	3	3	3	2	3	3	47
25	3	3	3	3	1	3	3	3	52
26	2	3	3	3	3	3	2	3	50
27	2	3	2	3	3	3	2	3	47
28	2	3	2	3	3	2	2	1	46
29	3	1	3	3	3	3	3	3	48
30	3	3	2	2	3	2	3	3	47

Table 6. continued

CHAPTER 4

RESULTS

This chapter will focus on testing: (1) if disturbance is associated with the occurrence of spotted knapweed; (2) if differences exist between spotted knapweed levels in the horse and human areas of the camps; and (3) the relationship between spotted knapweed and the recorded vegetation variables. Statistical analyses were performed with the use of Minitab (Schafer and Farber 1992) and Statxact (Mehta and Patel 1992) statistical software packages.

Relationship Between Spotted Knapweed and Disturbance Ratings

Opportunity Classes and Spotted Knapweed. Five of the camps with spotted knapweed fell in opportunity class four and one of the knapweed infested camps was located in opportunity class three. No infested camps occurred in opportunity classes one or two, classes which designate areas receiving less use. To test for an association between opportunity classes and the occurrence of spotted knapweed a Chi-square test was used (Table 7). The results of the test indicate there is strong evidence of an association between

opportunity classes and spotted knapweed. This would seem appropriate as opportunity classes and spotted knapweed are both associated with disturbance.

Table 7. The results of Chi-square testing used to see if a relationship exists between opportunity classes and spotted knapweed. Sample size is thirty.

Variable	Chisq	P-value
Opportunity class	8.90	.0187

SIW Impacts in Individual Camps and Spotted Knapweed Frequency. Only six of the thirty camps inventoried contained spotted knapweed. The weed seems to be uncommon within wilderness stockcamp settings in the Selway Bitterroot Wilderness Area. Table 8 suggests that the overall disturbance levels of the individual camps (light, moderate, heavy, or extreme) seem to have little if any influence on the abundance of spotted knapweed.

A chi-square analysis was conducted to test if a relationship exists between overall impacts or any of the eight variables found on the SIW (Table 2) and spotted knapweed occurrence. Simarily chi-square analysis was used to determine if a relationship exists between forest canopy cover (open or closed forest designation found

on the SIW) and camps with or without spotted knapweed. The results are shown in Table 9.

Table 8. Number of camps by overall impact levels with and without spotted knapweed.

	Overall Impact Levels			
	Moderate	Heavy	Extreme	Totals
with spotted knapweed	2	3	1	6
without spotted knapweed	7	7	10	24
totals	9	10	11	30

A relationship exists between the open forest designation on the SIW and the occurrence of spotted knapweed (p-value = 0.01). All camps where the weed was present fell into the open forest category. The association that spotted knapweed has with the open forest designation of the SIW is consistent with work by Losensky (1987), who listed limited light as a restrictive growth factor, and by Watson and Renney (1974, p. 693), who stated that "The knapweeds prefer open habitats and are not commonly found in shaded areas".

Among the eight impact variables on the SIW only one, development, had a statistically significant relationship with spotted knapweed (p-value = 0.05). In the six camps analyzed, four rated a 3 (the highest impact possible) and two rated a 2 regarding the

Table 9. The results of chi-square testing used to see if a relationship exists between spotted knapweed and variables on the Site Impact Worksheet. Sample size is thirty.

	Variable	Chisq	P-value
1.	Vegetation loss	4.36	.1126
2.	Mineral soil	3.96	.1382
3.	Tree damage	.1705	.6797
4.	Root exposure	1.292	.2557
5.	*Development	5.833	.0541
6.	Cleanliness	3.397	.1829
7.	Social trails	1.962	.3750
8.	Barren core area	1.086	.5811
9.	Closed/*nonclosed forest	5.639	.0104
10.	overall impact rating	1.47	.5373

development variable. The relationship between spotted knapweed and the development variable on the SIW is less obvious and can only be speculated upon. "Development" as defined on the SIW is the number and type of facilities (tent poles, log seats, or hitch rails for example) found within the camp. In the six camps with spotted knapweed, four had a rating of 3 (the highest possible) and two rated a 2 on the development scale. Several reasons for this relationship could be possible. First, more development within a camp may require the use of additional stock animals to transport equipment into the wilderness. These additional animals can increase the chances of weed spread as seeds may adhere to coats or hooves. Seeds may also be transported in the animals' digestive tracts and then be deposited in stock droppings within the camp. Hay used to feed the stock may also be a source of spotted knapweed seed (Marion et al.1985). Hay is generally used within stockcamp settings and only six of the thirty camps contained the weed. Greater development may add to increased soil disturbance which may provide spotted knapweed with more favorable growing conditions.

It's my opinion, however, that the camp development variable and spotted knapweed are linked because of the relationship which development has with the open forest designation. As stated earlier, all six of the weeded camps were open forested and four had a rating of 3 (the highest possible) and two rated a 2 on the development scale. Thus all camps containing spotted knapweed rated high concerning development. The development facilities most often

found were tent poles, hitch rails, and seats. Tent poles, hitch rails and log seats are items which are often made from cutting down live or dead trees. Cutting down trees for these facilities opens up the canopy allowing a more sunny condition favorable to spotted knapweed.

The p-values for the association of spotted knapweed with mineral soil increase (p-value-.14) and vegetation loss (p-value-.11) were only slightly higher than the .10 significance level (Table 9). Mineral soil is the layer of soil without any organic matter. The rating for both mineral soil and vegetation loss is the estimated difference between on-site and off-site cover. While not statistically significant, they are worth noting. An increase in both variables means more bare ground in the camps. Bare ground, if a seed source is present, could allow the initial establishment of spotted knapweed (Morris and Bedunah 1984).

Opportunity classes and the overall SIW impact levels in individual camps are both methods for classifying use and disturbance. At first glance it seems contradictory that a significant relationship exists between spotted knapweed and opportunity classes, but not between the overall disturbance level of individual camps and spotted knapweed. This discrepancy can be explained by the differences between opportunity class and SIW ratings. Five of the weeded camps fell into opportunity class four and one of the weeded camps fell into opportunity class three. Opportunity classes three and four include high use areas such as lake shores, trailheads

and trails. Trailheads and trails are areas used by most visitors entering the wilderness but only a few of these visitors use any one individual campsite. Therefore it is common that a moderately impacted campsite can exist in a high rated opportunity class area. There is thus not a simple relation between the opportunity class for an area and the overall SIW rating for an individual camp.

Opportunity classes, as shown by this data, are a more reliable indicator in predicting spotted knapweed than the overall impact rating on the SIW. Opportunity classes are used on a broad scale (i.e. estimated chance for solitude and generalization of environmental impacts) and are not as variable specific (i.e. vegetation loss, mineral soil increase, tree damage, root exposure, development, cleanliness, social trails and barren core area) as the SIW. Many of the impact variables found on the SIW which contribute to the overall impact rating of the camp seem to have little if any relationship to spotted knapweed. Only development and closed/open canopy have a significant association with the weed. It is possible that a camp could achieve a high overall impact rating by having high scores on variables that are not associated with spotted knapweed. This would explain why there is no significant relationship between spotted knapweed and the overall impact levels in individual camps but there is a significant relationship between spotted knapweed and opportunity classes.

Spotted Knapweed Densities in Horse and Human Areas of the Camps

It has been suggested that pack and saddle stock and their feed may be an important source of introduced plant species into wilderness settings (Cole 1983; Marrion et al. 1985). By dividing the campsites into horse and human areas and determining the densities of spotted knapweed for each, it was possible to test for significant density levels between the two areas.

One camp was not included in this statistical test because it was relatively small and the horse and human areas greatly overlapped. As the horse and human areas were difficult to distinguish, it was inappropriate to include this camp in a statistical analysis designed to test for differences between the two areas. Table 10 shows the occurrence of spotted knapweed for the horse and human areas of the five remaining camps where the weed was

Table 10. Number of plants and quadrats with and without spotted knapweed in horse and human areas of the stockcamps. Excluding outlier camp.

	Horse Area	Human Area	Totals
Plants	84	51	135
quadrats with weeds	16	13	29
total quadrats	1355	1264	2619

found. To test for significant differences in spotted knapweed density levels between the horse and human areas, a two sample t-test was used. I compared spotted knapweed in the horse area quadrats to spotted knapweed in the human area quadrats. There were 1246 quadrats in the human area and 1355 quadrats of the horse area.

The results of the two sample t-test show no significant differences in the number of plants in the two sections of the camps at the .10 significance level ($p = .53$). This finding shows that within the confines of the stockcamp there is no significant difference in density levels of the weed for either the horse or human areas. There are a number of possible reasons for this finding. Although pack animals may transport weed seed on their coats, hooves and feces and in their hay, the trampling done by the animals while corralled or tied may prevent spotted knapweed from becoming established. This trampling may kill the plant or compact the soil sufficiently enough to prevent germination.

A second possible explanation relates to the timing of the feeding and the type of feed given the animals. Before arrival at the trailhead, packstock may consume feed which is contaminated with spotted knapweed seeds. Seeds may thus pass through the animals and be deposited at the trailheads and along the trails in the form of manure before reaching the campsites. This would help explain the personal observations of spotted knapweed seen at trailheads and along trails. Once entering the wilderness area and arriving at the

campsites, outfitters and other stock owners may feed weed seed free pellets or hay to the animals which helps eliminate the spread/establishment of spotted knapweed in the campsite. It is also possible that camp users pull the weeds when they see them.

Relationship Between Spotted Knapweed and Vegetation Variables

Regressions of spotted knapweed density (y) versus the eight vegetation variables (x) were calculated to determine their relationships. Only data from the six camps with spotted knapweed were used. Table 11 indicates there is no strong linear association, either positive or negative, between weed density and the measured variables. Of the variables examined, only canopy cover showed a significant relationship with the density of spotted knapweed at the 0.10 level. The y intercept for canopy cover is .9745 and the slope is –.006752. This relationship is consistent with the results of the Chi-square testing, which found a positive association between spotted knapweed and the open canopy.

Scatter plots were also used to determine the relationship between spotted knapweed and vegetation (Figures 6 and 7). Figure 6 shows the relationship between the number of spotted knapweed plants per quadrat and the percent cover they occupied in the quadrats. There is a positive linear relationship between these two

variables, which shows that the number or spotted knapweed plants is a good measure of the percent cover of spotted knapweed.

Table 11. The results of linear regression analysis for spotted knapweed density versus vegetation variables.

Variable	R-sq	p-value
bare ground	0.2%	.281
moss	0.0%	.961
forbs	0.1%	.566
grass	0.2%	.318
litter	0.3%	.240
rock	0.0%	.670
tree	0.0%	.788
canopy cover	1.2%	.011

There appears to be no linear relationships between any of the eight quadrat variables and spotted knapweed. However, the density levels of spotted knapweed do decrease with the increase of percent coverage of most of the eight variables, with the possible exception of forbs and litter. As sunlight is a limiting factor for spotted knapweed, it is logical that as canopy cover increases, the number of spotted knapweed plants would decrease. Other studies

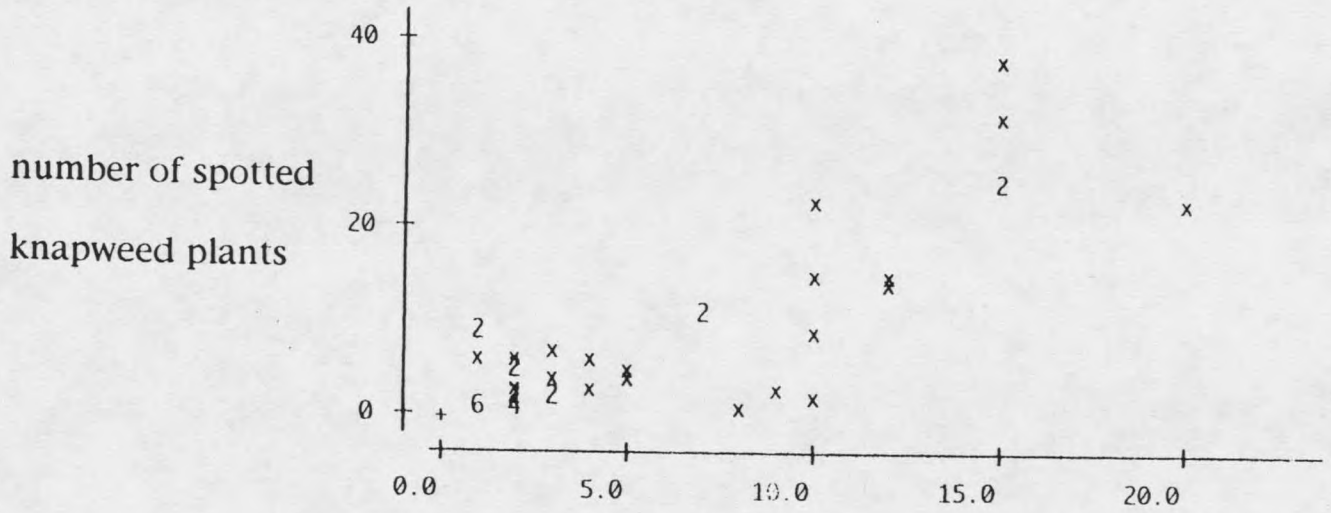


Figure 6. Scatter plot showing number of spotted knapweed plants and percent cover of spotted knapweed. Only data from camps containing spotted knapweed was used. If several points fall on the same spot, a count is given. If the count is over 9, a + is used.

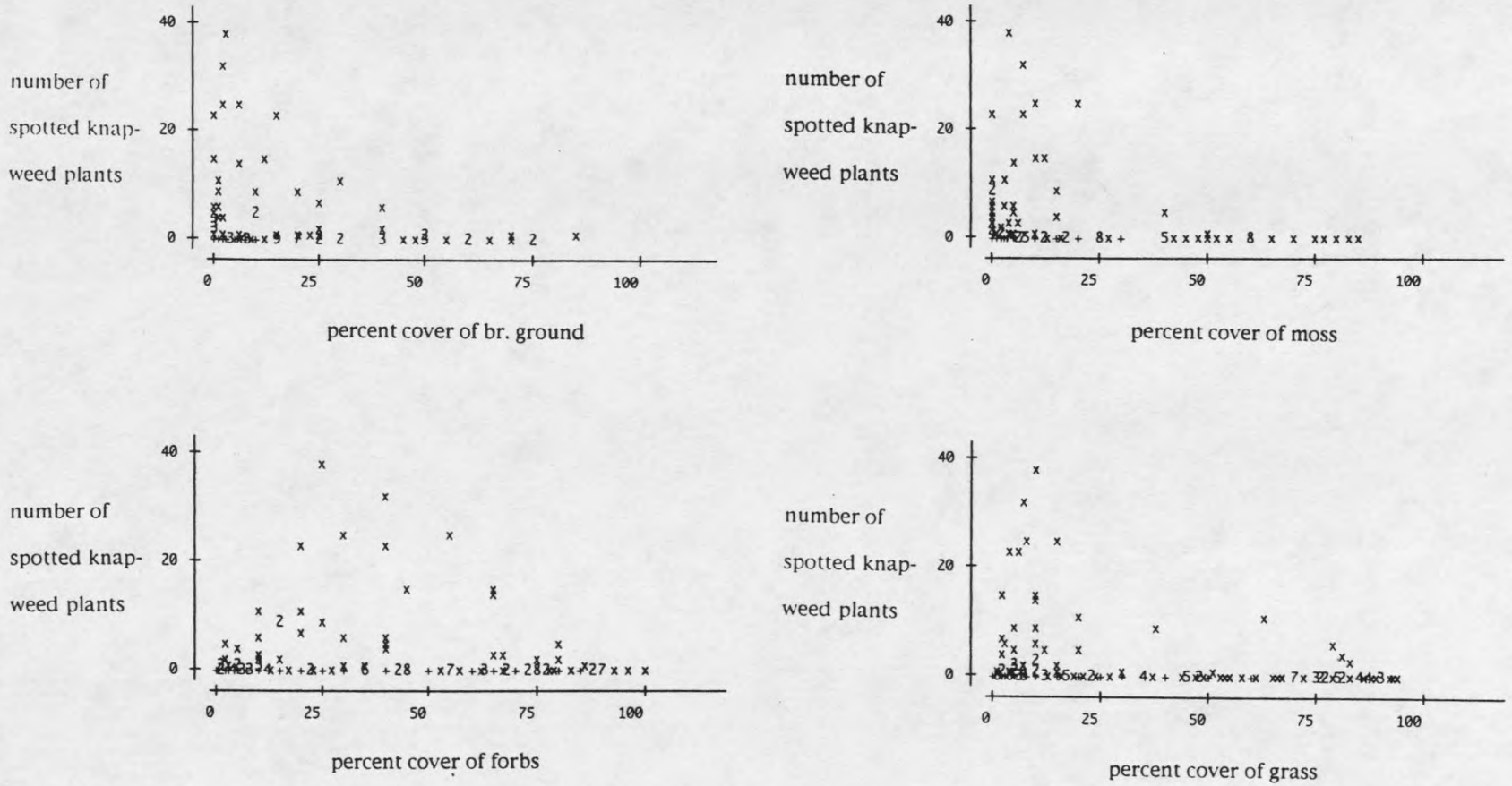
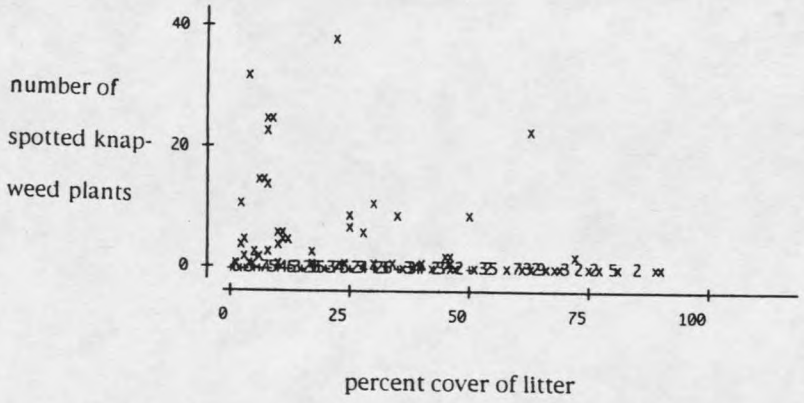
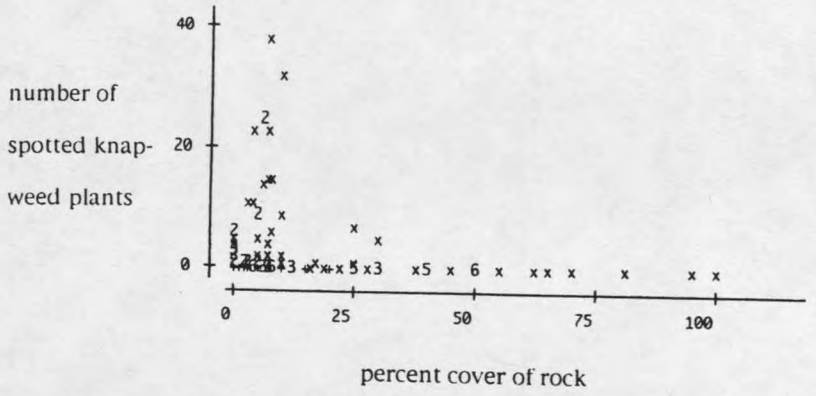
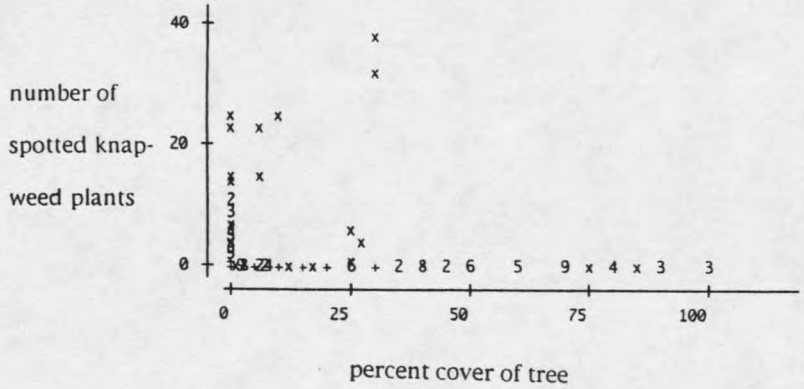


Figure 7. Graphs showing relationships between spotted knapweed and the eight vegetation variables. Only data from camps containing spotted knapweed was used.







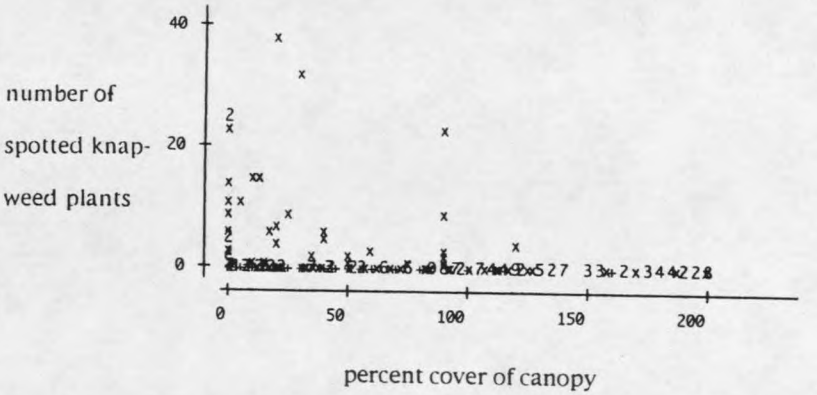


Figure 7 continued.

have shown that spotted knapweed establishment is enhanced by soil disturbance (Watson and Renney 1974) and bare ground (Moores 1986). As the percent vegetation cover increases, the percent of bare/disturbed ground decreases, allowing less area for spotted knapweed to grow. This would explain the negative relationship between spotted knapweed and the measured variables in this study.

This line of reasoning is contradicted, however, by the decrease in spotted knapweed with increases in bare ground (Figure 7). This decrease in spotted knapweed density with increases in bare ground may be due to the frequency of use in the camps. Usually areas with bare ground are locations in the camp where fire rings, tent sites, and horse hitches are concentrated. While some bare ground may be beneficial to spotted knapweed, areas frequently disturbed are void of all vegetation, including spotted knapweed. Both repeated disturbance and soil compaction may make it difficult for the weed to establish. Regardless of the explanation, the relation between spotted knapweed, bare ground and percent vegetation cover is not simple and cannot be resolved with the data from this study.

Environmental Controls on Spotted Knapweed

Camps where spotted knapweed was found shared several distinct environmental characteristics related to elevation, number of frost free days and open forest classification. Chicoine et al.'s 1985

study on spotted knapweed migration in Montana found ninety percent of the test infestations between 610 and 1829 meters (2,000 and 6,000 ft.) This study revealed similar trends with all six camps containing spotted knapweed located between 1524 and 1829 meters (5,000 and 6,000 ft.). Six camps that did not contain spotted knapweed were also located between 1524 and 1829 meters. No spotted knapweed was found in the fourteen camps located above 1829 meters (6000 ft.) and none of four camps located below 1524 meters (5000 ft.) contained the weed.

The camps located below 1524 meters are in elevations identified by Chicoine et al. (1985) as areas where spotted knapweed is likely to occur. Three of the four camps located below 1524 meters had a closed canopy, which may be the reason for the lack of spotted knapweed. The one camp below 1524 meters with open canopy had an opportunity class rating of two, which indicates little human disturbance and opportunity for spotted knapweed to be introduced.

Finklin (1983) reports that locations in the Selway-Bitterroot Wilderness area close to 914 meters (3000 ft.) have approximately 107 frost free days, while areas at 2134 m (7000 ft) have approximately seventy-four frost free days per year. No data regarding frost free days exists for the campsites sampled. However, given that the camps with spotted knapweed occurred at elevations between 1524 and 1829 meters (5000 and 6000 ft.) and considering data from Finklin, it is logical to assume that the camps with the

weed would have somewhere between seventy and ninety frost free days per year. This is also consistent with Chicoine et al. (1985), who found the majority of the infestations occurred in areas with fifty to one-hundred and twenty frost free days per year.

Although the elevations where I found spotted knapweed all are between 1524 and 1829 meters it does not imply that the plant is restricted to only these elevations. Lacey et al. (1992) reported that the weed has been observed between 579 and 3048 meters (1900 to 10,000 ft.).

As the campsites were located on flat areas, the aspect of the camps played little role in the differences in spotted knapweed densities between camps. Soil samples were not taken at any of the campsites because spotted knapweed infestation is influenced more by soil disturbance than soil properties (Lacey et al. 1992).

CHAPTER 5

SUMMARY and RECOMMENDATIONS

Summary

While spotted knapweed is prevalent at trailheads and along trails in the Selway-Bitterroot Wilderness Area (personal observation), it is not common or abundant in stockcamps in the wilderness. Only six of the thirty camps sampled contained the weed. While noxious weeds such as spotted knapweed are known to colonize and thrive in disturbed areas, this was not borne out for stockcamps observed in this study. The levels of disturbance within individual camps (light, moderate, heavy, or extreme as defined by the SIW) appear to have little influence on the presence of spotted knapweed. The positive relation between spotted knapweed and opportunity class, however, indicates that some degree of wide spread disturbance is necessary for spotted knapweed to exist in camps. Besides camp disturbance as measured by opportunity class, this study found that campsites with spotted knapweed all shared other common characteristics (Figure 8). These were elevation (between 1524 and 1829 m), open forest canopy and degree of development as defined by the SIW.

Campsites	Elevation 1524 -1829 meters	development rating of 2 or 3	open canopy	opportunity class of 3 or 4
number of camps with and without spotted knapweed	12	23	16	18
number of camps with spotted knapweed	6	6	6	6
percentage of camps with spotted knapweed	50%	23%	38%	33%

Figure 8. Common characteristics shared by all weeded camps.

Recommendations

A number of preventative measures can be expanded or initiated to slow the spread of spotted knapweed in areas like the Selway-Bitterroot Wilderness, or in locations where the weed could be a concern in the future. Educating backcountry users to the potential threats posed by spotted knapweed is one cost-effective way to help control weeds. Rules concerning the use of weed seed free hay or pellets and regulations regarding campsite activities and locations could also help. Organizing volunteer groups for a "day in the backcountry" for weed control and environmental education is another alternative. As the use of herbicides is counter to the spirit of the Wilderness Act, I do not recommend using chemicals in the wilderness. However, as all of the trailheads are located outside of wilderness boundaries, the use of herbicides may be appropriate and effective.

Weed Awareness Programs

Weed awareness programs are one way to help slow down the spread of spotted knapweed into areas like the Selway-Bitterroot. There are probably many wilderness users who are unaware of spotted knapweed and the threats it can have on Montana's native ecosystems.

One way to educate wilderness users of spotted knapweed is through signs set up at the trailheads. The advantages of this method include: (1) it has the capability to reach thousands of people; (2) it is low maintenance and time efficient; and (3) it could prove cost effective in the long run. The signs used should be laminated to protect them from the weather. Information on the signs should be simple and straight to the point and include color pictures of the weed. The threat that spotted knapweed poses to big game through loss of forage and how the weed can disrupt native plant diversity and ecosystems should be the emphasis of the text as many users relate directly to these issues. Instructions on handpulling the plant should also be included. Signing would probably not have any effect on existing large populations of the weeds because hand grubbing the entire population would be difficult. Signing could be effective, however, in containing or eradicating small populations of the weeds where hand grubbing could be effective.

Weed Susceptibility Evaluation for the Camps

The six camps which had populations of spotted knapweed all shared several site specific characteristics. Although some of these traits were common among all the camps sampled, (weeded and non-weeded) using these variables is appropriate as they may prove to

be "early warning signs" of the potential for spotted knapweed infestation. Figure 8 shows the variables shared by the weeded camps.

Each of these variables alone may or may not lead to spotted knapweed infestation. However, the combined presence of all or some of them may help indicate where spotted knapweed will occur. Figure 9 shows a form which I have created that is similar to the SIW presently used by Forest Service personnel. This form could be added to the existing SIW. It would provide an inexpensive and time efficient way to predict how susceptible a camp is to the possible infestation of the weed. Anyone familiar with the SIW would be able to complete the form after receiving a few minutes of explanation. The tabulation could be done either in the field or in the office.

I have rated the variables according to their importance regarding the occurrence of spotted knapweed on a scale of 1 to 3. For example, the variable elevation rated a 3 as fifty percent of the camps between 1524 and 1829 meters (5000 and 6000 ft.) contained the weed. The variable open canopy rated a 2 as thirty-eight percent of the open canopied camps contained spotted knapweed. The opportunity class variable also rated a 2 as thirty-three percent of the camps falling into this category had the weed. Finally, the variable development received a 1 as only twenty-three percent of the camps which rated a two or three on the SIW contained spotted knapweed. The "Spotted Knapweed Susceptibility Evaluation" may provide managers a tool for predicting to what degree camps are

SPOTTED KNAPWEED EVALUATION FORM

Circle the weights that apply to the camp.

Development is a 2 or 3 on SIW	Open forest	Opp. class is a 3 or 4	Camp is between 5000 and 6000 ft.
Weights 1	2	2	3

sum of weighted numbers

Weed index _____

KEY: WEED INDEX

0. The camp has little chance of spotted knapweed infestation.
1. The camp has a low chance of spotted knapweed infestation.
2. The camp has a moderate chance of spotted knapweed infestation.
3. The camp has approximatley a 50% chance of spotted knapweed infestation.

>4. The camp has greater than 50% chance of spotted knapweed infestation

Figure 9. Spotted knapweed susceptibility evaluation form.

susceptible to the invasion of spotted knapweed. Management actions deemed appropriate for each specific weed index number could then be carried out.

Regulations Regarding Spotted Knapweed

There are a number of regulations which could be implemented to slow the spread of the weed in the wilderness. These regulations should be phased in over a set period of time adequate to allow all parties involved time to become aware of and adhere to the changes.

Currently the Forest Service on the Bitterroot does not require the use of weed seed free hay in the wilderness area. Only six of the thirty campsites contained spotted knapweed. As hay is used primarily within the confines of the stockcamp it seems unlikely that spotted knapweed is being introduced to trail systems in the wilderness through contaminated hay. However, requiring all stock users, both public and outfitter groups, to use certified weed seed free hay or pellets would help reduce the chance of weed seeds entering the wilderness through hay or the digestive tracts of pack stock. This rule would be especially useful in locations currently not experiencing severe weed problems. The rule would be somewhat less useful in the Selway-Bitterroot where weeds already exist along the trail and at the trailhead. This is because even though weed seed free feed is used, packstock could still eat weeds along the trails or trailhead and carry seeds into the wilderness. While this rule

may affect existing weed species only slightly, it would help stop the establishment of other new weeds species.

Outfitters doing business in the wilderness area are required to obtain an outfitting permit and operating plan through the Forest Service. This permit and plan outlines rules and standards which the permittee must abide by. Examples of this include locating toilets more than two-hundred feet from water sources, refraining from tying stock to trees, and not exceeding fourteen day stay limits in one camp. Additional rules may be needed to help slow the spread of spotted knapweed. The results of this research indicate that the variables "development" and "open forest" on the SIW have a relationship with spotted knapweed. I suggest examining these variables to see how modifying use regulations might help control the weed.

Of the six camps with weeds, four rated a 3 (the highest possible) and two a 2 regarding development. The cause and effect relationship between spotted knapweed and development as defined by the Forest Service is not straight forward. It may be that more development means larger stock parties, the use of additional stock to transport equipment, or greater soil disturbance. Given that the reasons for the link between development as defined by the Forest Service on the SIW and the weed is unknown, additional restrictions or regulations regarding camp development are not justified by this study solely to attenuate the spread of spotted knapweed.

The relationship between the open/closed forest designation on the SIW and the weed is more straight forward. I believe that actions regarding this variable could be undertaken and prove to be beneficial in combating spotted knapweed in the camps. Currently permitted outfitters are allowed to cut down standing dead trees in the campsite for tent poles, hitch rails, firewood or other camp uses. Cutting down trees for these uses can lead to a higher impact rating with the development variable. It can also open up the canopy allowing more sunlight to reach the forest floor, a setting favored by spotted knapweed. The remaining stumps also leave the camps looking altered and unnatural, a condition which the Forest Service seeks to remedy. Precautionary steps could be undertaken to help with the problem of stumps and the removal of trees. The number of trees cut down in the camps could be restricted and the amount of trees cut could be specified to meet the minimum requirements for user needs. These specifications could be jointly determined by the permittee and Forest Service personnel prior to the outfitter obtaining his/her permit. This would ensure that both parties are in agreement and that the needs of both are met.

One alternative is to require or strongly encourage permittees to use steel or aluminum poles for all wall tents. This would discourage the cutting of trees and allow trees to grow back in places where the canopy has been significantly altered. Using aluminum or steel poles makes particular sense in this case as it would help with the open forest/spotted knapweed relationship and with the problem

of unsightly and unnatural stumps in the camps. This alternative would be more easily enforced and monitored in the wilderness.

Volunteer Groups and Weed Control

Volunteer groups can be utilized to help control weeds. These programs should be led by botanists, biogeographers, biologists, or other resource specialists. These projects could combine weed control (in this case by hand grubbing) with informative sessions on the natural surroundings. An example would be a weekend spent in the backcountry pulling weeds and learning about and identifying the native vegetation in the area. Portions of each day would be divided between controlling weeds and lectures/activities on the natural environment or on discussions of management strategies for the area. By combining the hard work of weed control with fun, interesting lectures and activities, volunteers would be more apt to return. There are several special interest groups as well as environmental education programs which could be called upon for volunteer work. Examples are the Backcountry Horsemen, the Rocky Mountain Elk Foundation, Friends of the Bitterroot, the Student Conservation Corp. and Wildland Studies. Any of these groups or individuals could participate in an "Adopt a Trailhead" effort to eliminate weeds from trailheads. These programs would serve not only to educate about and help eradicate spotted knapweed (or other

non-native species) it would also foster an understanding and appreciation for the natural environment.

Chemical Spraying

Trailheads where spotted knapweed is present provide opportunities for the weed to become attached to stock animals and to humans entering the wilderness. It is also here that animals may eat the plant, possibly carrying the seeds through their digestive tracts. I do not recommend the use of chemicals within wilderness boundaries. However, their use may be effective at trailheads infested with spotted knapweed located outside of these boundaries. The herbicide Picloram can provide 100% control of spotted knapweed for 1 to 5 years depending on site conditions (Davis et al. 1993).

Future Research

My study showed that spotted knapweed is not common within the confines of individual camps. However, the presence of exotics will continue to be a problem in backcountry and wilderness areas. Management plans designed to combat exotic plants cannot be short term or limited to any specific situations such as campsites or trails. Any successful "weed" management plan should use all available research, conduct ongoing research and integrate these into

all areas of resource management. Only by broadening our knowledge and understanding of weeds and their spread in different conditions can successful control and eradication methods be implemented. The results of the following research topics could be incorporated into management strategies regarding weed spread/establishment in backcountry areas: (1) determine if different impact characteristics exist between horse sites and backpacker sites and how these differences relate to exotics; (2) determine how weeds are entering wilderness areas; (3) explore the effects that spotted knapweed and other exotics have on plant diversity; (4) conduct baseline studies to map all existing noxious weed infested sites within wilderness/backcountry areas; and (5) revisiting camps inventoried in this study to see if changes occur regarding spotted knapweed.

Conclusions

The presence of spotted knapweed and other non-native species is now a recognized threat to the natural ecosystem processes associated with wilderness areas. Their existence in these areas also provides evidence of human presence and impacts, conditions counter to the Wilderness Act of 1964. By learning more about spotted knapweed and other weed species in wilderness areas already experiencing weed problems we may be able to prevent

weeds from establishing themselves in other relatively weed free wilderness settings.

This study has shown that spotted knapweed infestation of stock camps in the Selway-Bitterroot Wilderness is most likely to occur in camps between 1524 and 1829 meters (5,000 and 6,000 ft.), with opportunity class ratings of 3 or 4, with SIW development ratings of 2 or 3 and having open canopies. The relations that spotted knapweed has to these variables can be used to help predict what camps or areas are susceptible to spotted knapweed infestation. Data from this study and other research concerning weeds in wilderness settings is needed to prevent weeds from becoming established in wilderness areas which are relatively weed free. Proactive measures such as education and prevention, rather than eradication and containment, are preferred alternatives to stop the spread of weeds that threaten native ecosystems.

LITERATURE CITED

LITERATURE CITED

Arno, S. F., and Hammerly, R. P. 1984. Timberline-Mountain and Arctic Forest Frontiers. Seattle WA: The Mountaineers. 304.

Bedunah, Donald, J. 1992. The Complex Ecology of Weeds, Grazing and Wildlife. Western Wildlands 18: 6-11.

Benninger-Truax, Mary; Vankat, John, L.; and Schaefer, Robert, L. 1992. Trail Corridors as Habitat and Conduits for Movement of Plant Species in Rocky Mountain National Park, Colorado, USA. Landscape Ecology 6: 269-278.

Bitterroot National Forest. 1992. Facts for your information. Supervisor's office, Bitterroot National Forest. Hamilton Montana.

Bradley, Dennis, M. 1981. Geology of Northeastern Selway Bitterroot Wilderness Area, Idaho and Montana. M.S. Thesis, University of Idaho, Moscow.

Chicione, T. K. 1984. Spotted Knapweed (Centaurea maculosa L.) Control, Seed Longevity and Migration in Montana. M.S. Thesis, Montana State University, Bozeman.

Chicoine, T.; Fay, P.; and Nielsen, J. 1985. Predicting Weed Migration from Soil and Climate Maps. Weed Science. 34: 57-61.

Cole, D., and Fichtler, R. 1983. Campsite Impacts on Three Western Wilderness Areas. Environmental Management 7: 275- 288.

Cole, D. 1983. Monitoring the Condition of Wilderness Campsites. Ogden, UT: Intermountain Forest and Range Experiment Station, Research Paper INT-302. U. S. Department of Agriculture, Forest Service.

Cole, D. 1989. Viewpoint: Needed Research on Domestic and Recreational Livestock in Wilderness. Journal of Range Management 42: 84-86.

Cole, D. 1989. Wilderness Campsite Monitoring Methods: a Source Book. Ogden, UT: Intermountain Research Station. General Technical Report INT-259. U.S. Department of Agriculture, Forest Service.

Dale, D., and Weaver, T. 1974. Trampling Effects on Vegetation of the Trail Corridors of North Rocky Mountain Forest. Journal of Applied Ecology 11: 767-772.

Davis, E.; Fay, P.; Chicoine, T.; and Lacey, C. 1993. Persistence of Spotted Knapweed (*Centaurea maculosa*) Seed in Soil. Weed Science Volume 41: 57-61.

Department of Agriculture. 1991. County Noxious Weed Control Act and Administrative rules. State of Montana: Agricultural and Biological Science Division. Capitol Station. Helena, Montana.

Eddleman, L. E., and Romo, J. T. 1988. Spotted Knapweed Germination Response to Stratification, Temperature, and Water Stress. Canadian Journal of Botany 66: 653-657.

Exotic Vegetation Management Plan. 1986 Yellowstone National Park. Resource Management Office. Mammoth Hot Springs, Wyoming.

Finklin, Arnold, I. 1983. Weather and Climate of the Selway-Bitterroot Wilderness. University Press of Idaho. Moscow, Idaho.

Flathead National Forest. Final Environmental Impact Statement 1993. Noxious Weed Management Project. Spotted Bear and Hungry Horse Ranger Districts. Flathead County, Montana. Flathead National Forest. Department of Agriculture, Forest Service. Kalispell, Montana.

Forcella, Frank. 1992. Invasive Weeds in the Northern Rocky Mountains. Western Wildlands 18: 2-5.

Forcella, Frank, and Harvey, Stephen, J. 1983. Eurasian Weed Infestation in Western Montana in Relation to Vegetation Disturbance. Madrono 30: 102-109.

Groh, H. 1940. Turkestan Alfalfa as a Medium of Weed Introduction. Sci. Agr. 21: 36-43.

Harvey, Stephen, J., and Nowierski, Robert, M. Spotted Knapweed: Allelopathy or Nutrient Depletion? Proceedings of the 1989 Knapweed Symposium. Montana State University. Bozeman, Montana. 118.

Kelsey, Rick, G., and Bedunah, Donald, J. 1989. Ecological Significance of Allelopathy for Centaurea Species in the Northwestern United States. Proceedings of the 1989 Knapweed Symposium. Montana State University. Bozeman, Montana. 10-32.

Kummerow, Max. 1992. Weeds in Wilderness: a Threat to Biodiversity. Western Wildlands 18: 12-17.

Lacey, Celestine. 1989. Knapweed Management: a Decade of Change. Proceedings of the 1989 Knapweed Symposium. Montana State University. Bozeman, Montana.1-6.

Lacey, C. A.; Lacey J. R.; Fay, P. K.; Story, J. M.; and Zamora, D. L. 1992. Controlling Knapweed on Montana Rangeland. Montana State University Extension Service. Bozeman, Montana.

Lackschewitz, Klaus, 1991. Vascular Plants of West-Central Montana-Identification Guidebook. Ogden, UT.Intermountain Research Station. General Technical Report INT-277. United States Department of Agriculture. Forest Service.

Lesica, Peter; Ahlenslager, Kathleen; and Desanto, Jerry. 1993. New Vascular Plant Records and the Increase of Exotic Plants in Glacier National Park, Montana. Madrono 40: 126-131.

Lolo National Forest. 1991. Noxious Weed Management. Final Environmental Impact Statement 1991. Amendment to Lolo National Forest Land and Resource Management Plan. Lolo National Forest. Fort Missoula, Missoula, MT .

Losensky, John, B. 1987. An Evaluation of Noxious Weeds on the Lolo, Bitterroot and Flathead Forests with Recommendations for Implementing a Weed Control Program. Lolo National Forest. Fort Missoula, Missoula, MT.

Mass, Fred, H. 1989. To Contain Knapweed in Far-Western Montana. Proceedings of the 1989 Knapweed Symposium. Montana State University. Bozeman, Montana. 113-117.

Marion, Jeffrey, L.; Cole, David, N.; and Bratton, Susan, P. 1985. Exotic Vegetation in Wilderness Areas. Proceedings-National Wilderness Research Conference: Current Research. Fort Collins, CO. 114-120.

Mehta, C. and Patil, N. 1992. StatXact-turbo user manual. Cytel Software Corporation, 675 Massachusetts Avenue, Cambridge, MA.

Montana Department of Agriculture. 1986. Weed training manual. Environmental Management Division. Helena MT.

Mooers, G. B. 1986. Relationship of Critical Environmental Factors to the Success of Spotted Knapweed (Centaurea maculosa L.) in western Montana. M.S., Thesis University of Montana.

Mooers G. B., and Willard, E. E. 1989. Critical Environmental Factors Related to Success of Spotted Knapweed in Western Montana. Proceedings of the 1989 Knapweed Symposium. Montana State University. 126-135.

Morris, M. S., and Bedunah, D. 1984. Some Observations on the Abundance of Spotted Knapweed (Centaurea maculosa L.) in Western Montana. Proceedings of the Knapweed Symposium. 77-80. Montana State University. Bulletin 315.

Mueggler, W. F., and Stewart, W. L. 1980. Grassland and Shrubland Habitat Types of Western Montana. Ogden, UT. USDA Forest Service. Technical Report INT-66.

Noxious Weed Management Project. Draft Environmental Impact Statement 1993. Flathead National Forest. Spotted Bear and Hungry Horse Ranger Districts. Flathead County, Montana.

Noxious Weed Trust Fund. 1992. Montana Department of Agriculture. Agriculture and Biological Sciences Division. Helena, Monata.

O'Loughlin, Jennifer. 1992.Western Wildlands 18: Inside cover.

Pfister, R.; Korvalchik, B.; Arno, S.; and Presly, C. 1977 Forest Habitat Types of Montana. Ogden UT. Intermountain Forest and Range Experiment Station. General Technical Report INT-34

Schirman, Roland. 1984. Seedling Establishment and Seed Production of Diffuse and Spotted Knapweed. Proceedings of the Knapweed Symposium. 7-10. Montana State University. Bozeman, Montana. Bulletin 315.

Selway-Bitterroot Wilderness - General Management Direction. Prepared by: Nez Perce, Clearwater, Lolo and Bitterroot National Forests. 1992 Update. Hamilton, Montana.

Spears, B. M.; Rose, S. T.; and Belles, W. S. 1980. Effect of Canopy Cover, Seeding Depth, and Soil Moisture on Emergence of Centaurea maculosa and C. diffusa. Weed Research. 20. 87-89.

Spoon, C. W.; Bowles, H. R.; and Kulla, A. 1983. Noxious Weeds on the Lolo National Forest. A situation analysis staff paper. USDA Forest Service, Northern Region. 33.

Story, Jim. 1992. Biological Control of Weeds: Selective, Economical and Safe. Western Wildlands 18: 18-23.

Tyser, R.W., and Worley, C.R. 1992. Alien Flora in Grasslands Adjacent to Road and Trail Corridors in Glacier National Park, Montana (U.S.A.). Conservation Biology 6: 253-262.

United States Department of Agriculture. 1971. Common weeds of the United States. Dover Publications. New York.

Watson, A. K., and Renney, A. J. 1974. The Biology of Canadian Weeds. Centaurea diffusa and C. maculosa. Canadian Journal Plant Science 54: 687-701.

Westman, Walter, E. 1990. Park Management of Exotic Plant Species: Problems and Issues. Conservation Biology 4: 251-259.

Wheeler, Ralph. 1991. Undesirable Weeds of Idaho Forest Lands. Idaho State Department of Agriculture. Boise, Idaho.

Whipple J. 1991. *Exotic Plant List of Yellowstone National Park.* Mammoth Hot Springs, Wyoming.

Whitson, Tom, D.; Burrill, Larry, C.; Dewey, Steven, A., Cudney, David, W.; Nelson, B. E.; Lee, Richard, D.; and Parker, Robert. 1992. Weeds of the West. University of Wyoming. Laramie, Wyoming.

APPENDICES

APPENDIX A

The Selway-Bitterroot Wilderness - Site Impact Worksheets (SIW)

Selway-Bitterroot Wilderness - Site Impacts Worksheet (SIW)

1993 Edition

GENERAL SITE DESCRIPTION AND LOCATION:_____

_____

_____

_____

_____

_____

_____

_____

_____

(1) SITE NUMBER:_____ OPPORTUNITY CLASS:_____

(2) LEGAL DESCRIPTION: T_____ R_____ S_____ 1/4 SEC_____

(3) USGS QUADRANGLE NAME:_____

(4) DATE INVENTORIED - Month:_____ Day:_____ Year:_____

(5) INVENTORIED BY (Name):_____

(6) ELEVATION:_____

(7) VEGETATION: (Circle one)

1 - Closed forest

2 - Open forest

3 - Nonforested, densely vegetated

4 - Nonforested, sparsely vegetated

Dominant species_____

Habitat type (if known)_____

(8) LANDFORM: (Circle one)

1 - Floodplain 2 - Other valley bottom 3 - Cirque basin

4 - Sideslope 5 - Ridgetop 6 - Other_____

(9) DISTANCE FROM TRAIL: (Circle one and estimate distance)

1 - System trail (if so, Trail #:_____); Distance_____ ft.

2 - Non-system trail; Distance_____ft.

(10) TYPE OF USE: (Circle as many as apply)

1 - Foot 2 - River 3 - Stock

4 - Outfitter 5 - Other_____

(11) DEVELOPMENT (# on arrival / # when you left)

1 - Fire ring____ / ____

2 - Primitive seat____ / ____

3 - Constructed seat____ / ____

4 - Table/shelf____ / ____

5 - Ditched tent pad____ / ____

6 - Excavated tent pad____ / ____

7 - Hitchrail____ / ____

8 - Corral____ / ____

9 - Toilet____ / ____

10 - Meat rack____ / ____

11 - Poles____ / ____

12 - Other_____

(12) COMMENTS/OTHER INFORMATION:_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

SITE MEASUREMENT DATA 1993 Edition

Site #:_____ Date:_____ Inventoried by:_____

MAIN CAMP AREA -

Barren area estimate
Length - # of paces_____ x your pace length_____ = length in feet_____
Width - # of paces_____ x your pace length_____ = width in feet_____
Length_____ x Width_____ = Barren area estimate_____sq. ft.

ASSOCIATED STOCK HOLDING/OTHER IMPACT AREA (#1) - (repeat same measurement steps used for Main Camp Area)

Barren area estimate
Length - # of paces_____ x your pace length_____ = length in feet_____
Width - # of paces_____ x your pace length_____ = width in feet_____
Length_____ x Width_____ = Barren area estimate_____sq. ft.

ASSOCIATED STOCK HOLDING/OTHER IMPACT AREA (#2) - (repeat same measurement steps used for Main Camp Area)

Barren area estimate
Length - # of paces_____ x your pace length_____ = length in feet_____
Width - # of paces_____ x your pace length_____ = width in feet_____
Length_____ x Width_____ = Barren area estimate_____sq. ft.

ASSOCIATED STOCK HOLDING/OTHER IMPACT AREA (#3) - (repeat same measurement steps used for Main Camp Area)

Barren area estimate
Length - # of paces_____ x your pace length_____ = length in feet_____
Width - # of paces_____ x your pace length_____ = width in feet_____
Length_____ x Width_____ = Barren area estimate_____sq. ft.

ASSOCIATED STOCK HOLDING/OTHER IMPACT AREA (#4) - (repeat same measurement steps used for Main Camp Area)

Barren area estimate
Length - # of paces_____ x your pace length_____ = length in feet_____
Width - # of paces_____ x your pace length_____ = width in feet_____
Length_____ x Width_____ = Barren area estimate_____sq. ft.

ASSOCIATED STOCK HOLDING/OTHER IMPACT AREA (#5) - (repeat same measurement steps used for Main Camp Area)

Barren area estimate
Length - # of paces_____ x your pace length_____ = length in feet_____
Width - # of paces_____ x your pace length_____ = width in feet_____
Length_____ x Width_____ = Barren area estimate_____sq. ft.

ASSOCIATED STOCK HOLDING/OTHER IMPACT AREA (#6) - (repeat same measurement steps used for Main Camp Area)

Barren area estimate
Length - # of paces_____ x your pace length_____ = length in feet_____
Width - # of paces_____ x your pace length_____ = width in feet_____
Length_____ x Width_____ = Barren area estimate_____sq. ft.

ASSOCIATED STOCK HOLDING/OTHER IMPACT AREA (#7) - (repeat same measurement steps used for Main Camp Area)

Barren area estimate
Length - # of paces_____ x your pace length_____ = length in feet_____
Width - # of paces_____ x your pace length_____ = width in feet_____
Length_____ x Width_____ = Barren area estimate_____sq. ft.

TOTAL BARREN AREA ESTIMATES_____SQ. FT. (use this figure for #22 on Pg. 3)

Selway-Bitterroot Wilderness - Site Impacts Worksheet (SIW)

1993 Edition

		ON-SITE			ON UNUSED COMPARATIVE AREA		
(13)	VEGETATION COVER: (Be sure to compare similar areas, same species, slope, rockiness, and canopy cover)	1 - 0-5%	3 - 26-50%	5 - 76-100%	1 - 0-5%	3 - 26-50%	5 - 76-100%
		2 - 6-25%	4 - 51-75%		2 - 6-25%	4 - 51-75%	
(14)	MINERAL SOIL EXPOSURE: (% of area that is bare mineral soil)	1 - 0-5%	3 - 26-50%	5 - 76-100%	1 - 0-5%	3 - 26-50%	5 - 76-100%
		2 - 6-25%	4 - 51-75%		2 - 6-25%	4 - 51-75%	

	Rating (circle one category) 1	2	3	(do in office) rating x weight
(15) VEGETATION LOSS:	no difference in coverage	difference one coverage class	difference >1 coverage class	x 2 =
(16) MINERAL SOIL INCREASE:	no difference in coverage	difference 1 coverage class	difference >1 coverage class	x 3 =
(17) TREE DAMAGE: # of damaged trees ___	no more than broken lower branches	1-25 damaged trees or damaged trees > 25% of total # of trees on site	> 25 damaged trees or damaged trees > 50% of total # of trees on site	x 3 =
(18) ROOT EXPOSURE: # of trees with exposed roots ___	none	1-15 trees with roots exposed, or >25% of total trees on site	>15 trees with roots exposed, or >50% of total trees on site	x 3 =
(19) DEVELOPMENT: (exclude fire rings)	no facilities	primitive log or rock seat	facilities other than primitive seat	x 1 =
(20) CLEANLINESS: no. of fire scars/rings ___ human waste Y / N manure Y / N trash Y / N	no fire scars or rings	1 fire scar/ring, some trash or manure	> 1 fire scar/ring, or human waste, or much trash or manure	x 1 =
(21) SOCIAL TRAILS: no. of trails ___	no more than 1 discernible	2-3 discernible, max. 1 well-worn	>3 discernible or >1 well-worn	x 2 =
(22) BARREN AREA ESTIMATE: _____ (ft^2)	<50 ft^2	50 - 1,500 ft^2	>1,500 ft^2	x 3 =
			IMPACT INDEX	SUM

18-27=Light 28-36=Moderate 37-45=Heavy 46-54=Extreme

SITE SKETCH AND PHOTO DATA 1993 Edition

Site #_____ Date:_____ Inventoried by:_____

Roll number_____ Sequence on roll_____

Draw a schematic of the site layout. Include and label the main camp area, associated stock holding areas, distinguishable natural features (large boulders, lake shores, streams, distinctive trees, etc), system trails and social trails. Indicate locations of photos taken by using an arrow showing the direction of sight and the frame number on the roll (see key below). Indicate north with an arrow.

key to symbols

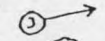


photo point


tree


stream

. . . . . social/non-system trail

_ _ 211 _ _ system trail

In office -

Code-a-Site done? (year)_____ Code-a-Site impact level_____

Site impact worksheet done previously? (year)_____ Site impact score_____ Impact level_____

APPENDIX B

Form used to collect vegetation data

Date ____ Tw. ____ Impact level ____ Ist. Bearing ____

Topo ____ Rn. ____ Elevation ____ Fire/Horse

Site # ____ Sec. ____ Bearing from Fire/horse ____ Comments

TRAN	Quad	1	2	3	4	5	6
	B. Gr.						
	Moss						
	Forbs						
L	Grass						
1	Litter						
	Rock						
	Tree						
	Den.						
	Cov.						
	Freq						
L	Brd						
2	Con.						
	Total						
L	Brd.						
3	Con.						
	Total						

TRAN	Quad	1	2	3	4	5	6
	B. Gr.						
	Moss						
	Forbs						
L	Grass						
1	Litter						
	Rock						
	Tree						
	Den.						
	Cov.						
	Freq						
L	Brd						
2	Con.						
	Total						
L	Brd.						
3	Con.						
	Total						

TRAN	Quad	1	2	3	4	5	6
	B. Gr.						
	Moss						
	Forbs						
L	Grass						
1	Litter						
	Rock						
	Tree						
	Den.						
	Cov.						
	Freq						
L	Brd						
2	Con.						
	Total						
L	Brd.						
3	Con.						
	Total						

TRAN	Quad	1	2	3	4	5	6
	B. Gr.						
	Moss						
	Forbs						
L	Grass						
1	Litter						
	Rock						
	Tree						
	Den.						
	Cov.						
	Freq						
L	Brd						
2	Con.						
	Total						
L	Brd.						
3	Con.						
	Total						