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INFORMATION SOURCES, WILLINGNESS TO VOLUNTEER, AND
ATTITUDES TOWARDS INVASIVE PLANTS IN THE SOUTHWESTERN
UNITED STATES

by

Leith Seeley Tidwell

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Forestry

UTAH STATE UNIVERSITY
Logan, Utah

2005

ABSTRACT

Information Sources, Willingness to Volunteer, and Attitudes
Towards Invasive Plants in the Southwestern United States

by

Leith S. Tidwell, Master of Science

Utah State University, 2005

Major Professor: Dr. Mark W. Brunson
Department: Forestry, Rangeland and Watershed Science

This thesis examines results of a survey conducted in the Southwestern United States focusing on attitudes towards invasive plants, public preferences for information sources and willingness to volunteer in invasive plant management. This research demonstrates that the public is interested in the problem and control of invasive plants. In a broad context there is agreement among respondents that invasive plants pose a threat to the environment and control efforts, including the use of herbicides, should be allowed to occur. Given the differences between general and specific attitudes towards invasive plants, it is suggested education and awareness programs be designed to fit specific rather than general attitudes. The interested public reflected in this research desires more information about invasive plant species and their control, and prefers to receive it through brochures and pamphlets. The study revealed a small subsection of the overall population that was capable and

willing to assist in volunteer efforts existing in the Western United States. Recreation, farm and grassroots environmental organizations are recommended as being potential sources of volunteers and participants in invasive plant control.

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Leith S. Tidwell

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CHAPTER 1

INTRODUCTION

The increasing occurrence and establishment of invasive plants has a tremendous effect on both the human and natural worlds. These biological invasions threaten biodiversity, resource availability, and worldwide economies (Vitousek et al. 1996). Invasive plants have been proven to reduce forage for both wild and domestic animals, alter ecosystem function and cause greater erosion through soil modification (Asher and Harmon 1995).

Every year one-quarter of the United States agricultural gross domestic product is estimated to be lost to the impact and cost of controlling of invasive plants (Simberloff 1996). This economic impact is estimated to be \$33 billion in agricultural losses and nearly \$1 billion in forest and rangeland forage (Pimental et al. 2000). To help reduce the effects of this growing problem, integrated weed management strategies of early control and prevention, in particular education programs are needed to increase awareness and volunteer participation to aid in control efforts. This thesis provides professionals and researchers with background information on public attitudes and knowledge which can be used to direct and create and broaden education and volunteer programs.

Weeds are defined as any plant growing to the detriment of a crop or to the disfigurement of a place (Merriam-Webster 2004). Simply, weeds are plants interfering with management objectives for a given area at a given time (J.M. Torell

from Whitson 2000). This definition includes situations as diverse as dandelions in the front lawn of a suburban home or leafy spurge incursions on ranchland.

The ecological niche principle states that no two species can occupy the same area and provide a similar function in an ecosystem at the same time, meaning no two species can, in a similar timeframe, obtain resources in a similar manner (Whitaker 1965). As a result species differentiate and specialize in differing ways to compete for scarce resources. A plant, for example, may grow larger leaves to shade out competing plants that grow beneath it. This specialization of ecosystem use and function allows many species to coexist within similar ecosystems. Invasive plants have the ability to affect ecosystems through their ability to out-compete, resulting in native plants being pushed out of their ecological niche.

The spread of invasive plants in an ecosystem is analogous to the expansion of wildfires (Dewey et al. 1995). Wildfires spread outward from "ignition points" with an exponentially expanding perimeter as wind and topography allow. Blown embers and sparks create hotspots outside a fire's perimeter that eventually begin to merge with the main fire body. Much like seeds can remain dormant in the soil for years, fire can smolder beneath the surface for an indefinite amount of time causing frequent flare-ups. Single plants or plant communities act as "ignition points" for invasions spreading outward depending on wind and topography. Seeds are often carried great distances by humans or animals creating hotspots for future infestations.

The weeds currently infesting the Southwestern United States originated in Europe and Central Asia. In their native ecosystems these plants pose few problems because they have evolved and specialized in certain ways under the pressure of

predators, other plants species, fungus, etc., all of which help to keep them in check (Sheley and Petroff 1999). These plants have the potential to thrive when introduced to new areas as these habitats lack the natural predators with which they coevolved.

Arizona, New Mexico, Utah and Colorado contain some of the most biologically distinctive and aesthetically pleasing landscapes in North America. This area, defined ecologically by the Colorado Plateau, and the Chihuahuan and Sonoran Deserts, has widespread plant invasions but has yet to be altered on a widespread basis. Although invasive plants are widespread in the region, the infestations which do exist are still found on a smaller scale, meaning these plants can be found on numerous sites occupying little area. This small infestation scale creates an excellent opportunity to eradicate existing invasive plant sites and increase the prevention of their spread.

To help raise awareness and understanding of this growing problem comprehensive outreach and education programs are needed. These programs fill a difficult role in helping to influence public perception and behavior towards natural resources and their management. The traditional approach of education and outreach programs has been through increasing knowledge levels with the assumption that better informed individuals will begin to exhibit more pro-management behavior and begin to make more "appropriate" decisions (Peyton and Decker 1987). This assumption follows from the theory of cognitive consistency, which states that individuals over the long term will tend to behave in a manner consistent with their knowledge levels (Heberlein and Black 1981). Therefore if you can increase an

individual's level of knowledge you can begin to enact desired changes in behavior and thus help to create and develop support for management decisions.

Education and outreach programs, however, are often developed without a careful understanding and consideration of the attitudes and knowledge levels of the target audience. Identification of receptive audiences along with an understanding of their attitudes and knowledge can provide direction in the creation of more effective programs (Sheley et al. 1996). This research provided a portion of the social data and analysis necessary for the development of extension programs dedicated to increasing public awareness and community involvement in management efforts.

Land managers frequently report that conflicts involving people and the environment are the hardest to comprehend and manage (Decker and Chase 1997). Since its inception, natural resource management has been dominated by physical and biological expertise; however, resource management has broadened its views to include an allowance for public attitudes and behaviors as part of the management equation (Manfredo 1989). The acceptance of policies and programs by interested publics is now an essential consideration in the decision-making process. Recognizing this need to involve the public in management, resource professionals have begun to develop systems to assess social and economic impacts in much the same way they do biological impacts. These processes involve the application of social science principles to current natural resource situations in the attempt to better inform professionals about the public acceptability of management actions. Social science data can help to identify types of people who are likely to support and participate in management programs as well as provide an understanding of the belief

structures underlying the attitudes people hold towards resources and their management.

Public awareness of invasive plants in the desert Southwest is believed to be relatively low. Institutional infrastructure for the management of these plants is also considered weak, due at least in part to the small infestation scale. The inherent difficulty within this "catch-22" of small infestation and low awareness lies in the fact that the best time to eradicate specific plant species is when the infestation is small but by the time public concern has grown to a level demanding the allocation of resources the problem has often grown out of control.

Research dealing with public attitudes towards invasive plants is quite limited. Most of the studies that have been conducted are limited in scope or geographic scale. Perceptions and knowledge of leafy spurge (*Euphorbia esula*) by land managers, decision-makers and ranchers were researched as part of TEAM Leafy Spurge, a research program designed to evaluate economic impacts of leafy spurge in North Dakota (Sell et al. 1998). Sheley et al. (1996) surveyed Montana residents for their knowledge level, attitudes towards invasive plants and preferred sources of information. Finally, visitors to the Bodega Marine Laboratory in Northern California were surveyed to determine their knowledge of weed species, origins of invasive plants and the impacts of invasive plants upon the environment (Colton and Alpert 1998).

Sell et al. (1998) researched perceptions and knowledge of leafy spurge, a noxious, perennial weed which has become widely established, in North Dakota. Through its aggressive growth and unpalatability to cattle this plant can cause serious

economic damage to ranchers and landowners. In some cases land in the infested areas has decreased 80 to 90 percent in market value due to the presence of leafy spurge (Sell et al. 1998).

Local land managers and decision-makers on grazing and non-grazing lands were asked to evaluate the social, economic and managerial factors that helped to limit implementation of control strategies. This leafy spurge study revealed a majority of respondents were concerned about controlling invasive plants on rangelands and felt that leafy spurge was a long-term problem. In many cases a simple lack of knowledge kept managers and ranchers from using the most effective control method.

Sheley et al. (1996) surveyed Montana residents to determine the public knowledge level concerning invasive plants. Most respondents knew that invasive plants were a problem; most could name at least one problem weed species and at least one factor of weed spread. Associations were established between levels of knowledge and respondents who indicated participating in outdoor recreational activities.

In their survey of visitors to the University of California's Bodega Marine Laboratory, Colton and Alpert (1998) concluded that the general public has a low awareness of biological invasions. This was due to individuals not personally feeling the impacts of weeds, the lack of effective education programs informing people of the impacts and the public perception that the net ecological impacts of invasions were not as serious as reported.

This research details the diverse attitudes toward invasive plants held by residents of the Southwestern United States, their knowledge of invasive plants and

their willingness to take part in management efforts. The survey results will assist in identifying specific needs of Extension audiences as well as determine the most effective delivery methods. The information obtained from this research will, hopefully, be used to bridge the gap between management efforts and decisions and public sentiment.

This thesis is organized into three major parts. Chapter 2 involves an examination of the attitudes held by individuals towards invasive plants and their management. Since behavior supporting invasive plant management actions is dependant upon individual attitudes, an understanding of personal attitudes, control option acceptability and demographic characteristics can be used by resource managers to create and influence pro-environmental behavior.

Chapter 3 involves an exploration of public preferences for information delivery methods. In many cases information exists in a ready form but natural resource professionals are unsure or unaware of different information distribution methods. Data expanding on how and where the public likes to receive information can help resource professionals to better design, develop and deliver education programs.

Chapter 4 consists of an assessment of volunteerism and the management of invasive plants. Volunteer participation in management and restoration efforts can provide opportunities conducive to teaching pro-environmental behavior as well as providing an effective and cost-efficient means of accomplishing tasks. This section will elaborate on those individuals willing to take part in management efforts, preference for volunteer activities whether it be monitoring, control, restoration and

education, and will provide a profile of those individuals likely to support and take part in management.

The final chapter is brief summary placing this research into its proper frame and context. The results described will assist in filling the knowledge and information gap currently existing between management and interested publics.

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CHAPTER 2

PUBLIC ATTITUDES TOWARDS INVASIVE PLANTS AND INVASIVE PLANT MANAGEMENT

Abstract

The increasing occurrence and establishment of invasive plants has profoundly affected both the human and natural worlds. To raise awareness and help reduce the effects of invasive plants there is a critical need for education and outreach programs. This chapter describes results of a survey in the Southwestern United States on attitudes towards invasive plants and perceptions of management practices.

Respondents were concerned about controlling invasive plants and about environmental impacts of these species. There was broad agreement that invasive plants pose a threat to the environment and that control efforts, including the use of herbicides, should be allowed. Differences occurred where decisions about specific types of management action to be used were involved, with the greatest differences on the subject of chemical control usage. As general and specific attitudes towards invasive plants differ, educational and awareness programs should be designed to address specific rather than general attitudes.

Introduction

The increasing occurrence and establishment of invasive plants has profoundly impacted both the human and natural worlds. These biological invasions threaten biodiversity, ecosystem health and worldwide economies (Vitousek et al.

1996). Invasive plants have been proven to reduce forage for both wild and domestic animals, alter ecosystem function and cause erosion through soil modification (Asher and Hermon 1995). Every year it is estimated that one-quarter of the U.S. gross agricultural domestic product is lost to the impact and cost of controlling invasive plants (Simberloff 1996). The value of this impact is estimated to be \$33 billion in agricultural losses and \$1 billion in lost forage (Pimental et al. 2000). Economic studies have indicated that in 2000 the total annual impact of all non-indigenous species in the United States was \$137 billion dollars (Pimental et al. 2000).

Definitions of invasive plants, or weeds, are as diverse as the species they represent. Weeds are said to be plants, without economic value, which interfere with activities and grow to the detriment of a place (Baker 1974), and that become dominant in native floras and plant systems (Reichard 2001). From the numerous definitions it can be established that weeds are plant species without economic value interfering with management objectives at a given place and time (J.M. Torell from Whitson 2000).

Most of the weeds currently infesting the Southwestern United States are European or Central Asian in origin. In their native ecosystems these species posed few problems because of their specialization under the pressure of native predators (Sheley and Petroff 1999). Introduced to new habitats in North America, these plants thrive due to lack of competition and predators slowing their growth. These plants displace native species in their natural habitats creating monocultures where no other plant species can survive. For example in Northern and Central California, Yellow Star Thistle (*Centaurea solstitialis*), an introduced poisonous plant from Eurasia, has

infested over four million hectares of pastureland resulting in an almost total loss of productivity (Campbell 1994).

The integrated weed management principles of prevention and early control of infestations are the key to slowing weed spread. In order to raise awareness and help reduce the effects of invasive plants there is a critical need for education and outreach programs detailing the problem. Natural resource agencies and professionals, under increasing budgetary pressures, often lack the resources to create and maintain effective control and prevention programs. The benefits of educational programs involve increasing awareness and knowledge among the general public in the hope that interested individuals can provide the attention and effort needed to effectively prevent the spread of infestations. These outreach programs fill a difficult role in helping to influence public perception and behavior toward natural resources and their management.

A traditional assumption of natural resource education programs has been that increases in knowledge levels will lead an informed individual to exhibit pro-management behavior and thus make more environmentally appropriate decisions (Peyton and Decker 1987). This follows from the theory of cognitive consistency, suggesting that individuals, over the long term, will behave in a manner consistent with their knowledge levels and beliefs (Heberlein and Black 1981). Through increasing individual knowledge, management can enact changes in behavior, thus helping to create support for management decisions. The narrow focus by professionals on knowledge levels, however, has limited the amount of behavioral

change that could be derived from altering the other components associated with the formation of attitudes, including emotional responses and core values.

Education and awareness programs concerning invasive plants are often developed with an incomplete understanding of the attitudes and beliefs of their intended audiences. Target audience identification along with knowledge of their attitude and belief structures can provide direction in the creation of more effective outreach programs (Sheley et al. 1996). This chapter examines results of a survey conducted in the Southwestern United States focusing on attitudes towards invasive plants and perceptions of management practices and their application. Since behavior is dependant upon individual attitudes, an understanding of personal attitudes, acceptability of control option usage in given situations and demographic characteristics as predictors of attitude can be used by natural resource managers to create support and influence desired pro-management behavior. Information from this study will be used to help design and implement education and community-based outreach programs concerning invasive plants.

Background

Social psychology theory states that individual behavior is determined by a combination of attitudes, beliefs, knowledge and values. This theory holds that individuals will act or react in a given manner towards an object based upon past experience and interactions. Patterns of behavior are dependant upon an underlying pattern of attitudes and beliefs, themselves the result of the evaluation of an object (Fishbein and Ajzen 1975). Attitudes arise from the interchange between fact-based,

logical knowledge of an object, feelings towards the object, and the relationship of the object to an individual's core values creating the standard we use in the assessment of an attitude object. It is this standard which forms the "building blocks" of attitude positions and behavior (Manfredo et al. 1995). To understand and influence a reaction towards an object, knowledge of specific attitudes and beliefs reflecting these "building blocks" along with an understanding of the overall belief structure is required (Donnelly and Vaske 1995). Understanding an individuals attitudes' and their formation allows one to link educational messages to those areas where a person may already possess a high empathy for a subject, thereby increasing concern and creating more pro-environmental and management behavior.

Attitudes towards an object, however, are frequently inconsistent with exhibited behavior. Although attitudes indicate a general predisposition to act in a given manner in a given situation, they do not automatically determine the performance of a specific behavior in all situations. Evaluation of an object results in the creation of a set of behavioral intentions, essentially how an individual will act in situations when confronted with a particular object. This set of intentions is a key factor in the determination of the extent and tone of an attitude. Each behavioral intention is related to a specific attitude object which is reflected in the pattern of behavior towards an object (Fishbein and Ajzen 1975). Often when confronted with an object in a specific setting these behavioral intentions will adapt to the current situation and exhibited behavior that is inconsistent with held attitudes may be displayed. These circumstances arise out of a concept known as integrative complexity (Eagly 1998).

Complexity is the idea that overall attitudes and resultant behavior are not determined by a single general attitude toward an object but are determined by the interplay between many specific attitudes and beliefs during the evaluation of that object (Eagly 1998). The concept of complexity acknowledges that an individual's exhibited behavior will be the result of interplay between related attitudes and situational factors. Attitudes are not held within a vacuum and are often subject to the influence of multiple factors, knowledge of which can better help professionals understand attitude formation (Nicholson 2000). Research has shown that the public favors environmental protection, especially when the impact upon their lives is a positive one (Shindler and Shelby 1993). Even though the individuals support environmental protection those beliefs are not held in isolation with private property rights, economic growth and the pursuit of wealth often influencing the creation of attitudes (Dunlap and Van Liere 1984). An example, in the case of invasive plants, is a favorable attitude towards control efforts in general but a negative attitude toward herbicide usage as an option.

Specific attitudes that have been measured with respect to particular interest behaviors have been shown to better predict behavior (Vining and Ebreo 1990). Cognitive, social-psychological research has given numerous descriptions of how motives are related to behavior and has helped to provide an understanding of motives and how they can be used to encourage environmentally responsible behavior (De Young 1986, Vining and Ebreo 1989). Intrinsic values like a conservation ethic (Simmons and Widmer 1990), community involvement (DeYoung 1986), and

adherence to norms (Vining and Ebreo 1989) have been found to be positively related to environmentally beneficial behaviors.

Although research examining specific invasive plant attitudes is limited, studies on related subjects can provide insight into how the public forms attitudes toward environmental issues. The traditional approach in environmental attitude research has been to use knowledge levels and socio-demographic characteristics to explain origins of attitudes (Steel et al. 1990, 1994, Van Liere and Dunlap 1981). Demographic characteristics, while not fully explaining why individuals hold pro-environmental behavior, do provide a glimpse into which types of individuals will support management actions. Jones and Dunlap (1992) found that those exhibiting pro-environmental behavior were generally younger, highly educated, relatively wealthy professionals living in urban environments. The general feeling, however, in the literature is that associations between pro-environmental behavior, i.e. behavior designed to protect the environment (Manzo and Weinstein 1987) and demographic variables tend to be weak and inconsistent from study to study (Van Liere and Dunlap 1991).

In their study of attitudes towards forest herbicide usage among Canadian and U.S. citizens, Buse et al. (1995) found a high level of unacceptability towards chemical control usage. The differences in views toward herbicide use tended to be based upon individual assessments of the risks posed to the environment, with the focus being the cumulative effects of the use of chemicals. This research demonstrated that the public possessed, at most, a limited knowledge of the impacts of herbicides but still hold a mostly negative attitude toward chemical usage. Since

science cannot offer a credible assessment of the risks involved with herbicides, individual values and beliefs often play more of a role in attitude formation than scientific knowledge. This finding is consistent with other environmental issues where the public is concerned. Unfortunately, research has shown that even if the public can be convinced that their information is inaccurate or incomplete there are no guarantees that they will then support management actions (Mater 1977).

Steel et al. (1990), in their examination of the perceptions of risk in the Great Lakes Region of the United States, found that those who possessed more education were more likely to assign higher risk estimates to natural resource issues than the general public. This study demonstrated that individuals with a greater amount of relevant knowledge were less likely to perceive risks showing a stronger link between beliefs and perceptions of environmental risks than beliefs and knowledge levels. Risk perception is important to note here because individuals forming attitudes towards invasive plants will often weigh the perceived risks of controlling infestations with the perceived impacts of those plants on the environment. The dilemma involved in this decision would be easier to understand and quantify if it was simply a rational cost-benefit analysis derived from environmentally conscious behavior. When confronted with an object, individuals will evaluate not only the attributes of that object but also those attributes in relation to other related objects. Thus as individuals are confronted with the dilemma of invasive plant control versus environmental protection their attitudes will begin to be shaped by and linked to more general environmental and economic attitudes.

Nicholson (2000), in a study similar to this research, studied wetland attitudes and conservation among various stakeholder groups in Northern Utah. Researching county leaders, hunters, residents and Sierra Club members, they found that overall each stakeholder group was supportive of wetland preservation and held a positive view of wetlands in the State of Utah. The study found general wetland attitudes were strong predictors of specific wetland attitudes. This research into wetland attitudes also found general environmental attitudes and association with a particular stakeholder group were also strong predictors of wetland attitudes.

Research detailing public attitudes towards invasive plants is quite limited. Most of the previously conducted studies are limited in their scope or geographic scale. Perceptions and knowledge of leafy spurge (*Euphorbia esula*) by land managers, decision-makers and ranchers were studied as part of TEAM Leafy Spurge, a research program designed to evaluate economic impacts of leafy spurge in North Dakota (Sell et al. 1998). Sheley et al. (1996) surveyed Montana residents for their knowledge level, attitudes towards invasive plants and preferred sources of information. Finally, visitors to the Bodega Marine Laboratory in Northern California were surveyed to determine their knowledge of weed species, origins of invasive plants and the impacts of invasive plants upon the environment (Colton and Alpert 1998).

Sell et al. (1998) researched perceptions and knowledge of leafy spurge (*Euphorbia esula*), a noxious, perennial weed which has become widely established in the Northern Great Plains. Through its aggressive growth and unpalatability to cattle, this plant can cause serious economic damage to ranchers and landowners. In

some cases infested land has decreased eighty to ninety percent in market value due to the presence of leafy spurge (Sell et al. 1998).

Local land managers and decision-makers on grazing and non-grazing lands were surveyed to evaluate the social, economic and managerial factors that helped to limit implementation of control strategies. This study revealed that a majority of respondents were concerned about controlling invasive plants on rangelands and felt that leafy spurge was a long-term problem. Public land managers of non-grazing areas, however, did not agree that rangeland weeds posed a threat to all ranchers and also felt that state and local governments were doing enough to combat weeds. In many cases a simple lack of knowledge kept managers and ranchers from using the most effective control method.

In order to develop a statewide noxious weed awareness program, Sheley et al. (1996) surveyed Montana residents to determine the public knowledge level concerning invasive plants. Most respondents knew that invasive plants were a problem; most could name at least one problem weed species and at least one factor of weed spread. The most mentioned impact of invasive plants by respondents was the reduction of biodiversity in the environment. The majority of respondents, also, did not perceive themselves as being actively involved in the spread of noxious weeds. Associations were established in this study between levels of knowledge and respondents who participated in outdoor recreational activities.

In their survey of visitors to the University of California's Bodega Marine Laboratory, Colton and Alpert (1998) concluded that the general public has a low awareness of biological invasions. This was attributed to individuals not personally

feeling the impacts of weeds, the lack of effective education programs informing people of the impacts and the public perception that the net ecological impacts of invasions were not as serious as reported.

Methods

Study Area

The study area for this research included eleven counties in the Southwestern United States. These study sites were selected as part of the Southwest Rangeland Invasive Plant Initiative, a low-cost, community-based approach to invasive plant management. These areas were: Kane\Garfield and Iron counties in Utah, La Plata County in Colorado; Yavapai, Coconino and Graham\Greenlee\Cochise counties in Arizona, and Grant and Colfax counties in New Mexico.

Methodology

Social data was gathered using a mail-back survey following Dillman's (2000) recommendations for effective survey research (Appendix A). An initial survey mailing followed by a reminder postcard was sent to all addresses. A second survey was sent approximately two weeks later to those who had not responded to the first mailing. To gather data representative of the general public a random sample of 2,700 households with a listed telephone number was obtained from a survey research firm (Survey Sampling, Inc, Fairfield, CT).

The study areas were sampled using cluster area random sampling, meaning the overall population is divided into segments based upon geographic location.

Specifically, this study utilized two-stage cluster sampling whereby counties in the geographic area were randomly selected and a random sample from each county was taken. Probability proportionate to size sampling in which the probability of selecting a resident in a given county varied inversely with the size of the cluster was used to better represent the county areas. This meant the random samples taken from each county varied according to the overall population within the county or county group. Cluster area random sampling treats each cluster as the sampling unit, i.e. part of a larger population group, if the clusters are considered heterogeneous within the cluster and homogenous between clusters in initial analysis. For analytical purposes the results from the study areas or clusters were combined to create an overall sample population group following guidelines suggested by Kish (1965).

Of the 2,700 mailed questionnaires, 630 usable surveys were returned. In the predominately rural counties within which this study was conducted there exists an inherent problem in sampling these areas. The method used to create the initial random sample utilized telephone listings, the most reliable frequently updated source, as the source for discovering the address of a chosen survey recipient. This method for selecting a random sample has an inherent problem in that in some cases, particularly rural areas, there are delivery problems where no street addresses are provided with the telephone numbers. Also, since telephone numbers are updated annually there is always a percentage of recipients who have moved and whose surveys are not forwardable. To overcome this sampling issue in the calculation of survey response rates 15% of surveys were estimated to be undeliverable based upon previous experience and literature review. Response rates ranged from a high of

34.9% for Iron County, UT to 18.3% for Colfax County, NM with an overall response rate of 27.2 % (Table 2.1).

The research instrument consisted of statements and questions regarding knowledge of plant ecology and effects, attitudes towards various control methods and their usage, and willingness to participate in community efforts. Demographic characteristics such as age, education, land ownership, income, income from agriculture and type of residence were also obtained. The data were then analyzed using SPSS statistical software (Norusis 1990) at Utah State University.

There are two major subheadings for the attitude data from this research: (1) attitudes towards invasive plants and (2) attitudes towards invasive plant management practices and their usage. Those sections focusing on general attitudes towards invasive plants included statements involving how much the respondent had thought and how much concern they possessed about invasive plants, whether priority should be given to the environment or the economy, and how large a problem they felt invasive plants were in their county and state. This section also included a series of attitude statements dealing with general invasive plant attitudes and specific areas of concern for the impacts of invasive plants along with trade-off questions which are useful in determining specific invasive plant attitudes.

The section evaluating invasive plant management, each of the control methods was defined: “**Chemical controls:** Using herbicides to help contain and control problem plants”; “**Mechanical Control:** Using methods such as tilling, hand-

Table 2.1: Response Rates

Study Area	Original Sample Size	Estimated Undeliverable	Returned Surveys	Response Rate(Est.)
Iron County, UT	300	45	89	34.9
Kane\Garfield, UT	250	37	67	31.5
Yavapai County, AZ	450	67	110	28.7
Coconino County, AZ	400	60	89	26.2
Graham\Greenlee\ Cochise, AZ	450	67	101	26.4
Grant County, NM	300	45	50	19.6
Colfax County, NM	250	37	39	18.3
La Plata County, CO	300	45	79	31.0
Total*	2700	403	630	27.2

*6 usable surveys were returned without ID numbers

pulling, and mowing to physically remove all or part of the plant.”; “**Biological Control:** Using living organisms such as insects and plant diseases to contain and suppress invasive plants.”; “**Cultural Control:** Using livestock grazing, competition by native plants, and re-vegetation to help favor desirable native species.”

Respondents were then asked to indicate how acceptable they felt the use of each method would be in different land management scenarios. These management scenarios included multiple-use lands, national parks and wildlife refuges, lands adjacent to residential areas, and agricultural lands.

Given the complex nature of the topic of invasive plants and the numerous issues affecting them, it is important to look at multiple factors associated with invasive plants. These included issues as diverse as environmental concern and government regulation to better identify factors associated with positive or negative attitudes towards invasive plants and their control.

The variables were evaluated using chi square analysis between variables including knowledge of invasive plants, demographic characteristics, concern for the impact of invasive plants and geographic location to determine which factors played a role in invasive plant attitudes. Correlation analysis was also conducted to determine how related attitude factors interact as well as to evaluate how geographic location affects attitudes towards invasive plants.

Non-Response Bias

It is important to not only understand respondents’ attitudes towards invasive plants but to also understand if those attitudes are representative of the overall

population. In order to determine if a non-response bias, or a difference between respondents and non-respondents, exists, ten percent of the non-respondents were contacted for a follow-up telephone study (Appendix B). The format and length of the mail survey made it prohibitive to ask each question over the telephone. A smaller telephone survey was created focusing on the major attitude, acceptability and demographic questions. Comparisons of responses to the follow-up phone survey and the mail-back survey revealed no significant differences occurring between the two research groups.

Results

Profile of Respondents

The majority of respondents were male (Table 2.2). The instructions for this survey indicated that the adult whose birthday occurred earliest in the year was to fill out and return the survey booklet, partly in the hope that an equal distribution of males and females would be achieved. The predominance of males may be because of the listing of the name on the address label, or because of a cultural tendency for subjects like invasive plants and the outdoors to be considered a mostly male domain.

The average age of respondents was 56 years with a range from 20 to 90. Respondents reported having lived in their respective states for an average of 27 years and at their current addresses for 14 years. The majority of respondents possessed at least some college, a bachelors or graduate degree.

In describing their current residence, suburban homes were indicated most often followed by small rural settings, small farms, apartments, condos or town

Table 2.2: Demographic Characteristics of Respondents

Characteristic	Group	Percentage	n
Gender	Male	66%	392
	Female	34%	204
Age		56 years	584
Current Residence	Large Farm	1%	8
	Small Farm	5%	31
	Small Rural	29%	168
	Apartment	4%	22
	Condominium/Town home	2%	14
	Suburban Home w/ Yard	59%	346
Own Residence	Yes	90%	531
	No	10%	61
Level of Education	Did not complete high school	2%	14
	High School	13%	76
	Some College	37%	219
	Bachelors Degree	22%	133
	Graduate Degree	26%	154
Years at Residence		14 years	584
Years in Area		27 years	584
Agricultural Income	None	86%	508
	Less than ten percent	2%	9
	Between ten and fifty percent	9%	50
	More than fifty percent	2%	12
	One hundred percent	1%	9
Household Income	Less than \$20,000	15%	75
	\$20,000 to \$39,999	25%	127
	\$40,000 to \$59,999	29%	150
	\$60,000 to \$79,999	17%	85
	\$80,000 to \$99,999	6%	30
	\$100,000 and above	10%	49

Table 2.3: General Invasive Plant Attitudes

Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
Properly used herbicides pose no threat to the environment	15%	36%	39%	10%
I am concerned about controlling invasive plants	2%	4%	54%	40%
It seldom makes economic sense to control invasive plants	40%	50%	7%	3%
The government isn't doing enough to control invasive plants	5%	24%	52%	19%
It doesn't pay to control weeds on my land when my neighbor doesn't control them on his	12%	48%	28%	12%
Public funds should be invested in controlling invasive plants	6%	14%	61%	19%
It is better to pay for prevention now than to pay for control later	2%	3%	56%	40%
I should have the right to use chemicals on my own property whenever I believe it is best	17%	30%	36%	17%
Herbicide spraying should only be allowed if it is done by hand	17%	43%	32%	8%

homes and large farms. The majority of respondents reported earning in the range of \$20,000 to \$60,000 a year.

General Invasive Plant Attitudes

To help identify general attitudes towards certain aspects of invasive plants and their management, respondents were asked to indicate their level of agreement with nine attitude statements (Table 2.3). These statements covered subjects from control methods to concern for invasive plants and help to provide an overall profile of how the public feels about invasive plants. When asked to show their level of concern for the problem of invasive plants, the vast majority of respondents agreed with the statement "I am concerned about controlling invasive plants." Roughly equal numbers agreed and disagreed with the statement "Properly used herbicides pose no risk to the environment." The majority of respondents disagreed with the statement "It seldom makes economic sense to control invasive plants." Most felt the government wasn't doing enough to control invasive plants, that they should have the right to use chemicals on their own property and that public funds should be invested in controlling invasive plants. The majority of respondents agreed that it was better to pay for prevention now than to pay for control later and disagreed with the statement "It doesn't pay to control weeds on my land when my neighbor doesn't control them on theirs."

Asked how much they had thought about invasive plants prior to this survey, respondents replied none to a moderate amount of time. Respondents also indicated they felt invasive plants were a moderate to serious problem in their county.

Table 2.4: Concern for the Impacts of Invasive Plants

Impact	None	Low Concern	Moderate Concern	High Concern
Loss of native plants	4%	10%	32%	54%
Reduced crop values	8%	21%	37%	34%
Reduced wildlife habitat quality	3%	9%	32%	56%
Interference with recreation	11%	32%	38%	19%
Increased wildfire danger	3%	11%	26%	61%
Reduced livestock forage quality	8%	22%	37%	34%

In order to identify which potential impacts of invasive plants play a role in forming attitudes, respondents were asked to indicate how great a concern impacts were to them personally. Most respondents were at least moderately concerned with all impacts, with native plants, wildlife and wildfire possessing the highest levels of concern (Table 2.4).to locate themselves on a scale ranging from "Priority should be given to maintaining natural conditions even if it creates negative economic impacts" to "Economic considerations should be given priority even if it creates negative environmental impacts." The majority of respondents showed they felt the economy and the environment should be given equal priority. It is interesting to note that the percentages for those favoring natural conditions were greater than those for giving economic considerations priority (Table 2.5).

Controlling invasive plants often means focusing on one area at the expense of another. To help determine where individuals place the highest priority in invasive plants and their management, a series of tradeoff questions was developed (Table 2.6). Respondents felt invasive plants should not be controlled if it could negatively affect the environment, the government should increase efforts even if it meant higher taxes, and that control should be increased even if it meant increased regulation. They felt biological, cultural and mechanical controls should be used before chemicals even if control takes longer. They also felt the most appropriate control method should be used regardless of cost, and that safety should be more important than effectiveness in deciding which control method to use.

Table 2.5: Invasive Plant Attitude Scales

Invasive Plant Scale	Mean	n
^a On the following scale please rate how serious a problem you feel invasive plants are in Southern Utah.	2.9	571
^b Managing public lands often involves tradeoffs between natural conditions (wildlife, endangered species) and economic considerations (employment, economic growth). Please locate yourself on these issues.	2.7	592
^c Prior to this survey, how much had you <u>thought about</u> invasive plants in your area?	3.2	579

^aScale from 1=not a problem in my state to 4=a serious problem in my county

^bScale from 1=priority should be given to maintaining natural conditions even if it creates negative economic impacts, 3=the environment and the economy should be given equal priority, 5=economic considerations should be given priority even if it creates negative environmental impacts

^cScale from 1=none to 5=considerable amount of time

Table 2.6: Tradeoffs between Management Goals

Column A	Prefer Col. A	Neut.	Prefer Col. B	Column B
Invasive plants should be managed even if control efforts could negatively affect the environment.	24%	26%	50%	Invasive plants shouldn't be managed if control could negatively affect the environment.
The government should increase control efforts on public land even if it means higher taxes.	42%	25%	33%	I do not want the government to increase control efforts if it means higher taxes.
I favor increasing the control of invasive plants even if it means increased regulation.	51%	19%	30%	I do not favor increasing the control of invasive plants if it leads to increased regulation.
Biological, cultural, or mechanical control should be used before herbicides even if it takes a lot longer.	62%	20%	18%	It is always best to use the control option that works fastest.
The economic costs of control should be the most important factor in deciding which control method to use.	17%	30%	53%	The most appropriate control method should be used, regardless of cost.
Effectiveness should be the most important factor in deciding which control method to use	17%	22%	61%	Safety should be the most important factor in deciding which control method to use.

Acceptability of Control Option Usage

An important underlying concept in this research is an examination of the components of attitude formation towards invasive plants and how these components affect behaviors. Specifically, which objects and concepts interact to create attitudes with a research emphasis on how these general attitudes combined with situational factors to form specific invasive plant attitudes.

To help determine where individual support for management actions may lie, survey recipients were asked to rate how acceptable they felt usage of control options were in specific management scenarios (Table 2.7). These scenarios were formulated based upon the public perception of the level of human interference agencies should adhere to in a particular management area. These areas ranged from protected lands including national parks and monuments, multiple use lands including national forests and BLM lands, agricultural lands, and areas adjacent to residential areas.

Respondents in each scenario were more likely to find the use of mechanical and cultural controls at least moderately acceptable. They were also more likely to find chemical control usage to be at best slightly acceptable in each scenario. Even though the order of preference for specific control methods remained constant throughout the scenarios it is important to note that the spread of responses became greater as respondents moved from protected lands to lands adjacent to residential areas.

In order to identify characteristics affecting acceptability of management actions, responses to each scenario were compared with a variety of related factors using chi-square analysis ($\alpha=.05$). Respondents finding the use of a specific control

Table 2.7: Acceptability of Invasive Plant Management

Control Option Available	Not at all Acceptable	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
Protected Lands				
Chemical Control	34%	30%	24%	12%
Mechanical Controls	6%	15%	26%	53%
Biological Controls	10%	17%	29%	44%
Cultural Controls	5%	12%	24%	59%
Multiple Use Lands				
Chemical Control	19%	34%	33%	15%
Mechanical Controls	5%	12%	27%	56%
Biological Controls	9%	17%	31%	43%
Cultural Controls	2%	7%	26%	64%
Agricultural Lands				
Chemical Control	27%	32%	24%	17%
Mechanical Controls	2%	6%	24%	68%
Biological Controls	10%	16%	28%	46%
Cultural Controls	3%	8%	23%	66%
Residential Lands				
Chemical Control	30%	33%	26%	11%
Mechanical Controls	2%	6%	28%	64%
Biological Controls	12%	18%	31%	39%
Cultural Controls	4%	13%	27%	55%

option highly acceptable in a scenario were also likely to find the use of other control options in that scenario to be highly acceptable. Generally those finding a control option highly acceptable in a given situation were also more concerned about controlling invasive plants. Also those finding biological controls, in particular, to be highly acceptable were also more likely to be concerned about the overall impacts of invasive plants.

The greatest differences between respondents finding control methods highly acceptable versus not acceptable occurred in the question concerning chemical control usage on protected lands. Respondents finding chemical usage highly acceptable were more likely to agree with the statements "Properly used herbicides pose no threat to the environment" ($\chi^2=199$), and "I should have the right to use chemicals on my own property whenever I believe it is best" ($\chi^2=138.3$). They disagreed with the statement "Herbicide spraying should be allowed only if it is done by hand" ($\chi^2=87.1$) and felt invasive plants should be controlled even if it negatively affected the environment ($\chi^2=116.2$), and that effectiveness should be the determining factor in the choice of a control option ($\chi^2=75.5$).

Respondents finding chemical control use on protected lands unacceptable were more likely to disagree with the statements "Properly used herbicides pose no threat to the environment" ($\chi^2=199$), and "I should have the right to use chemicals on my own property whenever I believe it is best" ($\chi^2=138.3$). They also preferred increasing control even if it meant more regulation ($\chi^2=21.3$), that safety should be the most important factor in deciding on a control option ($\chi^2=75.5$) and biological, mechanical, and cultural control should be used before chemical control ($\chi^2=167.6$).

It is necessary to note that as the questions referred to lands receiving lower levels of environmental protection, there were fewer differences between respondents finding control options acceptable and not acceptable. As a general rule the greatest differences existed where chemical controls were concerned and the fewest with biological and cultural controls. The results indicate chemical control usage can be acceptable but only in areas where the public perceives the environment needs less protection. Biological, cultural and mechanical controls were acceptable in all four scenarios. In fact, in certain situations only a negligible number of respondents found them to be not acceptable.

Correlation analysis was conducted to determine the strength of relationships between acceptability levels within the different scenarios (Table 2.8). Strong relationships were found to exist between chemical control responses on the protected, multiple use and residential areas. Biological acceptance was correlated between the protected, multiple use and residential area scenarios. Mechanical control use acceptability was correlated for all areas except agricultural lands and strong correlations were found for cultural control acceptance for all scenarios except protected lands. Also, a strong relationship was found between the statement "Properly used herbicides pose no threat to the environment" and the acceptability of chemical control option usage on agricultural land.

Factors Associated with Invasive Plant Attitudes

Responses to a series of attitude statements based upon Likert-type scales were compared to a set of related variables using chi-square analysis to identify

Table 2.8: Correlation Analysis and Acceptability of Invasive Plant Management

Scenario	Protected Lands	Multiple Use Lands	Resident. Lands	Agricult. Lands
Chemical Control				
Protected Lands	---	.81	.68	.65
Multiple-Use Lands	.81	---	.72	.66
Residential Lands	.68	.72	---	.69
Agricultural Lands	.65	.66	.69	---
Mechanical Control				
Protected Lands	---	.78	---	.54
Multiple-Use Lands	.78	---	.63	---
Residential Lands	---	.63	---	---
Agricultural Lands	.54	---	---	---
Biological Control				
Protected Lands	---	.83	.79	.76
Multiple-Use Lands	.83	---	.77	.74
Residential Lands	.79	.77	---	.81
Agricultural Lands	.76	.74	.81	---
Cultural Control				
Protected Lands	---	---	.59	.53
Multiple-Use Lands	---	---	---	.61
Residential Lands	.59	---	---	.59
Agricultural Lands	.53	.61	.59	---

factors associated with specific invasive plant attitudes. This Likert-type system measures the amount of agreement a respondent has with certain statements designed to measure the strength of the individual's attitudes.

Respondents agreeing strongly with the statement 'I am concerned with controlling invasive plants' were more likely to have high concern for crop values ($\chi^2=38.9$), recreation ($\chi^2=35.8$), wildlife ($\chi^2=83.8$), wildfire ($\chi^2=23.2$), and native plants ($\chi^2=144.9$). They were more likely to feel the government should do more to control invasive plants even if it meant higher taxes ($\chi^2=18.1$), and that invasive plants should be managed even if efforts could negatively affect the environment ($\chi^2=23.7$).

The statement with the greatest differences between those strongly agreeing and strongly disagreeing was "I should have the right to use chemicals on my own property whenever I believe it is best." Those respondents strongly disagreeing were more likely to have high concern for native plants ($\chi^2=28.9$) and wildlife ($\chi^2=21.6$) than other respondents but did not differ in their concern levels for other weed impacts.

Respondents strongly disagreeing were more likely to feel invasive plants shouldn't be managed if control could negatively affect the environment ($\chi^2=36.3$), and favored increasing control efforts even if it meant increased regulation ($\chi^2=54.8$). Respondents who strongly disagreed felt biological, mechanical and cultural control should be used before herbicides even if control took a lot longer ($\chi^2=73.8$) and that safety should be the most important factor in choosing a control option to use ($\chi^2=64.1$).

Respondents strongly agreeing with the statement "I should have the right to use chemicals on my own property whenever I believe it is best" were more likely to have high concern for forage ($\chi^2=21.6$). They were also more likely to feel invasive plants should be managed even if control could negatively affect the environment ($\chi^2=36.3$), to favor using the control option that worked the fastest ($\chi^2=73.8$), and that effectiveness should be the most important factor in deciding which control method to use ($\chi^2=64.1$). They were also less likely to favor increasing the control of invasive plants if it leads to increased regulation ($\chi^2=54.8$).

The statement "Properly used herbicides pose no threat to the environment" also contained noticeable differences between those strongly agreeing and those strongly disagreeing. Respondents strongly disagreeing were more likely to be concerned about native plants ($\chi^2=27.0$) and wildlife ($\chi^2=34.2$). They were more likely to favor biological, cultural and mechanical control over the use of herbicides ($\chi^2=106.9$) and felt safety should be the most important factor in deciding on a control option to use ($\chi^2=81.2$). Respondents strongly disagreeing also were more likely to favor increasing the control of invasive plants even if it meant increased regulation ($\chi^2=21.6$).

Respondents strongly agreeing with the statement "Properly used herbicides pose no threat to the environment" were more likely to have high concern for crop values ($\chi^2=23.6$) and to favor using the control method that worked fastest ($\chi^2=106.9$). They also were more likely to favor effectiveness as being the most important criterion when choosing a control method ($\chi^2=81.2$).

Demographic characteristics were not significant predictors of invasive plant attitudes. Small differences in ordinal and nominal level data were identified between geographic areas but were not found to be significant in analysis.

Discussion

This research demonstrates the public in selected Southwestern U.S. counties is interested in the problem and control of invasive plants. The general invasive plant attitudes measured indicate respondents are concerned about controlling invasive plants and about the impact these species have on the environment. In a broad context there is agreement among respondents that invasive plants pose a threat to the environment and control efforts, including the use of herbicides, should be allowed to occur.

There appears, however, to be differences between general and specific invasive plant attitudes. The results indicate individuals are utilizing attitudes related to, but not directly associated with, the problem and control of invasive plants. In particular it appears individuals may be transferring general attitudes towards the environment and their way of life to the subject of invasive plants. For example, respondents with an economic interest in the environment have a greater concern about the control of invasive plants regardless of the control method used, its impact, or the cost of the method. More specifically, these respondents may be transferring concerns they have about maintaining their livelihood and lifestyle to the problem of invasive plants rather than forming separate attitudes towards them. These respondents seem to be evaluating invasive plants through a prism of the effect

invasive plants will have on their economic and property interests rather than forming independent attitudes about the long term impacts of invasive plants and their control. Conversely, respondents favoring environmental protection appear to use related environmental attitudes as the basis for invasive plant attitudes instead of forming independent attitudes based upon their knowledge of invasive plants. These differences in attitude formation are best illustrated by examining the acceptability of the use of chemical control methods.

Through each management scenario certain patterns emerged in both the "highly acceptable" and "not acceptable" categories. Respondents with an economic interest in nature generally found the use of chemical control to be highly acceptable while those utilizing related environmental attitudes in formation generally found chemical use not acceptable. In the "highly acceptable" category respondents were more likely to have high concern for crop values and forage. Also, except in the multiple use land scenario, those finding chemical use highly acceptable were more likely to strongly disagree with the statement "It seldom makes economic sense to control invasive plants." They preferred "Invasive plants should be managed even if control efforts could negatively affect the environment" and felt that the control option that worked fastest and was the most effective should be used. The use of economic interest in attitude formation is also reflected in the correlation analysis conducted between acceptability variables. The only variable outside the various scenarios that possessed a strong correlation with acceptability was the statement "Properly used herbicides pose no threat to the environment" and the usage of chemical control on agricultural lands.

Overall, it appears that while respondents share a concern about the problem of invasive plants, their preferences for management strategies are shaped by the overall orientation toward protection and use of the environment. This finding is similar to other related studies researching general and specific attitudes towards environmental issues. Nicholson (2000) in a study of wetland attitudes among various stakeholder groups found Sierra Club members and hunters, while both supporting wetlands conservation, differed greatly in their response to hunting and waterfowl management. Similarly, Brunson and Steel (1996) found in their study of sources of variation in attitudes towards range management in the United States that public attitudes towards practices were derived more from an individuals environmental concern than from any deeply held, specific attitudes about rangelands.

Respondents' acceptance of management actions also appears to depend upon their perceptions of the type of land management area involved. The scenarios were designed to examine how attitudes would differ given multiple scenarios with different inherent factors, most notably the level of human involvement within each scenario. As the perceived level of human involvement decreased, a greater amount of differences between control option acceptability levels began to be found, with chemical control usage having the greatest differences throughout all four scenarios. These differences appear to follow the continuum of perceived level of management activity from protected lands to residential areas with the largest differences occurring in the protected lands scenario with decreasing differences found in the multi-use and agricultural scenarios.

A similar type of pattern emerges when examining differences within the acceptability of control options through all four management scenarios. The largest differences between respondents occur when chemical controls were involved, followed by biological and mechanical controls, with differences in acceptability of cultural controls being negligible. This result of chemical controls having the highest levels of polarization in the survey is similar to previous research conducted by Buse (1995) who found the public possessing a large amount of apprehension towards the use of chemicals and their preference towards using more biological controls and other integrated weed management principles.

In the areas where the greatest differences among acceptability occur, respondents expressing a particular level of acceptability towards a control option are also more likely to express that same level of acceptance towards other control options in the same scenario. For example, those who indicated a moderate level of acceptability towards biological control use on protected lands are more likely to show a moderate level of acceptance of mechanical control on protected lands. This connection between acceptability levels within the scenario would seem to indicate a stair step of acceptability attitude strength both within and across the scenarios. This is shown in the correlations between acceptance responses with those indicating a certain level of control option acceptability in one scenario responding in the same manner when asked about that same control option in the other scenarios.

This stair step of responses would seem to indicate there exists a "malleable middle" of respondents who can be targeted as potential supporters of management. Those respondents indicating use of a control option as highly acceptable or not

acceptable are generally seen as having strong attitudes that may not be as responsive to attempts at attitude change. Those respondents finding a low to moderate level of acceptability are concerned about invasive plants but lack either the knowledge or interest level needed to strengthen their attitudes one way or the other. As previous authors have concluded (e.g. Manfredo et al. 1995) it can be very difficult to change attitudes, but knowing which groups possess weakly held attitudes provides professionals with areas where educational programs and resultant behavioral change can be targeted.

Conclusion

Given the differences between general and specific attitudes towards invasive plants, education and awareness programs should be designed to fit specific attitudes rather than general ones. Basic awareness programs detailing the problem of invasive plants should be designed to conform to general attitudes while discussions about management of invasive plants should take into account the tremendous amount of differences in specific invasive plant attitudes.

The primary goal of natural resource education programs is the promotion of pro-environmental and, in many cases, pro-management behaviors. Changing behaviors through the transfer of information and knowledge requires an understanding of the behaviors underlying attitudes and beliefs. This research indicates that taking a personalized approach would be the most efficient manner of delivering information and knowledge. Attitudes and behavior towards invasive plants are stronger if the respondent is either affected directly by invasive plants and

their control or if they find invasive plants to be a threat to the environment. These sources of attitude strength both depend upon the perceived condition of the environment and the threat invasive plants has upon it. Helping individuals to understand the impact invasive plants have upon the environment and specific impacts associated with the control methods used would relate the problem on a personal level, thus better promoting support for management.

Specifically, land managers and professionals should focus their attention more on educating the public about integrated weed management and types of control methods other than herbicides. Evidence of sincere efforts to control invasive plants through alternative means such as grazing and mowing would provide positive direction towards helping individuals accept the use of herbicides. Educating the public that herbicides would be and are used as a last resort would also help with the acceptability of chemical controls.

Finally, including individuals and interested groups in the decision-making process involving the choice of control options would help minimize conflicts associated with usage. Taking interested and knowledgeable individuals and involving them in both decision-making and management efforts is one of the best ways to promote pro-environmental behavior as it helps to reinforce positive attitudes and alter negative ones.

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CHAPTER 3

INFORMATION SOURCES, PREFERENCES FOR INVASIVE PLANT INFORMATION AND INVASIVE PLANT MANAGEMENT

Abstract

Comprehensive education and outreach programs designed to increase awareness are necessary to assist in the prevention and control of invasive plants. The goal of educational programs is to persuade target audiences to believe and behave in a more appropriate manner meaning for programs to be effective they need to be both understood and acted upon. Media preferences are reflective of the expectations individuals possess when selecting media to fulfill intrinsic needs. This means particular mediums and specific content are chosen based upon what individuals think will be provided and what individuals feel the chosen media will do to meet their needs. This study supports the theory that interested individuals will seek more detailed information from a more specific range of sources. The interested public desires more information about invasive plant species and their control and prefers to receive it through brochures, and pamphlets.

Introduction

The increasing spread of invasive plants has had a tremendous impact on both the economy and the environment. These invasions by non-native species threaten biodiversity, resource availability and ecosystem processes (Vitousek et al. 1996). The spread of invasive species reduces forage, causes greater erosion through soil

modification and can affect human health (Asher and Hermon 1995). It is estimated that every year \$33 billion dollars in agricultural losses and nearly \$1 billion dollars in forest and rangeland forage are lost to the impact and cost of controlling invasive species (Pimental et al. 2000).

Comprehensive education and outreach programs designed to increase awareness are necessary to assist in the prevention and control of these biological invasions. These programs have a difficult task in increasing public involvement in management and in influencing perception towards natural resources and their management. The traditional underlying approach of these programs has been that with increased knowledge, better informed individuals will make more appropriate decisions and thus exhibit pro-management behavior (Peyton and Decker 1987). This concept arises from the theory of cognitive consistency, which states that individuals over time will begin to demonstrate behavior more consistent with their knowledge levels (Heberlein and Black 1981). Therefore, by increasing awareness and understanding of the problem of invasive plants, resource professionals can enact desired changes in behavior, create support for management decisions and, hopefully, increase participation in control efforts.

Education and outreach programs are often developed without a careful understanding of the target audience. Identification of receptive audiences along with an understanding of audience knowledge and attitudes can provide direction in the creation and delivery of information programs (Sheley et al. 1996). Extension professionals feel an ideal situation would be one in which natural resource professional's perceptions of public needs would, ideally, correspond with actual

public wants (Grieshop et al. 1990). Unfortunately, differences often occur between what the public wants and what researchers feel they need.

Historically, the delivery of information from professionals to the end users has been a difficult challenge for educators, extension personnel and land managers (Rollins 1993). Additionally, research into understanding the failure to address audience educational wants and needs has shown that increasing knowledge is not always the same as the diffusion and acceptance of that knowledge (Barao 1992). Understanding preferences for information delivery can better help education program managers exchange information about and raise awareness of natural resource issues more effectively. The key is in negotiating a balance between how the public prefers to receive information and how the public can best be reached with that information (Riesenberg and Gor 1989, Pounds 1985).

Technology transfer involves the presentation and diffusion of information and innovations to groups and individuals. This process, known as innovation adoption-diffusion, is the adoption over time of specific concepts by individuals or groups linked to specific channels of communication with a common social structure and system of values (Rogers 1995). Adoption of new technology is dependant upon the attributes of the innovation, the personal characteristics of the adopter and the social structure the adopter operates in (Didier 2002). The fluid interplay between these adoption factors makes it difficult to encourage the adoption of new innovations even with obvious benefits (Rogers 1995).

Most difficulties encountered in the adoption-diffusion process arise from the personal characteristics of the adopter. The classification of adopters into categories

based upon the time of adoption of innovation, relative to others in the social system, is known as innovativeness and is considered to be the key factor in determining when the adoption takes place. Rogers and Shoemaker (1971) found socioeconomic status, select personality variables, and communication variables were all related to the level of innovativeness and the adoption of new technologies. Research indicates individuals adopting early in the process tend to have more education, are younger, are more active information seekers and have higher social status and incomes (Didier 2002).

The conventional adoption-diffusion approach is individuals receiving information about an innovation or new idea and its advantages will make a rational decision to adopt based upon available information (Didier 2002). The primary factor in the process is the access a potential adopter has to relevant useful information about the innovation (Hooks 1983). This means through increasing the amount and availability of information, resource professionals can increasingly encourage adoption of new technologies and concepts. This research will provide resource managers and extension personnel with information on public preferences for information, which information sources are currently used, needed information about invasive plants as well as demographic and attitude characteristics that can influence choices of information sources.

Background

Communication is the transfer from sender to receiver of a message using a pre-selected medium. It is the process of one individual sharing specific ideas and feelings with other individuals and having that information understood.

Understanding this process of transferring information helps more effectively focus communication efforts in the attempt to change beliefs and attitudes. Information transfer, and a corresponding increase in knowledge, has been shown to change the beliefs forming the foundation for individual attitudes and behaviors. Unfortunately, directly changing individual behaviors through the exchange of information can be problematic (Manfredo et al. 1995). Research has indicated that achieving an attitude change in five percent of a target audience can be considered successful (Manfredo et al. 1995).

Transferring information, and hopefully changing behaviors, depends upon effective manipulation of the four communication variables: source, message, medium and receiver. The interchange between these four variables is complex and can prove difficult when forming rules for persuasive communication and attitude change (Manfredo et al. 1995). The components considered most important in persuasive communication are source credibility, audience receptivity, message content and the information delivery method. Content of the message and delivery method used define the availability of information and its ability to be retained by the target audience. Message content and delivery method have been the focus of most natural resource education programs but often without the audience in mind. Hunt

and Brown (1971), for example, found that most programs were written at a knowledge level higher than that of the audience and were lacking in interesting material.

The goal of educational programs is to persuade target audiences to believe and behave in a more appropriate manner. This means that for educational programs to be effective they need to be both understood and acted upon. If the message is not understood or is understood but not acted upon, the resources utilized to implement the program have been misused.

Marynowski and Jacobsen (1999) in their study of ecosystem management programs on Eglin Air Force Base in Florida, USA, utilized a baseline study of recreational users and neighboring citizens to construct an ecosystem-based education program. They found that by using this targeting procedure they were able to reach audiences at their knowledge levels and were able to build upon existing knowledge and attitudes. The ecosystem-based education program was able to improve all areas of knowledge and had a positive effect on overall attitudes. They also found that posters, brochures and youth booklets all contributed to higher knowledge scores while mass media improved overall attitudes.

Similarly, Cobourn and Donaldson (1997), in their research on water-use programs in Western Nevada, found that by using an initial audience assessment the development of an education program and its related community efforts were more effective in increasing knowledge and in the retention of volunteers.

Effective persuasive communication in the context of invasive plants requires simple, easy to understand, attractive messages (Manfredo et al. 1995). Programs that

have less need for explanation and are delivered in a manner consistent with audience wants are more likely to result in desired behavioral changes.

Determining how individuals make decisions about selecting particular information sources can be difficult. Individuals select sources based upon psychological needs motivating them to engage in media use to help fill those needs within their specific socio-political environment. Individuals differ in their perceived needs, meaning that individuals exposed to the same message will respond in different ways. Bright et al. (1993), in a study of responses to education messages involving the controlled burn policy in Yellowstone National Park, concluded messages targeting different beliefs were able to change positive attitudes but were not capable of changing negative ones. These differing responses to information messages illustrate the need to develop programs focusing on issues from different aspects of the communication process (Manfredo et al. 1995).

The primary factor in effective transfer of information and changing attitudes has been found to be an individual's interest in a subject. In his study of communication research and popular culture, Katz (1959) argued that media sources and messages are unable to influence individuals for which no utility or interest exists. Research indicates greater motivation to learn about a subject leads to higher knowledge levels regardless of the source (Garrazone 1984, 1985). Research into awareness of issues in South Africa found the strongest predictors of knowledge were personal interest in a subject and gender (Gandy et al. 1987) Since media usage is primarily a recreational activity, only those with higher interest levels will be motivated to seek out and process information (Gandy et al. 1987). Selection of

specific media sources and mediums by audiences suggests that individuals are goal-directed in their behavior, i.e. reasons exist for actions, are active users of media and use particular sources to gratify their perceived needs.

Individuals will notice and select those media and messages having the greatest potential for meeting their needs (Gandy et al. 1987). Activity, the degree to which an individual seeks specific media for specific purposes in relation to media usage, connotes active involvement in the selection of both information source medium and media message (Rubin 1993). Activity depends, in large part, upon the social context and amount of interpersonal interaction involved (Rubin 1993). The variation in audience activity and the effect it has on the ability to influence knowledge and attitude is a result of the interplay between media orientations, media attitudes and social-psychological factors.

Media orientation is the preference an individual has in looking to a particular source for information reflecting a greater amount of exposure and affinity for a media rather than any type of specific content (Rubin 1993). These media orientations imply there are subjects where certain media are thought to be more reliable and credible than others (Gandy et al. 1987). Individuals motivated to learn about subjects will look to specific information sources they feel are able to provide needed information. Based upon the subject involved, individuals will pre-select a subset of media, or source repertoire, they will look to when in need of information. These source repertoires will vary based upon subjects and can have differing numbers of sources depending on the complexity of the subject (Reagan 1996).

Media orientations are reflective of the expectations individuals possess when selecting media to fulfill intrinsic needs. This means particular mediums and specific content within those media are chosen based upon what individuals think will be provided and what they feel the chosen media will do to meet their needs. Research into information source repertoire has shown that there is a relationship between interest in a subject and the amount of sources selected with less complex issues utilizing easy-to-use media and a greater amount of sources for more complex topics (Reagan 1996).

Attitudes towards media and media content are reflections of the attitudes an individual generally holds towards media types and the subjects involved. Attitudes towards specific media are derived from the past ability of the media to fulfill needs and the perceived credibility of the source and medium. Research shows that the issue of credibility is relevant to both source and medium variables and is dependant upon perceived expertise and trustworthiness with competency and objectivity being the key factors (Kiosus 2001, Whitehead 1968).

Social psychological factors play an enormous role in the determination of orientations towards media, attitudes towards information sources and behaviors involved in media selection. Social psychological theory holds that individuals will act or react in a given manner towards media and message based upon past experience and interactions with patterns of behavior being created upon underlying attitudes and beliefs (Fishbein and Ajzen 1975). Thus, to better understand why an individual chooses a particular information source it is necessary to understand the attitudes and beliefs that underlie the decision-making process. Attitudes towards a

particular information subject will influence heavily where individuals will look for information. Individuals possessing a strong affinity for the environment are more likely to look for information about invasive plant control from environmental organizations than from plant chemical companies.

Research into invasive plant information sources and preference for topics is quite limited. Sheley et al. (1996) in their study of Montana residents found that individuals reported television as being the most effective in transferring information on invasive plants. Newspaper articles, newspaper advertisements, radio messages, brochures distributed with hunting licenses, utility bills, vehicle registrations and delivered to homes were also frequently mentioned.

Numerous studies, however, have been conducted examining preference for information sources about related natural resource topics. In a study of which sources are preferred for specific extension topics, Pounds (1985) found that professionals or businesses were most popular for all topics and extension services were popular sources for nutrition and energy conservation with friends as a source also being highly rated. Individuals were most likely to have found information from newspapers, magazines, radio and television. Oskam (1995) found in a more narrowly focused study that farmers relied primarily on magazines for farm practice information. Kuhns et al. (1998) found newspapers and magazines were the most popular sources of information about managing woodlands with both extension publications and agents also highly used.

In a closely related study of the distribution of gardening information in the Atlanta metropolitan region, Varlamoff et al. (2002) examined differences occurring

in source selection based on gender, education and age. They found those with higher education were more likely to use all the sources of gardening information provided. In particular those who had completed postgraduate studies were more likely to select information provided from botanical gardens and the internet than those who had simply attained a college degree. Younger homeowners were more likely to use more sources of information than older homeowners.

Methods

Study Area

The study area for this research included eleven counties in the Southwestern United States. These study sites were selected as part of the Southwest Rangeland Invasive Plant Initiative, a low-cost, community-based approach to invasive plant management. These areas were: Kane\Garfield and Iron counties in Utah, La Plata County in Colorado; Yavapai, Coconino and Graham\Greenlee\Cochise counties in Arizona, and Grant and Colfax counties in New Mexico.

Methodology

Social data was gathered using a mail-back survey following Dillman's (2000) recommendations for effective survey research (Appendix A). An initial survey mailing followed by a reminder postcard was sent to all addresses. A second survey was sent approximately two weeks later to those who had not responded to the first mailing. To gather data representative of the general public a random sample of 2,700

households with a listed telephone number was obtained from a survey research firm (Survey Sampling, Inc, Fairfield, CT).

The study areas were sampled using cluster area random sampling, meaning the overall population is divided into segments based upon geographic location. Specifically, this study utilized two-stage cluster sampling whereby counties in the geographic area were randomly selected and a random sample from each county was taken. Probability proportionate to size sampling in which the probability of selecting a resident in a given county varied inversely with the size of the cluster was used to better represent the county areas. This meant the random samples taken from each county varied according to the overall population within the county or county group. Cluster area random sampling treats each cluster as the sampling unit, i.e. part of a larger population group, if the clusters are considered heterogeneous within the cluster and homogenous between clusters in initial analysis. For analytical purposes the results from the study areas or clusters were combined to create an overall sample population group following guidelines suggested by Kish (1965).

Of the 2,700 mailed questionnaires, 630 usable surveys were returned. In the predominately rural counties within which this study was conducted there exists an inherent problem in sampling these areas. The method used to create the initial random sample utilized telephone listings, the most reliable frequently updated source, as the source for discovering the address of a chosen survey recipient. This method for selecting a random sample has an inherent problem in that in some cases, particularly rural areas, there are delivery problems where no street addresses are provided with the telephone numbers. Also, since telephone numbers are updated

annually there are always a percentage of recipients who have moved and whose surveys are not forwardable. To overcome this sampling issue in the calculation of survey response rates 15% of surveys were estimated to be undeliverable based upon previous experience and literature review. Response rates ranged from a high of 34.9% for Iron County, UT to 18.3% for Colfax County, NM with an overall response rate of 27.2 % (Table 2.1).

The research instrument consisted of statements and questions regarding knowledge of plant ecology and effects, attitudes towards various control methods and their usage, and willingness to participate in community efforts. Demographic characteristics such as age, education, land ownership, income, income from agriculture and type of residence were also obtained. The data were then analyzed using SPSS statistical software (Norusis 1990) at Utah State University.

The primary focus of this chapter is individual preference for information sources, along with an exploration of background factors associated with those preferences. Its secondary focus is upon those subjects where the public feels information and knowledge availability is lacking.

Respondents were asked if they had ever looked for information about invasive plants, sources used, sources they would prefer to receive information from, and what information about invasive plants they most need. Based upon the ordinal and nominal nature of the data, simple frequencies are reported. To better help professionals target educational programs to specific audiences; this research also contains an examination of various factors involved with selection of information sources. These factors include concern for the impact of invasive plants, knowledge

of invasive plants, demographic characteristics, willingness to participate in community efforts and concern for the environment as opposed to the economy. Chi-square analysis was used to determine factors associated with choice of information sources and preference for invasive plant information.

Results

When asked if they had ever looked for information about invasive plants, forty six percent of respondents indicated positively. Among those respondents who had previously looked for invasive plant information, the most common information source used was County Extension (Table 3.1). The sources with the smallest reported frequency among those who had looked for invasive plant information were radio messages and testimonials from local residents. All respondents were asked if, given their choice of sources, which would be most useful in providing information (Table 3.2). Respondent's brochures would be the most useful means of providing information and that radio messages would be the least useful source.

When asked what information about invasive plants was currently needed or what respondents would like to have, the majority of individuals indicated that information on invasive plant species and the control options available were the most needed (Table 3.3). The least common responses were economic information on invasive plant species and their control and information on community groups active in invasive plant control.

Table 3.1: Sources Used for Invasive Plant Information

Information Source	Percentage of Respondents Using Medium	n
County Extension	56%	275
Private companies or consultants	19%	272
Magazines	43%	272
Environmental organizations	25%	272
Newspapers	32%	272
County or city weed authority	40%	272
Radio	9%	272
State government agencies	25%	272
Television	14%	272
Federal government agencies	27%	273
Internet Websites	26%	272
Advice from family and friends	49%	272
Agricultural organizations (e.g., Cattlemen's Assoc.)	25%	272
Professional associations (e.g., Weed Science Society)	16%	272

Table 3.2: Preferred Sources of Invasive Plant Information

Information Source	Percentage Indicating Preference	n
Pamphlet, brochure or fact sheet	40%	233
Computer CD-ROM	3%	18
Video presentation	5%	31
Internet websites	8%	49
Periodic newsletters	11%	65
Newspapers	7%	41
Demonstration plots in your area	3%	19
Magazines	2%	10
Community workshops or classes	3%	20
Television	4%	25
Testimonials from local residents	2%	9
Radio	2%	9
On-site help from weed specialists or other professionals	9%	51

Factors Associated with Information Sources

Respondents were asked to provide extensive information on demographic characteristics. Of the demographic characters surveyed; sex, level of education, and type of residence were chosen as being the most important factors related to access to and choice of information sources. Extension was the source most often mentioned by all education levels as previously used. Those with some college were more likely to use advice from friends or family ($\chi^2=11.3$) while those with graduate degrees were more likely to seek information from environmental organizations ($\chi^2=13.1$). No differences from the overall profile of respondents occurred on the preferred sources of information and the desired invasive plant topic questions.

Respondents were asked if they lived on large farms, small farms, small rural landholdings, apartments, condos or suburban homes. The majority of respondents lived in suburban homes or small rural landholdings. Those individuals on small farms, small rural landholdings and suburban homes were more likely to have sought information on invasive plants ($\chi^2=22.5$) with extension services as the most common source ($\chi^2=14.0$).

Information on invasive plant species was once again mentioned as the most wanted topic of information. For the two main groups of suburban homeowners and small rural landholders, control options available and proper use of control methods were also frequently mentioned.

Table 3.3: Preferred Invasive Plant Information Topics

Information Subject	Percentage Indicating Need	n
Herbicide safety/effectiveness	42%	248
Invasive plant control options	56%	319
Bio-control safety/effectiveness	31%	179
Getting started in control	30%	166
Kinds of invasive plant species	60%	352
How invasive plants spread	34%	190
Proper use of control methods	52%	290
Economic information about invasive plants and their control	16%	90
Groups and organizations dealing with invasive plant control	21%	115

To evaluate knowledge levels, respondents were asked questions about factors of weed spread, the impact of invasive plants on the environment and were also asked to identify problem weed species in their area. Correct responses to these questions were used to create an overall knowledge score in these areas. Most respondents were able to identify factors of weed spread and the impacts associated with invasive plants but struggled in the identification of weed species.

Respondents with higher invasive plant knowledge levels were more likely to need information about bio-control safety ($\chi^2=16.6$) and control options ($\chi^2=12.5$). Those with moderate knowledge levels were more likely to need information about weed spread ($\chi^2=14.4$), and seek information from environmental organizations ($\chi^2=12.9$) and federal agencies ($\chi^2=18.8$).

A common goal of education programs is to increase participation of the public in decision-making and control efforts. In order to help with this, respondents were surveyed to determine if they had previously volunteered, their willingness to volunteer in invasive plant control efforts and which area of involvement they would prefer. Those willing to participate in invasive plant efforts were more likely to look for information ($\chi^2=29.3$) and more likely to seek information from county weed authorities ($\chi^2=7.2$), state agencies ($\chi^2=8.4$), federal agencies ($\chi^2=7.6$), and agricultural organizations ($\chi^2=7.7$). They were more likely to need information about bio-control safety ($\chi^2=12.2$), proper use of control ($\chi^2=4.9$), control options ($\chi^2=5.1$), and groups and organizations ($\chi^2=11.1$) involved in invasive plant control efforts.

Survey recipients were presented with a series of attitude statements and asked to indicate their level of agreement with each. These included statements on herbicide impacts, concern for controlling invasive plants, prevention versus control and herbicide spray methods. Those who agreed with the statement "Properly used herbicides pose no threat to the environment" were more likely to need information about herbicide safety ($\chi^2=8.6$) and less likely to need information about groups and organizations ($\chi^2=8.6$). Those who agreed with the statement "I am concerned about controlling invasive plants" were more likely to seek information about invasive plants ($\chi^2=22.3$), and generally needed information about control options ($\chi^2=10.1$) and getting started in control ($\chi^2=12.5$). Respondents agreeing with the statement "It is better to pay for prevention now than to pay for control later" were more likely to need information about weed spread ($\chi^2=8.4$). Those disagreeing with the statement "Herbicide spraying should be allowed only if it is done by hand" were more likely to have looked for information ($\chi^2=9.6$) and were more likely to prefer the county weed authority as a source ($\chi^2=12.5$).

To help determine concern for the problem of invasive plants, respondents were asked to rate themselves from "none" to "a considerable amount" on the time they had spent thinking about invasive plants prior to the survey. Those who responded "a considerable amount of time" were more likely to need information about bio-control safety ($\chi^2=27.9$), control options ($\chi^2=37.9$), and groups and organizations involved in invasive plant control ($\chi^2=18.7$). They were also more likely to use county weed authorities ($\chi^2=20.0$), state ($\chi^2=15.6$) and federal agencies

($\chi^2=16.3$), family and friends ($\chi^2=11.8$), and professional organizations as information sources ($\chi^2=12.9$).

Discussion and Conclusions

Through increasing the amount and availability of information, resource professionals can increasingly encourage adoption of new technologies and concepts. The overall results of this research illustrate that a segment of the public is interested in the topic of invasive plants, is concerned about the impact of invasive plants and is actively seeking information on invasive plants and their control. To better help explain how education programs can be helped by this research it is necessary to examine where the programs are targeted.

The goal of most education programs is to increase awareness and knowledge of invasive plants and to encourage individuals to take an active role in invasive plant management. To help prevent and control infestations of invasive plants, it is necessary to reach as many individuals as possible and not just those previously found to be interested. Unfortunately, resources, time constraints and funding limit the ability of professionals to target their education programs where they would be most effective. To better help professionals in the development of educational programs it is recommended the target audience be segmented based upon specific interests as individuals will react to information in differing ways.

The focus of most invasive plant information campaigns is increasing awareness of the problem and in providing basic information in an effort to raise overall knowledge. This focus overlooks the needs of interested individuals for more

detailed information provided in simple, easy to understand ways. Education programs should be developed with a focus on awareness and general knowledge or on providing specific information needed by a specific audience. Different target audiences possess different knowledge levels and needs. Knowing this, education programs can be designed with multiple points of view, focusing on the different areas of the communication process and providing information necessary to keep the target audience interested.

The results of this research show that two segments of the population exist: an interested public actively seeking information about invasive plants and pretty much everyone else. The interested public desires more information about invasive plant species and their control and prefers to receive it through brochures, and pamphlets.

A solution to the problem of limited resources for education programs lies in a two-part approach. The first step is an awareness campaign focusing on general invasive plant impacts and topics utilizing mass media such as television, magazines and radio designed specifically for the general public. The second step is a knowledge focus providing specific invasive plant information using more direct methods of information delivery such as brochures, fact sheets and Extension programs designed specifically for the segment of the public interested in invasive plants.

The results of this study support the theory that interested individuals will seek more detailed information from a more specific range of sources. Pamphlets, brochures and similar media are geared more towards delivery of information rather than increasing awareness of the problem. The study demonstrates a need for information topics and sources by this interested group that may not have previously

been noted. The interested public needs information on specific topics and seems to have difficulty in locating it. Programs that focus on the needed topics of invasive plant species, control options available and bio-control safety are sorely needed. The implementation of this two-part approach will increase the effectiveness of information sharing. By effectively sharing information with both groups, an increase in awareness and understanding is sure to follow.

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CHAPTER 4

VOLUNTEERISM AND INVASIVE PLANT MANAGEMENT

Abstract

Control of early infestations is considered vital to conservation of habitat and to the management of invasive plants. Land managers and agencies often lack the resources necessary to develop and conduct monitoring, restoration and control programs required for the early detection and prevention of invasive plant infestations. Involvement of volunteers in management efforts can provide critical information on the size and scope of infestations as well as needed labor in control and restoration efforts. This study provides agency, education and extension personnel with information on those participating in volunteer work, groups of individuals or organizations willing to help in management efforts along with factors associated with participation. A volunteer base capable of assisting in the management of invasive plants does exist in the Southwestern United States. Those willing to participate generally possess an environmental or economic "stake" in the management of invasive plants. These "stakeholder" groups can be targeted for participation in particular management areas based upon their recreational activities, affinity for the environment and concern for the impacts of invasive plants. Recreation, farm and grassroots environmental organizations may be areas where future volunteer recruitment efforts can be focused.

Introduction

Control of early infestations is considered vital to conservation of habitat and to the management of invasive plants. Land managers and agencies, however, often lack the resources necessary to develop and conduct monitoring, restoration and control programs required for the early detection and prevention of these infestations. Agencies responsible for invasive plant management can benefit a great deal from the participation of volunteers in monitoring and control efforts, and in the restoration of impacted ecosystems.

Involvement of volunteers in management efforts can provide critical information on the size and scope of infestations as well as provide essential labor in control and restoration efforts. Agencies and natural resource professionals can use volunteers not only to supplement staff but also in the development of long-term, community-based groups committed to the environment and the management of natural resources. Although volunteer programs can require a high initial input of resources, over the long term these programs can provide a significant contribution to the management of invasive plants (Krazny and Lee 2002). To help create an environment conducive to sustained volunteer participation, land managers and extension personnel need an accurate representation of the needs and characteristics of current and potential volunteers (Nicholson 2000).

This study provides agency, education and extension personnel with information on those participating in volunteer work, types of individuals or organizations willing to help in management efforts along with factors associated

with participation. In addition the roles of education, monitoring, restoration and control efforts in volunteer work are discussed and information on individuals likely to participate in these areas is provided. Results and suggestions from this research can be used to develop sustainable "grassroots" volunteer programs associated with invasive plant control and management.

Background

Volunteerism has been defined as a community service provided through an individual free will (Phoenix et al. 2002), an activity in which an individual gives freely to benefit people, groups or organizations (Henderson and Silverburg 2002) and as a distinct form of social behavior which incorporates helping and community service (Omoto and Snyder 2002). The definition that best fits this research is that of volunteerism as a long-term, planned, non-obligatory, pro-social behavior that occurs in an organization setting (Penner 2002).

The defining characteristics of volunteer activity as voluntary, sustained, and ongoing suggests that an examination of the motivations and attitudes behind participation may provide a better understanding of current and potential volunteers (Clary et al. 1998). Acts of volunteerism that seem similar on the surface may actually reflect different motivational processes, themselves based upon attitude, knowledge and experience, which show themselves in specific forms of helping. An understanding of these motivational factors can be used to identify potential volunteers, help to influence volunteer behavior and assist in volunteer retention (Clary et al. 1998).

The reasons people volunteer are very complex and difficult to quantify. The traditional approach to the measurement of participation has been to assume that demographic characteristics are sufficient predictors of volunteerism (Wandersman et al. 1987). Demographic variables, while not fully explaining why individuals volunteer, do help to provide a suggestion as to who does participate. However, the general feeling in the literature is that associations between pro-environmental behavior, i.e. behavior designed to preserve and protect the environment (Manzo and Weinstein 1987), and demographic variables tend to be weak and inconsistent from study to study (Van Liere and Dunlap 1981).

Zweigenhaft et al. (1996) in a review of volunteer literature found that generally younger people with greater education and higher incomes were more likely to participate in volunteer work. The research also indicated that married individuals along with females were also more likely to volunteer. These characteristics seem to be changing, though, as the population of the United States begins to age. Over the last twenty-five years, a marked increase in participation among older Americans has begun to take place (Okun et al. 1998). It also appears that males are beginning to take a more active role in volunteer participation as well (Zweigenhaft et al. 1996).

Similarly, Hines et al. (1986) attempted in their review of literature to determine if any common variables existed that might motivate environmentally responsible behaviors. Using age, income, education and gender as variables to examine the differences between groups that undertook pro-environmental action and those who did not, they found that younger, more highly educated individuals with

higher incomes were more likely to report engaging in pro-environmental behavior than older, less educated individuals with lower incomes.

Demographic variables alone, while helping to provide a profile of those who can and do currently volunteer; fail to fully explain the attitudes and motivations underlying volunteerism. This is because individual motivations are a function of attitudes, knowledge level and prior experience, not just their demographic backgrounds. It is these elements of attitudes, knowledge and experience that determine how a person will volunteer as well as the satisfaction they derive from volunteer activities (Clary et al. 1998). Understanding these factors allows organizations to better recruit, train and motivate potential and current volunteers.

Previous studies, particularly those conducted among AIDS volunteers by Allen Omoto and Mark Snyder (1995); suggest two main motivations for volunteer participation. The primary factor associated with motivation is a feeling of moral or religious obligation to help solve a problem; this is also known as community concern. The secondary motivation is simply a self-centered attempt to derive a form of benefit for oneself (Kuntz 2001). These two factors may seem mutually exclusive but it is actually a combination of them that motivates volunteers. In fact, those volunteers who are able to sustain their participation longest are those who feel a sense of moral obligation while deriving a degree of personal benefit (Kuntz 2001).

Five major factors associated with motivation to volunteer have been identified by researchers (Omoto and Snyder 2002). These include: belief in a set of values, a desire for increased knowledge and understanding, volunteering as a means to an end, identification with a particular community and volunteerism as a form of

self defense (Kuntz 2001). The present study focuses upon an examination of values, desire for knowledge, volunteering as a means to an end, and identification with a particular community as motivations for participation in invasive plant management.

What factors then play a role in volunteering in the field of natural resources and in pro-environmental behavior? In his study of the Nature Conservancy Volunteer Stewardship Program in Illinois, a group tasked with restoring endangered native ecosystems near their communities, Schroeder (1998) found that individuals volunteered in restoration efforts for a variety of reasons. More often than not volunteers held remaining ecosystems in a higher value and often saw themselves as an army waging war against the encroachment of invasive plants. The volunteers felt that participating in restoration provided a more satisfying experience than the other ways with which they could be spending their free time. They also felt that they could make a bigger difference by being involved and by playing an active role in restoration efforts. The volunteers reported developing a sense of community and teamwork among the group and very much enjoyed sharing newfound knowledge and skills. One of the most important reasons for participation in restoration efforts was the ability to spend time out of doors in a new and different way.

Social-psychological theory states that an individual's behavior is largely determined by attitudes, knowledge of issues, normative beliefs and personal experiences (Donnelly and Vaske 1995). It is a working combination of these elements that determines how an individual will act or react in any given situation. Any change or alteration in one or more of these factors can equal a corresponding change in actual behavior. The recruitment, training and retention of volunteers can

play an integral role in changing attitudes and promoting behavior. An important role of land management agencies is to help educate and raise awareness of the problem of invasive plants amongst the general public, thereby helping to increase responsible behavior. This research proposes that a feedback loop affecting these behavioral elements exists and possesses components with which resource professionals can promote pro-environmental and management behavior.

Settings in which volunteer participation can affect attitudes are quite widespread (Nicholson 2000). Participation in volunteer work can create and strengthen bonds with the local community, can increase awareness and support for invasive plant management decisions and can create local networks focusing on invasive plants and their management (Maine 1993). There are many areas in which individuals and groups can participate in invasive plant management activities. These include control efforts, restoration of impacted ecosystems, education programs and monitoring efforts.

Control

Control of invasive plants involves the physical removal or alteration of all or part of the plant to deter future growth and expansion. An acceptable level of control is thought to be one that changes the competitive balance of an ecosystem toward the more desirable species (Sheley 1997). The management tools most often utilized to promote this shift in balance include chemical, mechanical, biological and cultural control methods.

Individuals and groups can easily take part in control efforts. The most effective use of volunteer help can occur in the arena of mechanical control, which involves hand-pulling, tilling, mulching, mowing and burning of plants. This method is friendlier than chemical or biological control to the environment but also requires the highest input of human labor. Interested parties can take part in these physical efforts to eliminate small infestations and problem areas.

Restoration

Restoration is the reversal of biodiversity loss and ecosystem degradation with the goal of reassembling the impacted ecosystem to a state that more closely resembles the original (Geist and Galatowisch 1994). Restoration efforts can help individuals develop a relationship with nature (Jordan 1994) and can also help to develop and create support in community building efforts (Geist and Galatowisch 1994).

The involvement of local citizens in natural resources and their management, particularly hands-on tasks, can help to develop a long-term commitment to an ecosystem and an area (Nicholson 2000). Attention and awareness can then be focused upon the problem at hand allowing individuals to see the environment as their environment and then afford it protection and stewardship as such (Maine 1993).

An example of successful restoration efforts from both a human and ecologically standpoint is the Task Force to Bring Back The Don River Watershed in Ontario, Canada. The Task Force to Bring Back the Don is an environmental stewardship group tasked to restore the Don River watershed near Toronto, Canada,

to a clean, serene landscape from a heavily polluted and degraded one (Donald 1997). Since its inception the Task Force has placed over 24,000 plants, opened a river access point and restored wetland areas for wildlife habitat (Donald 1997). Members of the Task Force resembled members of other environmental organizations involved in restoration. The majority were in their thirties and forties, owned their own homes and worked full-time. Members, generally, had above average incomes, college educations and usually did not have young children in the home.

This research about the Task Force to Bring Back the Don shows several interesting relationships. The data suggest that individuals are more likely to volunteer if they know that members in their own age group are also participating. The more active members were more likely to belong to other organizations and to participate in recreational activities on the Don Watershed. Active members also possessed a desire to develop new skills as well as have the opportunity to utilize previously held ones. As far as activity level was concerned, social interaction seemed to be the dominant variable associated with continued involvement (Donald 1997).

Education

Education efforts involve the delivery of information by volunteers to interested audiences that may otherwise not be reached by professionals due to time and resource constraints or personality differences. The approach used most often to create education programs is the train-the-trainer method. In this method agency staff, university faculty and extension personnel conduct workshops and short courses for

educators who then in turn teach the information to others (Krazny et al. 2002). This method reflects the innovation-adoption and technology transfer approach associated with extension whereby professionals design and develop a technology and transfer it to receptive users (Krazny and Lee 2002, Rogers 1995).

Krazny and Lee (2002), in their evaluation of an extension education program concerning invasive plants conducted by Cornell Cooperative Extension in New York State, found several interesting factors relating to education efforts and volunteers. The researchers found that for educators and team leaders, informing their clientele about invasive plants was the primary motivation behind participation. Second was a desire to further their own level of knowledge about invasive plants.

Monitoring

Monitoring is the collection and accumulation of data over time for the purposes of planning and evaluation. In this activity volunteers gather data on native plants, conditions of local ecosystems and the rate and locations of weed spread. This information is then used to determine when, where, and how control and restoration efforts are utilized. The use of interested volunteers in monitoring programs can provide baseline data on the distribution of infestations. Although these volunteer activities require a high initial input of resources, the results of such programs can make a significant contribution to management activities (Krazny et al. 2001).

One example of this type of volunteer activity is the Adirondack Chapter of The Nature Conservancy Voluntary Monitoring Program (Krazny et al. 2001). This program engaged nineteen skilled volunteers in the monitoring of invasive plants in

the Adirondack State Park in Upstate New York. These volunteers identified the location and distribution of thirteen invasive plant species along the major roadways in the state park. The results of this monitoring program have been used by The Nature Conservancy to prioritize invasive plant activities and to initiate discussions among government and non-profit organizations about the coordination of activities within the park (Krazny et al. 2001).

Methods

Study Area

The study area for this research included eleven counties in the Southwestern United States. These study sites were selected as part of the Southwest Rangeland Invasive Plant Initiative, a low-cost, community-based approach to invasive plant management. These areas were: Kane\Garfield and Iron counties in Utah, La Plata County in Colorado; Yavapai, Coconino and Graham\Greenlee\Cochise counties in Arizona, and Grant and Colfax counties in New Mexico.

Methodology

Social data was gathered using a mail-back survey following Dillman's (2000) recommendations for effective survey research (Appendix A). An initial survey mailing followed by a reminder postcard was sent to all addresses. A second survey was sent approximately two weeks later to those who had not responded to the first mailing. To gather data representative of the general public a random sample of 2,700

households with a listed telephone number was obtained from a survey research firm (Survey Sampling, Inc, Fairfield, CT).

The study areas were sampled using cluster area random sampling, meaning the overall population is divided into segments based upon geographic location. Specifically, this study utilized two-stage cluster sampling whereby counties in the geographic area were randomly selected and a random sample from each county was taken. Probability proportionate to size sampling in which the probability of selecting a resident in a given county varied inversely with the size of the cluster was used to better represent the county areas. This meant the random samples taken from each county varied according to the overall population within the county or county group. Cluster area random sampling treats each cluster as the sampling unit, i.e. part of a larger population group, if the clusters are considered heterogeneous within the cluster and homogenous between clusters in initial analysis. For analytical purposes the results from the study areas or clusters were combined to create an overall sample population group following guidelines suggested by Kish (1965).

Of the 2,700 mailed questionnaires, 630 usable surveys were returned. In the predominately rural counties within which this study was conducted there exists an inherent problem in sampling these areas. The method used to create the initial random sample utilized telephone listings, the most reliable frequently updated source, as the source for discovering the address of a chosen survey recipient. This method for selecting a random sample has an inherent problem in that in some cases, particularly rural areas, there are delivery problems where no street addresses are provided with the telephone numbers. Also, since telephone numbers are updated

annually there are always a percentage of recipients who have moved and whose surveys are not forwardable. To overcome this sampling issue in the calculation of survey response rates 15% of surveys were estimated to be undeliverable based upon previous experience and literature review. Response rates ranged from a high of 34.9% for Iron County, UT to 18.3% for Colfax County, NM with an overall response rate of 27.2 % (Table 2.1).

The research instrument consisted of statements and questions regarding knowledge of plant ecology and effects, attitudes towards various control methods and their usage, and willingness to participate in community efforts. Demographic characteristics such as age, education, land ownership, income, income from agriculture and type of residence were also obtained. The data were then analyzed using SPSS statistical software (Norusis 1990) at Utah State University.

There are two major subheadings for the data from this research: a quantitative analysis of factors associated with volunteerism and a quantitative analysis of factors associated with participation in specific volunteer activities.

Respondents were asked if they currently volunteer, whether they volunteer as an obligation, if they had previously worked with invasive plants or the environment, and if they were willing to participate in invasive plant management. Within these questions respondents were also asked to indicate how many hours a week they participated, describe the organization with which they volunteered and in which types of management they would consider participating.

Results

When respondents were asked whether or not they currently participate in volunteer work forty-seven percent gave affirmative answers (Table 4.1). These individuals average roughly five hours of volunteer work per week and twenty hours per month. Twenty percent volunteered as an obligation, most often with a church or school group. Thirty-eight percent volunteered in the environment most commonly with the USDA Forest Service or Boy Scouts of America.

Ten percent of respondents had volunteered previously in an activity involving invasive plants, with forty-three percent of all respondents indicating that they would be willing to participate in management activities (Table 4.1). Of the latter group thirty-nine percent indicated they would take part in education, thirty-seven percent in control efforts, thirty-eight percent in restoration and fifty-five percent in monitoring.

Of the 630 surveys returned, 571 responded to the question, "Do you participate in any type of volunteer work in your community" (Table 4.1). These 571 respondents were utilized to identify different variables possibly associated with a willingness to volunteer.

Variables Associated with Willingness to Volunteer

Motivational factors, including the attitudes, knowledge and beliefs underlying them, are not held in isolation from other factors. Thus to better examine the motivations behind volunteerism it is useful to compare the attitudes and knowledge of those willing to participate with those not willing. Using t-tests

(independent samples, $p < .05$) the mean scores for those indicating a willingness to participate and those not willing were compared based upon a variety of factors to determine where and if any differences existed (Table 4.3). These factors included level of agreement with select attitude trade-off analysis and statements, demographic characteristics, results of specific knowledge scales. Chi-square analysis was utilized to determine differences between demographic characteristics.

The next section involved the respondent's level of concern for the various negative impacts of invasive plants. The two variables that possessed the highest degree of difference were concern for wildlife and for recreation. In both cases, respondents expressing concern for those aspects of invasive plant impacts had higher willingness to volunteer.

Demographically "yes" and "no" respondents differed in age, years lived at their present address, level of education, and the amount of income earned from agriculture (Table 4.4). "Yes" respondents were younger, lived fewer years at their current address, had higher levels of education and were more likely to earn income from agriculture.

Respondents were asked to locate themselves on scales describing how much they had thought about invasive plants, whether when forced they favored the economy or the environment, and how serious a problem they felt invasive plants were in their state and county (Table 4.3). Respondents who were willing to volunteer in weed management tended to think more about invasive plants and to feel more strongly that weeds are a problem in their area.

Table 4.1: Invasive Plants and Volunteerism

Volunteer Activity	Yes	No	n
Do you participate in <i>any type</i> of volunteer work in your community?	47%	53%	593
Do you volunteer as an <i>obligation</i> to an employer, church, or other group?	20%	80%	577
Have you ever done any volunteer work associated with the <i>environment</i> ?	38%	62%	590
Have you ever done any volunteer work with <i>invasive plants</i> ?	10%	90%	591
Would you be <i>willing to participate</i> in volunteer invasive plant management?	43%	57%	571

Table 4.2: Preference for Invasive Plant Volunteer Activities

Activity Type	Percentage Indicating Willingness to Participate	n
Education	39%	245
Ecosystem Restoration	38%	245
Control Efforts	37%	245
Monitoring of Weed Spread	55%	245

Table 4.3: Variables Associated with Willingness to Volunteer

Variable	Yes	No	t-score	sig.
^a Concern for impacts of invasive plants on wildlife	3.5	3.3	2.2	.03
^a Concern for impacts of invasive plants on recreation	2.8	2.6	2.8	.00
^b It is better to pay for prevention now than to pay for control later	3.4	3.2	3.2	.00
^c Acceptability of chemical control on lands used primarily for agriculture	2.2	2.0	2.2	.03
^d Knowledge of factors of weed spread	5.8	5.0	5.3	.00
^e Knowledge of invasive plant impacts	4.4	3.8	3.8	.00
^f Identification of weed species	2.9	2.4	4.8	.00
^g Prior to this survey how much had you thought about invasive plants	3.3	2.7	6.1	.00
^h Please indicate how serious a problem you feel invasive plants are in your area	3.4	3.1	6.2	.00
Age	51.7	59.6	-6.4	.00

^aImportance scale of 1-4 where 1=not important; 4=important

^bAgreement scale of 1-4 where 1=strongly disagree; 4=strongly agree

^cAcceptability scale of 1-4 where 1=not acceptable; 4=highly acceptable

^dKnowledge scale from 1 to 7 correct answers

^eKnowledge scale from 1 to 6 correct answers

^fKnowledge scale from 1 to 4 correct answers

^gScale from 1=none to 5=considerable amount of time

^hScale from 1=not a problem in my state to 4=a serious problem in my county

Table 4.4: Demographic Characteristics of Volunteer Activity Preferences

Characteristic	Rest.	Monit.	Cont.	Educ.
Age in Years	47.2*	51.0	50.1*	51.1
Years at Address	9.1*	10.7	12.2	10.7
Years in State	20.0*	24.8	26.6	18.6
^a Level of Education	3.9*	3.7	3.7	3.9*
^b Area Growing Up	3.3*	2.9	3.0	3.1
^c Type of Residence	4.6	4.5	4.6	4.5
^d Own Current Residence	1.2	1.1	1.1	1.2*
^e Income from Agriculture	1.3*	1.4	1.5*	1.4
^f Income	3.3	3.3	3.4	3.2

*statistically significant

^a 1=did not complete high school; 2=high school graduate; 3=some college; 4=bachelors degree; 5=graduate degree

^b 1=rural(farm); 2=rural(non-farm); 3=small town (<10,000); 4=large town (10,000-100,000); 5=city (>100,000); 6=suburban area

^c 1=large farm/ranch; 2=small farm; 3=small rural; 4=apartment; 5=condominium; 6=suburban home with yard

^d 1=no; 2=yes

^e 1=none; 2=<10 percent; 3=between 10 and 50 percent; 4=more than 50 percent but not all; 5=100 percent

^f 1=less than 20,000; 2=20,000 to 39,999; 3=\$40,000 to \$59,999; 4=\$60,000 to \$79,999; 5=\$80,000 to \$99,999; 6=\$100,000 and above

Knowledge of an issue, and the opportunity to gain increased knowledge, is often thought to be a primary motivation behind pro-social (volunteer) behavior (Omoto and Snyder 1995). To test this assumption, respondents were asked a variety of questions about the various aspects of invasive plant ecology and impacts. For sections dealing with factors of weed spread and impact of invasive plants on the economy and the environment, respondents were asked to evaluate a series of factors and impacts and determine what role they played in weed spread and their concern for impacts. The next section dealt with plant identification. In this area survey recipients were provided with four full-colored photos of invasive plants common to their area and asked to indicate whether they had encountered it before and if they had knowledge of the plants name. For each section respondents were evaluated for correct responses which were then summed to create an overall knowledge score useful for comparison. Statistical analysis based upon these comparisons produced a significant difference between "yes" and "no" respondents on all knowledge scales.

"Yes" respondents correctly recognized an average of 4.4 impacts out of 6 while "no" respondents on average identified 3.8. impacts correctly. "Yes" respondents were able to identify an average of 5.8 out of 7 factors of weed spread while those expressing a desire to not participate had an average correct score of 5.0. Those willing to volunteer were able to correctly identify an average of 2.9 out of the four plants. Those not willing to volunteer identified an average of 2.4 plants correctly.

Variables Associated with Volunteer Preferences

Using only those respondents who indicated a willingness to volunteer in invasive plant management, the variables detailed above were compared between those indicating they would like to take part in the specific volunteer activities, i.e. restoration, education, control and monitoring, and those that indicated they would not like to participate.

Education

Those who expressed an interest in taking part in education activities were concerned about the negative impacts of invasive plants on recreation (Table 4.5) and were more likely to disagree when asked if "Herbicide spraying should be allowed only if it is done by hand." Their knowledge levels were somewhat higher than other respondents. They scored higher on the identification of factors of weed spread and were able to correctly identify more weed species. They were also more likely to have thought about invasive plants before they received the survey.

Restoration

Restoration is the volunteer activity where many differences were apparent between those willing and non-willing participants (Table 4.6). Those seeking to take part in restoration efforts were more concerned about the effects of invasive plants on recreation and wildlife, and less likely to be concerned about the impacts upon forage than those uninterested in participation. They were less likely to agree with the statement "Properly used herbicides pose no threat to the environment."

Table 4.5: Variables Associated with Willingness to Participate in Education

Variable	Yes	No	score	sig.
^a Concern for the impacts of invasive plants on recreation	2.9	2.7	8.8 ¹	.00
^b Herbicides should only be allowed if it is by hand	2.2	2.3	6.3 ¹	.01
^c Knowledge of factors of weed spread	6.1	5.6	-2.2 ²	.03
^d Identification of weed species	1.2	1.1	2.2 ²	.04
^e Prior to this survey how much had you thought about invasive plants	3.5	3.2	-2.0 ²	.05
^{f1} Biological, cultural or mechanical control should be used before herbicides even if it takes longer vs. ³ It is always best to use the control option that works fastest	1.5	1.7	8.7 ¹	.00

¹F-score²t-score^aImportance scale of 1-4 where 1=not important; 4=important^bAgreement scale of 1-4 where 1=strongly disagree; 4=strongly agree^cKnowledge scale from 1 to 7 correct answers^dKnowledge scale from 1 to 4 correct answers^eScale from 1=none to 5=considerable amount of time^fTradeoff scale indicating agreement with 1=agree with statement 1; 2=neutral; 3=agree with statement 3

Table 4.6: Variables Associated with Willingness to Participate in Restoration

Variable	Yes	No	score	sig.
^a Concern for the impacts of invasive plants on wildlife	3.6	3.4	-2.2 ²	.02
^a Concern for the impacts of invasive plants on forage	2.7	3.1	3.1 ²	.00
^a Concern for the impacts of invasive plants on recreation	2.9	2.7	6.1 ¹	.01
^b Properly used herbicides pose no threat to the environment	2.3	2.6	2.1 ²	.04
^c Knowledge of factors of weed spread	6.1	5.6	-2.6 ²	.01
^d Identification of weed species	3.0	2.8	5.1 ¹	.03
^{e1} Effectiveness should be the most important factor when deciding which control method to use vs. ³ Safety should be the most important factor when deciding on control methods	2.6	2.3	-2.5 ²	.02
^{e1} Invasive plants should be managed even if control efforts could negatively affect the environment vs. ³ Invasive plants shouldn't be managed if control could negatively affect the environment	2.4	2.2	8.8 ¹	.00
^{e1} Biological, cultural or mechanical control should be used before herbicides even if it takes longer vs. ³ It is always best to use the control option that works fastest	1.4	1.7	3.2 ²	.00

¹F-score²t-score^aImportance scale of 1-4 where 1=not important; 4=important^bAgreement scale of 1-4 where 1=strongly disagree; 4=strongly agree^cKnowledge scale from 1 to 7 correct answers^dKnowledge scale from 1 to 4 correct answers^eTradeoff scale indicating agreement with 1=agree with statement 1; 2=neutral; 3=agree with statement 3

Respondents willing to take part in restoration were more likely to oppose herbicide usage if it posed environmental harm, chose safety over effectiveness as criterion for choosing control methods, and were more likely to favor environmental protection over economic growth. They were also generally younger, had spent less time at their current address, spent less time in the particular state and possessed more formal education. They were more likely to have grown up in larger population areas, typically owned their current residences and tended not to earn income from agriculture. Those who wished to volunteer in restoration were able to correctly identify more factors associated with the spread of invasive plants than those not willing to participate.

Monitoring

Those respondents indicating they would be willing to participate in monitoring activities were concerned with the negative effects of invasive plants on wildlife, native plants, recreation and forage (Table 4.7). They were also more likely than those not indicating an interest in monitoring to agree with the statement "I am concerned about controlling invasive plants."

Control Efforts

Respondents willing to engage in control activities were concerned about invasive plants' effect on crop values (Table 4.8). They were less likely to agree with "herbicide spraying should only be allowed if it is done by hand," had more often

Table 4.7: Variables Associated with Willingness to Participate in Monitoring

Variable	Yes	No	score	sig.
^a Concern for the impacts of invasive plants on native plants	3.6	3.3	-2.8 ²	.00
^a Concern for the impacts of invasive plants on wildlife	3.6	3.4	-2.0 ²	.05
^a Concern for the impacts of invasive plants on forage	3.1	2.8	-2.2 ²	.03
^a Concern for the impacts of invasive plants on recreation	2.8	2.7	8.91 ²	.00
^b I am concerned about controlling invasive plants	3.4	3.2	-2.2 ²	.03
^c Knowledge of factors of weed spread	5.9	5.7	3.9 ¹	.05

¹F-score²t-score^aImportance scale of 1-4 where 1=not important; 4=important^bAgreement scale of 1-4 where 1=strongly disagree; 4=strongly agree^cKnowledge scale from 1 to 7 correct answers

Table 4.8: Variables Associated with Willingness to Participate in Control

Variable	Yes	No	score	sig.
^a Concern for the impacts of invasive plants on crop values	3.2	2.9	-2.1 ²	.04
^b Herbicide spraying should only be allowed if it is done by hand	2.2	2.4	2.2 ²	.03
^b I am concerned about controlling invasive plants	3.4	3.3	5.3 ¹	.02
^c Knowledge of impacts of invasive plants	4.6	4.2	-2.1 ²	.03
^d Prior to this survey how much had you thought about invasive plants	3.5	3.0	-3.4 ²	.00
^e Please indicate how serious a problem you feel invasive plants are in your area	3.5	3.3	-2.3 ²	.02

¹F-score²t-score^aImportance scale of 1-4 where 1=not important; 4=important^bAgreement scale of 1-4 where 1=strongly disagree; 4=strongly agree^cKnowledge scale from 1 to 6 correct answers^dScale from 1=none to 5=considerable amount of time^eScale from 1=not a problem in my state to 4=a serious problem in my county

thought about invasive plants, and considered invasive plants to be more of a serious problem than those not wishing to take part.

Those willing to participate in control tended to oppose government participation in control if it meant higher taxes and preferred the statement "It is always best to use the control option that works fastest" over "Biological, cultural and mechanical controls should be used before herbicides even if it takes longer." They were more likely to value effectiveness as the criterion for choosing a control method even if herbicides are likely to be the most effective control method available and also placed effectiveness over safety and cost as the most important decision-making factor as far as usage was concerned.

Discussion

Similar to the findings of Zweigenhaft et al. (1996), Southwest residents who would volunteer in weed management and education are typically younger, with more education and higher incomes. Generally individuals who possessed knowledge of weed spread and species were more likely to indicate willingness to participate. This knowledge often corresponds to the overall perception of the problems associated with invasive plants, and it makes sense that individuals understanding the problem would seek to help reduce its impact. On the other hand those who are concerned about invasive plants and their spread are also more likely to obtain information about them.

Probably due to time and resource constraints, the primary method for recruiting volunteers in invasive plant management has been to look to interested

extension clienteles possessing knowledge of plant and weed ecology and to suggest certain activities and tasks to perform. Unfortunately this recruiting method may have reduced the number of groups useful for accomplishing management activities to those readily available, such as Master Gardener programs, church and scout groups. This approach requires the least amount of the professional input necessary to facilitate education and outreach programs' as less time is needed to train and commit volunteers.

Volunteer and pro-social behavior that seems similar on the surface may actually reflect differing attitudes, beliefs and values and those motivational processes they underlie. To better illustrate this, it is useful to examine what motivational factors an individual may have that constitutes an "interest" or "stake" in an issue. This implies simply that an individual possesses an attitude or viewpoint that determines the type and intensity of interest they will have in a subject. One individual may feel an attachment for wetlands and migratory waterfowl only because they enjoy hunting, while another may value these things because of the positive effect they have on the environment. While arriving at the issue of conservation of wetlands from disparate sides, the end result is still the desire to preserve habitat and waterfowl. The findings of this study show an untapped reservoir of volunteers exists to help with invasive plant management. This group of volunteers possesses different motivations than traditional volunteers, and may be found in overlooked areas like outdoor recreation and environmental groups.

This study found that individuals with interest in the environment and the outdoors are potential sources of volunteer assistance. As a general rule it is possible

to say that knowledge levels, concern for the impacts of invasive plants on recreation and wildlife, and the acceptability of control measure usage particularly chemical controls, are predictive of participation in weed management. An especially important finding of this study is that there were noteworthy differences in the characteristics of people wishing to volunteer for different types of weed-related tasks.

Respondents choosing restoration as a volunteer activity have more interest in protecting and preserving the environment, while those choosing to participate in control efforts often possess a vested economic interest in eliminating invasive plants. This finding supports the conclusion that specific groups should be targeted by resource professionals for tasks depending upon their interest in invasive plants. Respondents interested in monitoring were concerned about aspects of weed invasion (forage and native plant impacts) that those preferring other activities were not. Those with a higher level of environmental concern and an affinity for outdoor activities can be recruited to participate in restoration and monitoring. Individuals with an interest in maintaining economic and lifestyle conditions can be targeted for participation in control efforts.

Conclusion

A volunteer base capable of assisting in the management of invasive plants does exist in the Southwestern United States. It appears that those willing to take part in efforts represent a unique subsection of the overall population. Those willing to participate generally possess an environmental or economic "stake" in the management of invasive plants. These "stakeholder" groups can be targeted for

participation in particular management areas based upon their recreational activities, affinity for the environment and concern for the impacts of invasive plants.

Recreation, farm and grassroots environmental organizations may be areas where future volunteer recruitment efforts can be focused. The challenge for resource professionals is to provide engaging volunteer programs designed to fit the diverse interests of these "stakeholder" groups.

These groups share a similar goal of eradicating and preventing the spread of invasive plants but do differ as to how this should be accomplished. Support exists for invasive plant management activities, but as in other areas of resource management it can be further strengthened. The potential for attitude change towards management exists in the involvement of volunteers insofar as an environment conducive to change is allowed to exist and flourish. Allowing individuals to see the impacts of invasive plants on the environment through volunteer participation in a setting tied to their personal interests can help immeasurably in the alteration of negative attitudes.

Recreation, farm, and grassroots environmental organizations may be areas where future volunteer recruitment efforts can be focused. The challenge for resource professionals is to provide engaging volunteer programs designed to fit the diverse interests of these "stakeholder" groups.

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CHAPTER 5

CONCLUSION

Invasive plants are a profound and growing threat to functioning ecosystems; second only to habitat loss as the greatest current threat to native species in the United States (Baker 2001). The spread of invasive and exotic species results in the loss of farm and rangeland productivity, increased cost of control for private and public interests, and reduced biodiversity (Vitousek et al. 1996).

The key to limiting invasive plant infestations is a combination of the integrated weed management principles of prevention, early control and ecosystem restoration. Agencies and professionals lack the resources to create programs designed to increase effective efforts in these three critical areas. Part of the solution to this problem of limited resources is in increasing involvement and support in decision-making and public participation in control efforts. Increased public involvement can limit conflicts associated with management decisions and can provide additional manpower and resources to assist management in controlling invasive plants.

This research was designed to assist land managers and resource professionals with information on the types of individuals willing to participate in volunteer weed management efforts, and how these individuals would prefer to receive information on invasive plants, as well as how information needs and volunteerism were related to attitudes and knowledge to invasive plants. Information in this study can be used to

create education programs targeted to increase awareness of the problem of invasive plants and public participation in control efforts.

Chapter 2 contained an examination of individual attitudes towards invasive plants and the acceptability of control option usage. Respondents were interested in the invasive plant problem and were, generally, in favor of controlling them although the respondents indicated that environmental safety should be a priority. Respondents found biological, cultural and mechanical control use to be more acceptable than chemical controls. Individuals also indicated high levels of concern for the specific impacts of invasive plants.

In the formation of attitudes towards invasive plants it appears individuals are transferring general environmental attitudes and attitudes towards their way of life, i.e. economic and cultural concerns, to the problem of invasive plants rather than forming separate attitudes. Differences were found between general and specific attitudes particularly in the acceptability of control option usage. Given the differences found it is suggested that for an education and awareness program to succeed it needs to link the problem of invasive plants with specific interests the audience may have, for example, illustrating how invasive plants will affect recreation in the outdoors.

Chapter 3 was an assessment of individual preferences for information sources including sources previously used for invasive plant information and preferred topics of invasive plant information. Results showed that a portion of the public was interested in the problem of invasive plants and was actively engaged in seeking information on them and their control. This research supported the theory that

individuals will begin to seek more detailed information from a more specific range of sources as their interest in a subject grows. It is recommended that education programs follow a two-part approach to raising awareness and knowledge of invasive plants. The first step involves a broad, limited technical knowledge approach designed to increase awareness of the problem of invasive plants. The second step is a more detailed approach providing specific information on invasive plants and control to those individuals already interested and affected by invasive plants.

Chapter 4 provided an analysis of individuals expressing willingness to volunteer as well as an explanation of factors involved in volunteer participation. The study revealed a subsection of the overall population that was capable and willing to assist in volunteer efforts existing in the Western United States. Similar to previous research individuals expressing a willingness to volunteer were younger, had greater education and earned higher incomes (Zweigenhaft et al. 1996). Individuals with a greater understanding of the impacts of weed spread and knowledge of weed species were more likely to indicate a willingness to take part in control. Those respondents willing to participate in volunteer efforts possessed an environmental or economic "stake" in helping to combat infestations of invasive plants. Individuals with a "stake" in controlling invasive plants can be targeted for participation in control efforts, particularly those involved in recreation, those with high levels of environmental concern, and individuals worried about the impacts of invasive plants. Recreation, farm and grassroots environmental organizations are recommended as being sources of volunteers and participants in invasive plant control.

Analysis of invasive plant attitudes and associated factors shows there is a need for targeted education, awareness and volunteer programs in the Western United States. The best-case scenario for land managers is the creation of a viable source of volunteers that can be utilized in prevention, control and restoration efforts. The central theme throughout the results of this research is that of general versus specific both in attitudes and information. The best approach to reaching the untapped resource of volunteers that exists is having an understanding of where general and specific information is needed.

Previous research has indicated, particularly in the study of information sources, that individuals will spend most of their resources engaged in activities and subjects interesting or impacting them (Gandy et al. 1987). The key to generating awareness and, hopefully, recruiting volunteers is the connection of the problem and impacts of invasive plants to specific areas of interest individuals possess. Examples from this research include showing how invasive plants affect recreational activities, native plants, wildlife and wildfire, and how individuals can help to limit the impacts through assisting with management efforts.

It would be most efficient in invasive plant education programs initially to create a general awareness program written in real and understandable terms that illustrates how invasive plants affect the environment and the economy as a whole. This section should focus as much on educating individuals about the environment and the economy as it does on the principles of invasive plants. After this initial education program is developed, a more specific section could detail how invasive plants fit within the environment and the specific effects invasive plants have on the

environment and the economy. For example, in many awareness efforts the principal impact used to illustrate the importance of controlling invasive plants is reduced biodiversity. If the recipient of this information does not have a fair understanding of the importance of biodiversity the potential for attitude change is seriously curtailed. An alternative is to create programs educating individuals on biological and environmental principles using the impacts of invasive plants as the framework within which the education effort takes place.

This study has involved an examination of invasive plant attitudes and associated factors and their effect upon preferences for information sources and exhibited or intended behavior. The ultimate goal is to provide direction for natural resource managers in the creation of invasive plant and related education and volunteer programs. It has attempted to answer is how attitudes towards invasive plants are formed and how knowledge of invasive plant attitudes can be utilized to facilitate desired behavioral change. This information enables management to make decisions more in line with public desires reducing the potential for conflicts. It also allows managers to generate support for efforts and target groups that can be used to assist in decision-making and control efforts.

Further research is necessary to determine connections between environmental attitudes and behavior. Specific case studies of invasive plant volunteers and their motivations for participating are needed to generate a more complete profile of those willing to participate. Also, more research into the impact of educational programs on attitudes is needed to determine their efficacy. Studies detailing knowledge and attitudes both before and after educational programs would

help to illustrate how knowledge affects both attitudes and behavior and provide more guidance in program design.

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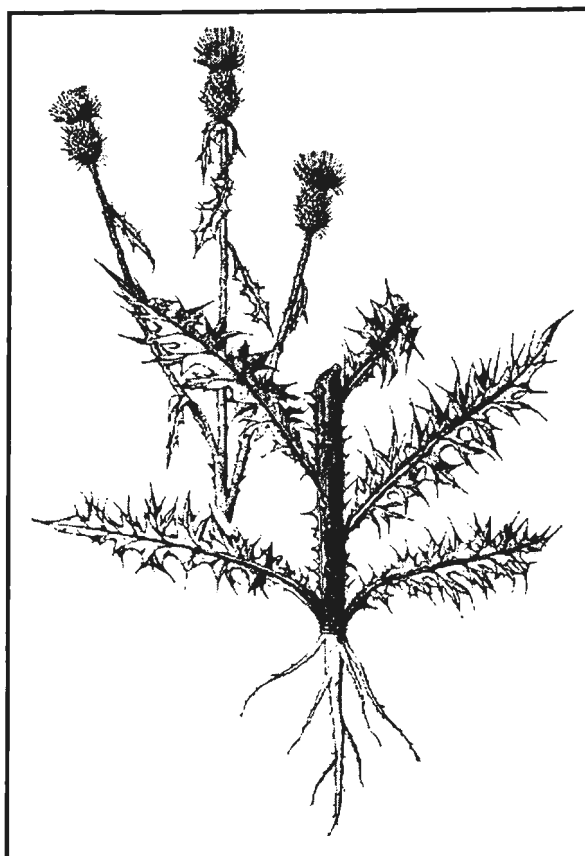
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Appendices

Appendix A: Sample Mail Survey Questionnaire

A Survey of Southern Utah Citizens



Southwest Rangeland Invasive Plant Initiative

Rangeland Resources Department

Utah State University

Logan, Utah

The questions in this survey concern invasive plants. By invasive plants we mean weeds that spread easily, are not native to the Southwest, and interfere with human activities such as recreation, livestock grazing, etc. Please answer each question as well as you can. It is important for us to know and understand how the public feels about invasive plants. For some questions you may not have an opinion or any prior knowledge. It is important that you let us know this as well.

1) Prior to this survey, how much had you thought about invasive plants in your area?

None 1-----2-----3-----4-----5 A considerable
/ amount of time
moderate amount of time

2) The following list contains some of the factors that can help invasive plants spread to new locations. Please circle the response that indicates whether you knew before you began this survey that each factor could help weeds spread.

	YES	NO	Not Sure
Recreation activities (hiking, horseback riding, etc.)	1	2	NS
Grazing by cattle or sheep	1	2	NS
Residential or commercial development	1	2	NS
Movement by wildlife	1	2	NS
Wind or rain	1	2	NS
Residential landscaping	1	2	NS
Motor vehicles	1	2	NS

3) Some natural and human actions have more influence on the spread of invasive plants than others. For each of the following, please indicate how important a role you believe each one plays in the spread of invasive plants.

	Not at all Important	Slightly important	Somewhat important	Very important
Motor Vehicles	1	2	3	4
Livestock grazing	1	2	3	4

Recreation activities	1	2	3	4
Home landscaping	1	2	3	4
Residential development	1	2	3	4
Wildlife	1	2	3	4
Wind and water	1	2	3	4

4) Invasive plants can affect the economy and environment in various ways. For each of the following effects of invasive plants, please indicate whether you had heard of it before, had never heard it before, or aren't sure.

	YES	NO	NOT SURE
Loss of native plants	1	2	NS
Reduced crop values	1	2	NS
Reduced wildlife habitat quality	1	2	NS
Interference with recreation	1	2	NS
Increased wildfire danger	1	2	NS
Reduced quality of livestock forage	1	2	NS

5) For each of the following negative effects of invasive plants, please indicate how great a concern they are to you personally.

	None	Low	Moderate	High
Loss of native plants	1	2	3	4
Reduced crop values	1	2	3	4
Reduced wildlife habitat quality	1	2	3	4
Interference with recreation	1	2	3	4
Increased wildfire danger	1	2	3	4
Reduced livestock forage quality	1	2	3	4

6) Managing public lands often involves tradeoffs between natural conditions (wildlife, endangered species) and economic considerations (employment, economic growth). Please locate yourself on these issues.

1-----2-----3-----4-----5		
/	/	/
Priority should be given to maintaining <u>natural conditions</u> even if it creates negative economic impacts	The environment and the economy should be given <u>equal priority</u>	<u>Economic considerations</u> should be given priority even if it creates negative environmental impacts

We would like to know where you look for information about invasive plants and what types of invasive plant information you would like to have. For the following questions, please indicate ALL relevant responses.

7) Have you ever looked for information about invasive plants?

☐ Yes ☐ No (Please go to question # 9)

8) If you answered yes to #8 above, what sources of information have you used?

(Check all that apply)

- | | |
|---|---|
| <input type="checkbox"/> County Extension | <input type="checkbox"/> Private companies or consultants |
| <input type="checkbox"/> Magazines | <input type="checkbox"/> Environmental organizations |
| <input type="checkbox"/> Newspapers | <input type="checkbox"/> County or city weed authority |
| <input type="checkbox"/> Radio | <input type="checkbox"/> State government agencies |
| <input type="checkbox"/> Television | <input type="checkbox"/> Federal government agencies |
| <input type="checkbox"/> Internet Websites | <input type="checkbox"/> Advice from family and friends |
| <input type="checkbox"/> Agricultural organizations (e.g., Cattlemen's Assoc.) | |
| <input type="checkbox"/> Professional associations (e.g., Weed Science Society) | |

9) If you had your choice, which of the following sources of invasive and exotic plant information would be most useful to you? (Please check only one)

- | | |
|--|--|
| <input type="checkbox"/> Pamphlet, brochure or fact sheet | <input type="checkbox"/> Computer CD-ROM |
| <input type="checkbox"/> Video presentation | <input type="checkbox"/> Internet websites |
| <input type="checkbox"/> Periodic newsletters | <input type="checkbox"/> Newspapers |
| <input type="checkbox"/> Demonstration plots in your area | <input type="checkbox"/> Magazines |
| <input type="checkbox"/> Community workshops or classes | <input type="checkbox"/> Television |
| <input type="checkbox"/> Testimonials from local residents | <input type="checkbox"/> Radio |
| <input type="checkbox"/> On-site help from weed specialists or other professionals | |

10) What information about invasive plants do you currently need or would like to have? (Check all that apply)

- | | |
|---|---|
| <input type="checkbox"/> Herbicide safety/effectiveness | <input type="checkbox"/> Invasive plant control options |
| <input type="checkbox"/> Bio-control safety/effectiveness | <input type="checkbox"/> Getting started in control |
| <input type="checkbox"/> Kinds of invasive plant species | <input type="checkbox"/> How invasive plants spread |

_____ Proper use of control methods _____

_____ Economic information about invasive plants and their control

_____ Groups and organizations dealing with invasive plant control

11) Many people have differing opinions about the impacts and effectiveness of invasive plant control. Please circle the response which best illustrates your beliefs about each of the following statements. Your answers will not be judged as right or wrong, but simply on the basis of your opinion. If you feel you do not know enough to give an opinion please circle the letters NS for that statement.

	Strongly Disagree	Disagree	Agree	Strongly Agree	Not Sure
Properly used herbicides pose no threat to the environment	1	2	3	4	NS
I am concerned about controlling invasive plants	1	2	3	4	NS
It seldom makes economic sense to control invasive plants	1	2	3	4	NS
The government isn't doing enough to control invasive plants	1	2	3	4	NS
It doesn't pay to control weeds on my land when my neighbor doesn't control them on his	1	2	3	4	NS
Public funds should be invested in controlling invasive plants	1	2	3	4	NS
It is better to pay for prevention now than to pay for control later	1	2	3	4	NS
I should have the right to use chemicals on my own property whenever I believe it is best	1	2	3	4	NS
Herbicide spraying should only be allowed if it is done by hand	1	2	3	4	NS

Various methods are available that can be used to help control invasive plants. Following is a brief description of each of the four basic control options. We would like to know your beliefs about each type as well as your opinion about where they should be used.

Chemical Control: Using herbicides to help contain and control problem plants.

Mechanical Control: Using methods such as tilling, hand-pulling, and mowing to physically remove all or part of the plant.

Biological Control: Using living organisms such as insects and plant diseases to contain and suppress invasive plants.

Cultural Control: Using livestock grazing, competition by native plants, and revegetation to help favor desirable native species.

16) For each of the invasive plant control options just described, please circle the response that best indicates how acceptable you feel their use is on multiple use lands such as national forests and BLM lands, which are managed for grazing, logging, mining, and outdoor recreation, as well as wildlife and water quality.

	Not at all Acceptable	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
Chemical Control	1	2	3	4
Mechanical Controls	1	2	3	4
Biological Controls	1	2	3	4
Cultural Controls	1	2	3	4

17) For each of the control options, please indicate how acceptable you feel their use is in areas managed primarily to protect the environment such as national parks and wildlife refuges.

	Not at all Acceptable	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
Chemical Control	1	2	3	4
Mechanical Controls	1	2	3	4
Biological Controls	1	2	3	4
Cultural Controls	1	2	3	4

18) For each of the control options, please indicate how acceptable you feel their use is on lands adjacent to residential areas.

	Not at all Acceptable	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
Chemical Control	1	2	3	4
Mechanical Controls	1	2	3	4
Biological Controls	1	2	3	4
Cultural Controls	1	2	3	4

19) For each of the control options, please indicate how acceptable you feel their use is on land used primarily for agriculture (pastures, crops, tree farms, etc.)

	Not at all Acceptable	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
Chemical Control	1	2	3	4
Mechanical Controls	1	2	3	4
Biological Controls	1	2	3	4
Cultural Controls	1	2	3	4

20) On the following scale please rate how serious a problem you feel invasive plants are in Southern Utah.

1	2	3	4
/	/	/	/
Not a problem in my state	A problem in my state, but not in my county	A moderate problem in my county	A serious problem in my county

21) Often natural resource managers must decide on trade-offs between different management goals. For each of the following pairs of statements below, please tell us which of the statements you prefer by circling the number which best describes your beliefs in Column A or Column B. If you have no opinion, please circle neutral. If you have no knowledge of the subject, please circle NS.

Column A	Prefer Col. A	Neutral	Prefer Col. B	Column B	Don't Know
Invasive plants should be managed even if control efforts could negatively affect the environment.	1	2	3	Invasive plants shouldn't be managed if control could negatively affect the environment	NS
The government should increase control efforts on public land even if it means higher taxes	1	2	3	I do not want the government to increase control efforts if it means higher taxes	NS
I favor increasing the control of invasive plants even if it means increased regulation.	1	2	3	I do not favor increasing the control of invasive plants if it leads to increased regulation.	NS
Biological, cultural, or	1	2	3	It is always best to use	NS

mechanical control should be used before herbicides even if it takes a lot longer.

the control option that works fastest.

The economic costs of control should be the most important factor in deciding which control method to use.

1

2

3

The most appropriate control method should be used, regardless of cost.

NS

Effectiveness should be the most important factor in deciding which control method to use

1

2

3

Safety should be the most important factor in deciding which control method to use.

NS

We are interested in knowing your level of interest in participating in invasive plant management activities. For the following questions please tell us about your current participation in volunteer work and your level of interest in such activities.

22) Do you participate in any type of volunteer work in your community?

_____ YES _____ NO

If yes, approximately how many hours per week? _____

23) Do you volunteer as an obligation to an employer, church, or other group?

_____ YES _____ NO

If yes, which organization? _____

24) Have you ever done any volunteer work associated with the environment?

_____ YES _____ NO

If yes, with which organization? _____

25) Have you ever done any volunteer work with invasive plants?

_____ YES _____ NO

If yes, with which organization? _____

26) Would you be willing to participate in volunteer invasive plant management?

_____ YES _____ NO

If yes, which type of work would you want to do? (Check all that apply)

_____ Education _____ Ecosystem Restoration

_____ Control Efforts _____ Monitoring of Weed Spread

_____ Other (If yes, which type? _____)

27) Please rate the following items on their importance to you in deciding whether to participate as a volunteer in an invasive plant management activity.

_____ Opportunity to work with friends and family

_____ Public or informal recognition

_____ Better understanding of invasive plants and the environment

- ☐ Personal stake in invasive plant management
- ☐ Training that will help with future career goals
- ☐ Benefits like food and child care
- ☐ Opportunity to meet new people and make new friends

Finally, we would like to know more about your background. This information will only be used in making comparisons and will remain strictly confidential. Feel free to answer only those questions with which you feel comfortable.

28) Are you ☐ female ☐ male?

29) In what year were you born? _____

30) How long have you lived at your current address? _____ years.

31) How long have you lived in Southern Utah? _____ years.

32) What is the highest level of education you completed?

- ☐ Did not complete high school ☐ Bachelor's degree
- ☐ High School ☐ Graduate degree
- ☐ Some college, but not a four year degree

33) Which answer best describes where you lived longest while growing up?

- ☐ Rural (farm) ☐ Rural (non-farm)
- ☐ Small Town (<10,000) ☐ Large Town (10,000-100,000)
- ☐ City (>100,000) ☐ Suburban Area

34) What type of residence do you currently live in?

- ☐ Large Farm\Ranch (>1,000 acres) ☐ Apartment
- ☐ Small Farm\Ranch (<1,000 acres) ☐ Condominium/townhome
- ☐ Small Rural landowner (<10 acres) ☐ Suburban Home with yard

35) Do you own your current residence? ☐ YES ☐ NO

33) What portion of your income comes from agricultural sources?

- ☐ None ☐ <10 percent ☐ Between 10 and 50 percent
- ☐ More than 50 percent but not all ☐ 100 percent

34) Which category describes your approximate annual household income?

- ☐ Less than \$20,000 ☐ \$20,000 to \$39,999
- ☐ \$40,000 to \$59,999 ☐ \$60,000 to \$79,999
- ☐ \$80,000 to \$99,999 ☐ \$100,000 and above

Dear Survey Recipient,

Invasive plants (weeds) are an increasing problem in Southern Utah. Because these plants have a negative impact on the environment and the economy that affects everyone in our communities, we are studying public attitudes towards invasive plants. In this survey, we are interested in finding out what residents of Southern Utah think about invasive plants and efforts to control them. Information from this survey will be used to develop and refine education programs concerning invasive plants.

Your household has been selected from a random sample of households in Southern Utah. This survey should be completed by the adult in your household whose birthday comes earliest in the year. Your participation in this survey is completely voluntary, but we need everyone's response so we can truly understand how residents in Southern Utah feel about invasive plants. Your answers to the survey will be kept completely confidential. The identification number on the survey is solely to help us keep track of the surveys; your name will not be attached to the survey itself, and the list of names and numbers will be kept in a locked cabinet in a separate room from the completed surveys.

When you have completed the survey, please fold the booklet in half and return it to us in the enclosed prepaid business return envelope. Thank you for your time and effort in completing this survey. If you have any questions, feel free to contact the survey manager, Leith Tidwell, at the phone number or addresses listed below.

Mark Brunson
Research Director
Department of Forest Resources

Utah State University
5215 Old Main Hill
Logan, UT 84322-5215
(435) 797-2458
brunsonm@cnr.usu.edu

Leith Tidwell
Survey Manager
Department of Forest Resources

Utah State University
5215 Old Main Hill
Logan, UT 84322-5215
(435) 797-1009
weedsurvey@hotmail.com

Dear Survey Recipient,

A few weeks ago, we sent you a survey on invasive plants (weeds) and their management in your area. Because **everyone** has an interest in how invasive plants are managed, we need your response to make our data complete. In case you misplaced the original survey, we've included a copy with this letter. If you've already completed and returned your first survey, thank you. We should be getting it shortly.

Because these plants have a negative impact on the economy and the environment that affects everyone in our communities, we are studying public attitudes towards invasive plants. We are interested in finding out what residents of Southern Utah think about invasive plants and efforts to control them. Information from this survey will be used to develop and refine education programs concerning invasive plants.

Your household has been selected from a random sample of households in Southern Utah. This survey should be completed by the adult in your household whose birthday comes earliest in the year. Your participation is **completely voluntary**; however, in order to understand the opinions of citizens in Southern Utah, **we need your response**. Your answers will be kept **completely confidential**. No record of your name will be attached to your responses.

When you have completed the survey, please fold the booklet in half and return it to us in the enclosed prepaid business return envelope. Thank you for your time and effort in completing this survey. If you have any questions, feel free to contact the survey manager, Leith Tidwell, at the phone number or addresses listed below.

Mark Brunson
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Department of Forest Resources

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Invasive Plant Study

About two weeks ago we sent you a questionnaire concerning invasive plants and their management. Your opinions are important to us. If you have already completed and returned the questionnaire, thank you. If not, we encourage you to take the time to complete it as soon as possible and return it in the prepaid envelope. Your response will help us understand what citizens want for the future management of invasive plants.

In the event that your original questionnaire was misplaced, contact Leith Tidwell (*see below*) and I will send you another copy. Thank you for your help.

Sincerely,

Mark Brunson
Professor

Leith Tidwell
(435)-797-1009
weedsurvey@hotmail.com

Appendix B: Follow-Up Telephone Survey

ID #: _____
 TEL: _____
 NAME: _____
 CONTACT: 1st _____ 2nd _____ 3rd _____
 Call Back: _____

Hello, this is _____ from Utah State University, is Mr\Mrs _____ home?
 May I speak with them? *(If not home ask when they will be home or when would be a better time to contact them. If they are not available ask for any available adult.)* Hi
 Mr\Mrs _____ I'm calling about a survey we recently mailed to your home
 about invasive plants in your area.

Are you familiar with this survey? Yes _____ No _____

If No: Would you like us to send you another copy of our survey? Yes _____ No _____
 If Yes: Get mailing information

Thank them for their time and assure them they will have a copy of the survey within 5-7 days.

If No: Would it be okay if I asked you a few questions from our survey?

If No: Thank them for their time.

If Yes: Proceed with confidentiality statement

If Yes: Our records indicate that we have not yet received your completed survey. In order for our survey results to be most useful, we need to get information from as many citizens as possible. Therefore, I was wondering if I could take just a few minutes of your time to ask some questions concerning invasive plants?

If No: Thank them for their time.

If Yes: Proceed with confidentiality statement

If Callback: Time _____ Person _____

(Confidentiality Statement)

I would like to assure you that this survey is entirely voluntary and confidential. If there are any questions that you feel uncomfortable answering just let me know and we will move on to the next question.

First for statistical purposes we would like to know what reason or reasons you have for not completing the survey?

_____ Time

_____ Not Interested

_____ Did not receive it

_____ Refusal

☐ English not first language ☐ Lack of Knowledge
☐ Lack of reading skills ☐ Forgot
☐ Other (Specify) _____

We'd like to know how much you've thought about invasive plants in your area before we contacted you. Please answer on a scale from 1 to 5, where 1 means you never thought about invasive plants and 5 means you've spent a considerable amount of time thinking about them.

☐ 1 ☐ 2
☐ 3 ☐ 4
☐ 5

Public land management can often involve tradeoffs between natural conditions and economic considerations. On a scale from 1 to 5 with 1 meaning that priority should be given to natural conditions such as endangered species and 5 being that priority should be given to economic considerations such as employment and economic growth, please rate how you feel about these tradeoffs.

1-----2-----3-----4-----5

For the following question concerning multiple use lands, such as national forests or BLM lands where grazing, logging and recreation are managed, I will provide a definition of different control methods used. After each definition please indicate if you feel the method of control is not acceptable, slightly acceptable, moderately acceptable or highly acceptable.

Chemical Control involves the use of herbicides to help maintain and control invasive plants. Do you feel that chemical controls are not acceptable, slightly acceptable, moderately acceptable or highly acceptable for use on multiple use lands.

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
1	2	3	4

Mechanical Control uses methods such as tilling, hand pulling and mowing to physically remove all or part of the plant. How acceptable do you feel this method is on multiple use lands?

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
1	2	3	4

Biological control uses living organisms such as insects and plant diseases to contain and suppress invasive plants. How acceptable do you feel this method is on multiple use lands?

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

Cultural control uses livestock grazing, competition by native plants and revegetation to help favor desirable native species. On multiple use lands, how acceptable to you feel their use is?

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

In reference to the definitions given above please rate how acceptable you feel the use of each method is for lands adjacent to residential areas. Please tell us if you feel the method is Not Acceptable, Slightly Acceptable, Moderately Acceptable, or Highly Acceptable.

Chemical Control

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

Mechanical Control

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

Biological Control

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

Cultural Control

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable

1 2 3 4

We would also like you to rate these methods for acceptability when used on agricultural lands such as pastures, crops and farms.

Chemical Control

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

Mechanical Control

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

Biological Control

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

Cultural Control

Not at all	Slightly	Moderately	Highly
Acceptable	Acceptable	Acceptable	Acceptable
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

On a scale of 1 to 5 please rate how serious a problem you feel invasive plants are in your area where 1 means it is not a problem at all and 5 means it is a serious problem.

1-----2-----3-----4-----5

Finally, we would like to know more about your background. This information will only be used in making comparisons and will remain strictly confidential. Feel free to answer only those questions with which you feel comfortable.

In what year were you born? _____

How long have you lived in your area? _____

What is the highest level of education you completed?

- | | |
|---|-------------------------|
| _____ Did not complete high school | _____ Bachelor's degree |
| _____ High School | _____ Graduate degree |
| _____ <i>Some college, but not a four year degree</i> | |

What type of residence do you currently live in?

- | | |
|---|-------------------------------|
| _____ Large Farm\Ranch (>1,000 acres) | _____ Apartment |
| _____ Small Farm\Ranch (<1,000 acres) | _____ Condominium/townhome |
| _____ Small Rural landowner (<10 acres) | _____ Suburban Home with yard |