URBAN RESIDENTS' PERCEPTIONS ABOUT THE CITY OF AUSTIN'S WILDLANDS

A Thesis

by

LAURA ELIZABETH MARTIN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2010

Major Subject: Rangeland Ecology and Management

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Approved by:

Chair of Committee,	Urs P. Kreuter
Committee Members,	J. Richard Conner
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ABSTRACT

Urban Residents' Perceptions about the City of Austin's Wildlands. (August 2010)
Laura Elizabeth Martin, B.S.; B.S.; M.S., Texas A&M University
Chair of Advisory Committee: Dr. Urs P. Kreuter

Increasing resettlement in and around Austin, decrease in water discharge rates and loss of endangered species habitat led to the creation of the City of Austin wildlands. The study consisted of a mail survey of 1,000 residents living near the City of Austin's Water Quality Protection Lands and Balcones Canyonland Preserve for the purpose of identifying residents' perceptions and knowledge about the wildlands in order to provide direction for the City of Austin Wildland Division's environmental education program. The two specific objectives were to (1) Understand factors that influence residents' knowledge, determine if previous participation in an environmental programs increases their level of knowledge, and to ascertain the effectiveness of different information outlets for increasing residents knowledge about environmental issues pertaining to the Edwards Aquifer and City of Austin's wildlands and (2) Identify factors that influence residents' approval or disapproval of land management actions and the alternative recreation activities on the City of Austin's wildlands.

For objective one, it was expected that socio-demographic variables (eg: older, educated, males that live within Austin for a longer period of time) and behavioral variables (eg: previous involvement in environmental organizations), and acquisition of prior information about the wildlands would be positively associated with wildland knowledge. For objective two, it was expected that residents' management support would be positively associated with the perception that one of the purposes of the wildlands is to protect endangered species, respondents' positive experiences with the wildlands, pro-environmental behavior, and perceptions that the wildlands increase their property value. It was also expected that approval of wildland management actions would be positively associated with the extent to which residents have been negatively

affected by wildlife and their level of concern about wildlife impacts on their property. Also, it was expected that respondents' approval of vegetation management actions, such as the use of fire, would be negatively associated with the extent to which residents have seen smoke on the wildlands and their level of concern about wildfire.

The regression analyses conducted to test the first objective showed positive associations between local newspaper readership and residents' knowledge about environmental issues and the City of Austin's wildlands. Previous pro-environmental behavior by residents positively related to their knowledge about environmental issues pertaining to the wildlands. Furthermore, survey respondents who were older, male, and had lived in the City of Austin for a longer time were positively associated with environmental and City of Austin's wildland knowledge levels. Some strategies for information dissemination about the wildlands include the use of local newspapers and homeowner association newsletters. New City of Austin residents who are younger and live in close proximity to the wildlands are the suggested target audience for initiating a proposed environmental education program.

The results of regression analyses conducted to address objective two showed that approval of wildland management actions were positively associated with knowledge about rangelands and negatively associated with the level of concern about being negatively impacted by management actions used by the City of Austin. Results suggest that knowledge about specific environmental benefits associated with the management actions can improve respondents' support for management actions such as the use of prescribed fire and harvesting overpopulation of deer and hogs.

The results of this study should help the City of Austin by providing (1) information about factors that influence residents' knowledge and suggested information dissemination channels (2) descriptive information about respondents' environmental knowledge levels, and (3) aid to improve an existing education program for the purpose of increasing support for management actions that are critical for attaining the objectives of the WQPL and BCP.

DEDICATION

To my family and friends

ACKNOWLEDGEMENTS

I would like to thank my committee members and my chair, Dr. Urs Kreuter, for guiding and advising me throughout my graduate school term. Thank you for helping me find a project, advising me on courses, and editing my manuscripts through the last couple years.

I would like to thank William Conrad, Kevin Thuesen, Scott Rowin, Daniel Dietz, Dolph Scott, Cappy Smith, Shelly Miller and the many other employees within the City of Austin Wildland Division that helped me throughout the process of collecting data. Also I would like to thank, the City of Austin for funding this project.

Thank you to my fellow colleagues in Dr. Kreuter's lab, Mike Sorice and David Toledo. I am grateful for your friendship; times spent listening to me and providing helpful input. I also acknowledge Tammy Nguyen and Will Yarberry III for their help with data entry.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Page

CHAPTER I
INTRODUCTION

The City of Austin Wildland Division manages and administers two categories of land, which are displayed in Figure 1. The first category incorporates the Water Quality Protection Lands (WQPL). The role of properties in this category is to maintain the high quality of water that discharges from the Barton Springs section of the Edwards Aquifer, and they are strategically located along the recharge and contributing zones of this segment of the Aquifer. The second category is the Balcones Canyonland Preserve (BCP). This preserve was developed in and around the vicinity of Austin to protect habitat for two endangered neo-tropical songbirds, the Black-capped vireo (*Vireo atricapillus*) and the Golden-cheeked warbler (*Dendroica chrysoparia)*, by retaining open space with nesting habitat. Through these two conservation initiatives the City of Austin has acquired critical land for these two initiatives either by purchasing land directly or by conservation easements on privately owned land (Bond Resolution 1992).

The WQPL were purchased as the result of citizens proactively passing two utility bonds in 1998 for the purpose of the long-term sustainability of Barton Springs, a subsequent open space acquisition bond in 2002, and several federal grants and conservation easements (WQPL 2001). These networks of open space preserves are valuable for protecting water quality and quantity in the Austin region because of the vulnerable nature of karst aquifers. For example, pollutants dissolved in the catchment area of several springs in Austin invariably end up in the discharge water at the springs because of the poor filtration characteristics and rapid transmission of water flowing through the karst geology in which the Edwards Aquifer is located (Mahler et al. 1999). The WQPL contains 25,906 acres of land for watershed management within several sub regions that include: Bull Creek, Barton Creek, Slaughter Creek, Beer Creek, and Onion Creek (Austin 1995a).

This thesis follows the style of Journal of Environmental Management.

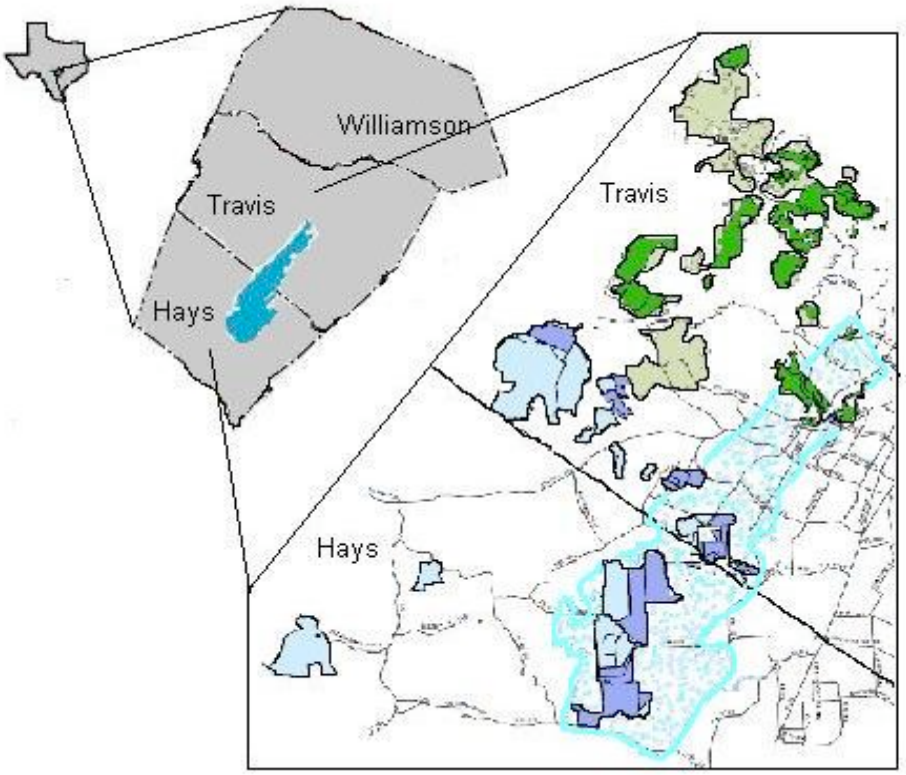

Figure 1. Map of the study area in Austin, TX. The Barton Springs segment of the Edwards Aquifer is located in the blue region across Travis and Hays counties. The WQPL are in the two shades of blue and the BCP areas are in the two shades of green. The dark blue and dark green colors show the City of Austin owned and managed wildlands.

In addition to its water quality protection efforts, the City of Austin also increasingly faced legal risks from impacts of urban encroachment into surrounding areas on the habitat of eight endangered species (2 birds and 6 karst invertebrates) and 27 additional species of concern. In 1992, citizens approved the bond that would aid in acquiring and improving land to protect water quality, conserve endangered species, and provide open space for public access defined within the habitat conservation plan (RECON and USFWS 1996). In 1996, the City of Austin and Travis County developed

a regional conservation plan, the Balcones Canyonlands Conservation Plan (BCCP), to offset any harmful effects to the endangered species and, as result, the U.S. Fish and Wildlife Service issued a federal incidental take permit for the City and County (Conrad et al. 2006). The long-term goal for endangered species habitat is the acquisition of 30,428 acres for the protection of the eight endangered species managed within the BCP; which is a system of habitat preserves established under the BCCP. To achieve this, The BCP incorporates a partnership of organizations and landowners that own and manage land throughout the preserve, including the City of Austin, Travis County, Nature Conservancy of Texas, Lower Colorado River Authority, Travis Audubon Society, and private BCP partners. The major land parcels are located in the following watersheds: Bull Creek, Barton Creek, Cypress Creek, North Lake Austin, South Lake Austin, Pedernales and West Austin (Austin 1995a).

The City of Austin hired the ETC Institute in 2009 to conduct a survey to access citizens' satisfaction of major city services and provide direction to the city by identifying community priorities (ETC 2009). The ETC report of the study provided the following findings that show how creating and managing urban wildlands over the last ten years has improved residents' quality of life, regional water quality, and overall perception of the City of Austin. Survey respondents were satisfied with the city's water conservation program and the quality and number of parks and recreation programs. Despite these results due to the continued residential development in and around the wildlands, the City of Austin has experienced increasing conflict with new neighbors who perceive threats from the nearby city's wildlands.

As a result, the City of Austin funded the study presented in this report to better understand the perceptions and concerns of the neighboring residents regarding perceptions and concerns about the WQPL and BCP. Specifically, the wildland managers wished to understand residents' knowledge and perceptions about the purpose of the WQPL and BCP, bio-physical issues pertaining to them, and management practices and recreation activities on them. They also wished to ascertain residents' perceptions about risks associated with the proximity of their land to the wildlands and

about other rural-urban interface issues. Finally, they wanted to assess residents' willingness to engage in educational programs and environmentally supportive behavior that are beneficial for the maintenance of the WQPL and BCP.

PROBLEM STATEMENT

The increase in urbanization of former rural areas has led to a decline in open space. In turn, this has decreased the area and quality of open space in the contributing and recharge zones for the Edwards Aquifer. In addition, the increase in pollutant runoff due to the increase in impervious surfaces can adversely affect the quality of water discharged from local springs because of the poor filtration characteristics of the karst geology and the rapid passage of water flowing into and through the aquifer. As a result of this growing problem, and the desire of Austin's residents to protect Barton Springs, two land acquisition and management programs were developed by the City of Austin. Through the purchase and management of wildlands, several watersheds in Travis and Hays County are benefiting from an increase in protection of water quality and endangered species habitat.

As residential development continues, there is a knowledge gap about the extent to which residents are affecting or being affected by the wildlands, and about residents understanding of land management practices used by the City of Austin on the wildlands. The awareness, knowledge and attitudes of communities that border the wildlands are currently unclear. The wildlands are experiencing a range of actions from neighbors that interfere with land management activities. These actions include such things as unauthorized access, illegal trail creation and vandalism. Additional rural-urban wildland interface issues include the misapplication of pesticides and fertilizers along with illegal dumping of garbage and non-native plant distribution by residents in the wildlands. To address these issues, the City of Austin has developed an education and outreach program to target the communities adjacent to the wildlands. For this educational campaign to be effective, the overall perceptions and misconceptions of neighboring residents about the wildlands need to be clearly understood.

OBJECTIVES AND HYPOTHESES

The first objectives of this study is to assess specific socio-demographic characteristics that influence residents' knowledge, to determine if previous participation in environmental programs increases their level of knowledge, and to ascertain the effectiveness of different information outlets for increasing residents' knowledge about the City of Austin's wildlands and environmental issues pertaining to the Edwards Aquifer.

The hypotheses that will be tested are:

> (1) The knowledge of the City of Austin's residents about karst aquifers, endangered species, rangelands, and City of Austin wildlands is higher for well-educated, males who have lived in Austin for a longer period of time, reside close to the wildlands, and are members of homeowners associations.
>
> (2) Austin residents' level of knowledge about karst aquifers, endangered species, rangelands, and City of Austin wildlands are positively related to their participation in environmental organizations, level of interest in an environmental education program, their use of local media or Internet as an information source, and their receipt of notices from the City about the wildlands.

The second objective of this study is to identify factors that influence residents' approval or disapproval of land management actions and the alternative recreation activities on the City of Austin's wildlands.

> (3) Residents' management support will be positively associated with the perception that the one of the purposes of the wildlands is to protect endangered species, environmental knowledge levels about the role of fire and negative impacts as the result of the overpopulation of deer and hogs, respondents' positive experiences with the wildlands, pro-environmental behavior, and perceptions that the wildlands increase their property value.

(4) Respondents approval of wildland management actions is positively associated with the extent to which residents have been negatively by wildlife and their level of concern about wildlife impacts on their property.

(5) Respondents' approval of vegetation management actions, such as the use of fire, will be negatively associated with the extent to which residents have seen smoke on the wildlands and their level of concern about wildfire.

(6) Residents' approval of recreation activities will be positively associated with perceived benefits from the wildlands and negatively associated with their perceptions of the purpose of the wildlands is to protect endangered species.

CHAPTER II
LITERATURE REVIEW

KARST GEOLOGY AND THE EDWARDS AQUIFER

The Edwards Plateau is comprised of predominantly limestone bedrock with a few inches of shallow topsoil (Wilcox 2005). The karst aquifer is composed of a network of underground caves and channels that provide an inlet for ground water, and the underground water is rapidly transferred through permeable bedrock (White 2002). There are two types of zones for the Barton Springs catchment: a recharge zone, and a contributing zone. A recharge zone is an area where water actually enters, via cave opening or percolation, the underground labyrinth of caves and channels. A contributing zone is an area that feeds a recharge zone. Most of the subsurface water from these areas enters the aquifer via recharge zone (Hunt et al. 2003).

The attributes of a karst aquifer include thin soils that increase the speed of infiltration and reduce the residence time for necessary biological processes to occur. Because the ground composition is limestone, water flows straight through with almost no filtering (Mahler et al. 1999). Karst aquifer systems are sensitive to developmental pressures because of the vulnerable nature of the recharge features. Surface water that could potentially carry pollutant sediments such as: pesticides, hydrocarbons, metals or other contaminants could discharge into the spring (Vesper et al. 2001). A case study on the environmental degradation of karst systems in the Mediterranean suggests that these systems have high vulnerability to pollution. Karst environments can be rapidly changed through anthropogenic influences, due to the high connectivity of the surface and subsurface networks. The complexities of the geomorphology and hydromorphology of karst systems weaken the opportunity for an effective contamination monitoring system to be established. Reducing degradation will be accomplished as the local population develops more of an environmental awareness (Parise and Pascali 2003).

The Barton Springs segment is the smallest of the three segments of the Edwards Aquifer. It has been estimated that approximately 90% of the flow from this segment of

the aquifer ends up in Barton Springs. The Colorado River is the northern boundary of this segment and a groundwater "bad-water line" divides the southern San Antonio segment of the aquifer. A bad water line is simply a region of the aquifer with a large amount of dissolved solids in the water (Slade et al. 1986). The aerial extent of the Barton Springs aquifer is 155 mi^2 along the Balcones Fault Zone (Hunt et al. 2004). Research has simulated historical trends and predicted future trends of the flow in the Barton Springs segment of the karst aquifer. The goal of this computer model is to predict future regional changes in discharge levels. The stratified nature of karst water levels might now have improved water table predictions (Barrett and Charbeneau 1997).

The watershed of the Barton Springs aquifer has a contributing zone of 684 km^2 and a recharge zone of 233 $km^{2,}$ with a confined zone covering 158km^2. The contributing zone is not located directly above the aquifer, but the surface run off from the Glen Rose formation influences the quantity of water that eventually becomes recharge water. The recharge zone is the area where the limestone outcroppings surface and water infiltrates. The confined area has features, such as Del Rio clay, that prevent the water's penetration (Mahler et al. 1999). The surface water in the aquifer travels east across the contributing zone through one of the many creeks, including Barton, Williamson, Bear, Onion, Slaughter, and Little Bear. When the water reaches the recharge zone, 85% of it is infiltrated and becomes groundwater, which travels north toward Barton Springs and other small springs (Mahler et al. 1999).

Funding from the EPA enabled the Barton Springs/Edwards Aquifer Conservation District (BSEACD) to conduct groundwater dye tracing studies from 1996 to 2001 for the purpose of better understanding the groundwater flow. The results showed that the distance was not necessarily an influence on the time it took the dye to travel from injection to discharge location. This is directly related to the complexity of the flow path through conduits and possible absorption of the organic dye. For example a recharge feature located at Onion Creek traveled 17.3 miles over a period of three days to Barton Springs. This study identified three groundwater basins that flow northeast through different routes. These include the: Cold Springs Basin, Sunset Valley, and

Manchaca region. This research also revealed that streams that were thought to have recharged Barton Springs actually flow into Cold Springs, located on the Colorado River. It is estimated that under high flow conditions, the groundwater can travel four to seven miles in one day, but under low flow conditions the water travels at a daily rate of only 0.6 miles. In conclusion, the groundwater tracing study provided information that confirmed the quick flow nature of this karst aquifer. This data could assist in risk recovery and monitoring if a hazardous spill were to occur around sinkholes, caves, or within the recharge zone area (Hunt et al. 2003).

WATER QUALITY MANAGEMENT

The composition and structure of woody plants in semiarid regions have changed over the last century. Former savannas have transitioned to denser canopy coverage, which in turn creates shrub or woodland ecosystems (Van Auken 2000). Texas was once mostly grasslands and savannahs, but Ashe Juniper and other upland woody native species have become invasive. The Edwards Plateau region in Central Texas has a shallow limestone soil structure that favors Ashe Juniper encroachment (Scifres 1980).

Brush management is one method of increasing water yield in some areas in Central Texas. Modern scientific research has laid the foundation for the WQPL management plans and practices. A study that details clearing juniper and creating a grassland savannah ecosystem to increase infiltration has been published. The three-year study by Owens et al. (2006) measured rainfall and discovered that only about 40% of the rainfall infiltrated into the soil because of the rate of intercept by Ashe Juniper. Huang et al.'s study reconfirms that controlling woody plants that are located above a karst geology increases the streamflow (Huang et al. 2006).

The karst limestone geology type has characteristics such as shallow soils and woody plant encroachment by Ashe Juniper (*Juniperus ashei Buchholz*) (Wilcox et al. 2006). Notably, karst geology and Ashe Juniper (*Juniperus ashei Buchholz*) relationships in the Edwards plateau are not well understood (Dasgupta et al. 2006). Some research conducted in the western region of the Edwards Plateau suggests that clearing juniper from small catchments without springs present has no substantial effect

on streamflow (Wilcox 2005). However, for the rangelands in Texas where the WQPL are located, the relationship between woody plant density and streamflow has been found to be significant. An increase in water yield was recorded in areas where the upland regions have deep drainage features. When deep-rooted plants are removed in upland areas they can no longer access the groundwater reservoirs. Shallow rooted plants do not affect the reservoir conditions because the water is unavailable due to the geologic conditions (Wilcox et al. 2006). Another study by Huang et al. noted a 46 mm annual increase in streamflow as the result of juniper removal on karst landscapes (Huang et al. 2006). In conclusion, catchments that are spring-fed and have a karst geology have the potential for an increase in streamflow when woody plant establishment is controlled.

The reason Ashe juniper (*Juniperus ashei Buchholz*) decreases water yield is due to their dense canopies that intercept precipitation, as well as the requirement for increased soil moisture (Thurow and Hester 1997; Olenick et al. 2005). Alternately, it should also be noted that another study concluded that removing juniper has no overland effect (Dugas et al. 1998). Clearly, brush removal practices can increase water yields when the soil, geology, and water processes are of a certain condition (Dugas et al. 1998; Olenick et al. 2005). Beginning in 1996, 15-minute intervals have been recorded to track the conductance rate at the main spring (Massei et al. 2007). Real-time data on the conductance level of twenty-six springs, creeks, and streams in Travis County can be found at http://tx.usgs.gov. Management plans on the WQPL take the hydrogeologic and ecological conditions into consideration, creating goals and implementing practices that will maximize the water yield (Dasgupta et al. 2006).

ENDANGERED SPECIES ASSOCIATED WITH THE EDWARDS AQUIFER

Two neo-tropical migratory songbirds and six karst invertebrates are noted as endangered species within the Balcones Canyonland Conservation Plan. There are an additional twenty-seven species of concern, which range from various karst invertebrates and two plants including the Canyon Mock Orange *(Philadelphus ernestii)* and Texabama Croton *(Croton alabamensis var. texensis)*. The Golden-cheeked warbler

(Dendroica chrysoparia) (GCW), Black-capped vireo (*Vireo atricapillus*) (BCV), and the Barton Springs Salamander are the main species focus for management considerations for the City of Austin's wildlands (Austin 2008).

The GCW and BCV are similar in that they are neo-tropical migratory songbirds that spend more than half of the year in Central/South America for the winter and migrate to more temperate climates in the mid-March until and June for breeding. The BCV is endangered because of habitat loss due to brush clearing, fire suppression, and urbanization. The GCW is threatened due to habitat fragmentation and rapid urban development throughout Central Texas (Damude 2003).

One endangered bird species in Central Texas that relies on Ashe-juniper is the GCW. Its habitat range is throughout thirty-three counties in Central Texas and South Texas (Dramude 2003). Its nesting habitat consists of large blocks of juniper-oak vegetation and they forage in oak understory areas (Kroll 1980). They need a combination of dense mature juniper and mixed hardwood with a canopy of 15 ft for nesting because the shredded bark is used as material in nests. Each pair needs 3 to 6 acres for breeding and up to 5 to 20 acres for total habitat. The diet consists of mostly insects such as caterpillars, spiders, and beetles that are usually in canyon bottomlands and along creeks. Populations are also impacted by cowbird parasitism (Dramude 2003).

Another endangered species that inhabits a mixture of woodlands and grasslands in Central Texas is the BCV. The BCV's breeding habitat preference is patchy shrub-oak growth with moderate tree cover of irregular height (Graber 1961). Grzybowski et al. 1994 study suggested BCV select habitat areas with low thick deciduous vegetation distributions with 30 – 60% total cover area (Grzybowski et al. 1994). Plant composition in Texas is usually Ashe juniper, Texas oak, live oak, sumac, Texas persimmon, and other species in mid-successional stages (Rollins and Armstrong 1997). The plant composition is not as important as the nature of open grassland and mixed woody shrubs (Dramude 2003). The BCV breeds from March to late April in temperate climates and then migration occurs from July to September (Graber 1961). The spatial distribution of the local population ranges from Central Texas, Oklahoma, and Mexico

(Dramude 2003). The BCV's diet consists of small insect, larvae, small spiders, and flies (Graber 1961). An additional threat to the BCV is nesting parasitism by the Brown-headed cowbirds. The cowbirds lay eggs within the vireo nest and often remove the vireo egg. The cowbirds also attempt to poke tiny holes in the eggs of the vireo (USFWS 1991).

In 1997, the Barton Springs salamander (*Eurycea sosorum*) was listed as an endangered species by the federal and state government. Even though it is not one of the main focal species in the BCCP the salamander benefits from the water quality improvements through the preservation of open space within the recharge zone. The threats include water quality degradation through such avenues as groundwater contamination, increased water loss, and chemical spills. The salamanders' only documented habitat is within four spring (Main, Eliza, Sunken Garden, Upper Barton) outlets in Austin, TX. The habitat characteristics are stenothermal meaning that it exists at only a narrow temperature range. Its diet includes small ostracods, larvae, and snails. The salamanders can reproduce year round and females become sexually reproductive within 11 to 17 months after hatching. The longest living salamander in captivity is known to be 10 years old. Currently the City of Austin has a monitoring program for water quality and salamanders as well as a captive breeding program (USFWS 2005).

The BCCP includes the six endangered karst invertebrates that spend their lives in caves. These include the Tooth Cave Ground Beetle (*Rhodine Persephone*), Tooth Cave Pseudoscorpion (*Tartarocreapris texana*), Tooth Cave Spider (*Neoleptoneta myopica)* Kretschmarr Cave Mold Beetle (*Texmaurops reddelli*) and Bone Cave Harvestman (*Texella reyesi*). Not much is known about the biology of each of these species. All have adaptations to their environment for survival and feed on tiny insects and organic matter (Austin 1995b).

INFORMATION CHANNELS AND ENVIRONMENTAL KNOWLEDGE

Previous studies suggest that the public tends to more frequently use mass media (newspapers, television) for sources of environmental information (Steel et al. 1990; Brothers et al. 1991; Jacobson et al. 2001). Newspapers have been found to be a more

important information source than television or radio (Bailey 1971). Although television has been recorded as the most frequently used source for obtaining environmental information respondents who read newspapers have higher levels of environmental knowledge (Brother et al. 1991). Alaimo and Doran's (1980) results suggest that radios and magazines focusing on nature issues were important sources of natural resource information. Not all previous studies found mass media sources to be the preferred or most useful method of communication. Several studies had results that suggested interpersonal communication with agency personnel, personal experiences, and interactive methods (field trips, presentations) were more useful information sources than newspapers, television, and environmental groups (Force and Williams 1989; Wright 2000; Williams 2001).

Studies have mixed results on the relationship between television viewership and environmental knowledge. One studies result suggests that respondents who viewed more television were less likely to behave in an environmentally positive manner (Ostman and Parker 1987). Contrary to this, Brothers et al. (1991) study measured the impact of a television program on viewers' environmental knowledge. After viewing a certain program participants were asked to fill out a survey of environmental questions that included some which had been presented on the television show and some that had not been discussed on the television program. Survey respondents that had viewed the television program had higher knowledge scores. But when the use of television and newspaper readership are compared residents' knowledge of the Great Lakes showed that newspaper readers were more knowledgeable than those who relied on television as a source of environmental information (Brothers et al. 1991). The mass media can be an effective information dissemination tool. For example, in one study local newspapers and television increased residents' knowledge about political candidates (Becker and Dunwoody 1982).

Local newspapers are useful information channels but they are limited in the amount of detailed information they present. A study conducted by Laurian (2003) measured information through frequency of newspaper readings, attendance of meetings,

and percent to which residents felt informed about environmental issues. The results showed that newspapers and social networks increased awareness but were insufficient in providing detailed information about environmental issues. For example, reading the local newspaper increased residence awareness of toxic sites but did not increase their information levels on the status of these sites (Laurian 2003). Steger et al. (1988) study examined information sources related to residents' knowledge acquisition regarding the ecology of acid rain. Neither newspapers nor television were effective channels for educating the public in Ontario, CA and Michigan about the complicated issues of acid rain. Newspapers were rated the most important information channel but they did not correlate with knowledge levels.

Other studies results suggest that the public's most useful method of communication were newsletters and brochures (Branson and Reiter 1996). The use of brochures for information distribution might be an effective method but there are mixed results for this action increasing knowledge. Residents living in the rural-urban interface of Orange County, California, were issued an educational brochure discussing elements of living close to nature (George and Crooks 2006). Later, a questionnaire was issued to residents who had received the brochure and to those who had not, to test the differences in knowledge, perceptions, and attitudes. The results showed small, but significant, differences between the two groups of residents only 21% of residents issued the brochure remembered receiving it. They also suggest that tailoring future educational efforts may be more effective Young and Witter (1994) suggest that follow up communication after brochures are distributed might encourage residents to read the material.

SOCIO-DEMOGRAPHIC INFLUENCES ON ENVIRONMENTAL KNOWLEDGE

In previous studies, questionnaires have been used to gather information about the publics' perspective on a variety of environmental issues (Kellert 1979). Several surveys direct their population of interest toward specific types of stakeholders (Riley and Decker 2000; West and Parkhurst 2002). Similar to this study, other studies

addressing wildlife issues in urban areas have directed surveys toward residents living next to large tracts of public lands (Schoenecker and Shaw 1997; Chase and Decker 1998; Enck and Brown 2002). Several studies on pro-environmental behavior suggest that young, educated, and liberal people were more likely have proactive environmental positions (Arbuthnot 1974; Van Liere and Dunlap 1981; Mohai and Twight 1987; Arcury 1990; Schultz and Stone 1994; Theodori and Luloff 2002). However, one study found that the level of education was not relevant in explaining individual related knowledge about industrial pollution near the Great Lakes (Steel et al. 1990). A couple studies found males to have higher levels of environmental knowledge and concern about environmental issues (Arcury 1987; Hobert et al. 2003). Additionally, Hobert et al. (2003) results suggest that older males had more environmental concern, but Reading et al. (1994) study's results suggest that younger females scored high on questions pertaining to ecosystem management actions in the Greater Yellowstone area.

Personal experience seems to be a useful predictor in explaining environmental knowledge. Studies have found that prior environmental organizational membership and higher education levels were associated with environmental knowledge (Maloney and Ward 1973; Heer et al. 2003). Another study conducted a mail survey in the Central Cascades Adaptive Management Area within western Oregon focused on understanding residents public environmental knowledge and preferred method of information exchange. A random sample was selected from telephone directories and an attentive public sample was selected from a pre-existing list of stakeholders from the USFS. The attentive public were people who had previously requested to receive information about natural resource issues in their local watershed. Results suggested that the attentive public sample were more knowledgeable about environmental issues pertaining to their local watershed. Additionally, they scored higher on the survey section pertaining to forest management knowledge (Williams 2001).

Place based perceptions comparing urban to rural people have suggested that urban people are more likely to be concerned with environmental issues (Buttel and Flinn 1976; Van Liere and Dunlap 1981; Fransson and Garling 1999; Brody et al. 2004).

Residents' proximity to an environmental area and residence length has had a significant relationship with knowledge. Brody et al. (2004) suggest that environmental perception can be a location-based variable as well as a socio-economic and demographic variable. Residents' proximity to the creeks in their study was significantly related to perception, knowledge, and familiarity. Larson and Santelmann (2007) also took into consideration how the proximity to the resources related to the residents' knowledge and attitude of the issue on hand. Proximity to water was significant in explaining the support, concern, and importance of the natural resource. Long-term residents who lived closer to the creeks were more aware of pollution. Laurian's (2003) study found that residence length was a significant predictor of awareness of local toxic sites within the region, but other socio-economic variables such as age, gender, and education were not significant (Laurian 2003). Similarly, William's (2001) study found that respondents who had lived within the watershed area longer were more knowledgeable about the forest processes.

Knowledge of residents who access the environmental area is higher than those citizens who do not access the lands. A study on the publics' knowledge toward ecosystem management showed that citizens who used the Elgin Air Force Base Natural Resource areas were more knowledgeable about the forest, fire ecology, native and endangered species than other citizens (Jacobson and Marynowski 1997). This could be a reflection of the users' exposure to systems at Eglin. Accessing the land may influence their attitudes, which highlights some indirect relationship between knowledge and attitudes (Hungerford and Volk 1990). Furthermore, a study focused on understanding recreationist perceptions and knowledge about forest suggested that frequency and duration of forest visit had no significant relationship with forest perception and knowledge (Heer et al. 2003).

FACTORS INFLUENCING MANAGEMENT SUPPORT

Support or management actions may increase as a result of knowledge but decrease in response to the risks associated with such actions. Some have argued that technical knowledge influences citizen's judgment and acceptability of management practices; however, they also acknowledge that it is possible that increased

understanding may reinforce citizen's opposition toward a management practice (Stankey 1996). Contrary to this, other studies suggest that participants in educational programs who learn about the benefits of fire are more likely to support fire usage as a management tool (Jacobson et al. 2001; Loomis et al. 2001). As the result of the Texas Master Naturalist (TMN) training program participants knowledge increased and attitudes about natural resource management became more supportive (Bonneau et al. 2009). A survey to measured residents' acceptance capacity for cougars in Montana and the results showed that cognitive risks were much higher than actual risks and the higher the associated risk the lower the wildlife capacity. Underlying values are more likely to influence perceived risk rather than knowledge of cougar behavior. Low education levels correlated with high-risk perception, but that does not imply that education would modify risk perceptions (Riley and Decker 2000).

Approval of lethal methods for controlling wildlife is influenced by ecological knowledge, level of concern of being negatively influence by wildlife, and perception of wildlife. Loker et al.'s (1999) study focused on exploring the social acceptability of wildlife management actions for deer, geese, and beavers within three suburban areas in New York. As residents experienced more severe problems with wildlife their concern about wildlife increased. Furthermore, their acceptance of lethal and invasive management actions meant to control wildlife populations also increased. Approval of lethal methods for controlling white-tailed deer in suburban areas in New York were related to resident's level of concern about personal economic damage and perceptions of wildlife as a nuisance (Loker et al. 1999). In contrast a similar study found that urban residents' perceptions toward wildlife near three national parks in Colorado influenced their support of applying lethal methods for controlling wildlife populations. Results suggest that the urban-wildland communities perception implies a developing social construct "suburban deer." These deer are no longer "wild" but because of the interaction with people and behavioral changes they have become "human-made subspecies" viewed as pets or pests. With respect to wildlife management, communities had negative reactions toward hunting deer in a suburban environment (Leong 2010).

Management support is also related to frequency of experience and conflict with wildlife. Citizens' attitudes towards elk management in Colorado indicated that residents desired to see elk near their homes and were not concerned about the landscape-damaged cause by the elk. The residents (84%) indicated that the Colorado Division of Wildlife should make the final decision for wildlife management after receiving public input (Chase and Decker 1998). A study communicated the problem of an overpopulation of hogs to hunters with the idea of hogs competing with other game animals for food. This motivated hunters to support the hog-removal program, which would also benefit endangered species and forest regeneration. The specific message was framed in such a way to attract the audience to support the program's objectives (Jacobson 2005).

Perceptions of management practices can be influenced by perceived risks of wildlife. Residents who experience wildlife problems are more likely to have an opinion about the wildlife management. Respondents who had experienced severe damage from white-tailed deer were more likely to consider deer a nuisance and this influenced their perception in a negative manner. This highlights that individuals' experiences influence their opinions (West and Parkhurst 2002). Some studies suggest that environmental knowledge are good predictors for environmental risk perceptions; however, Steel et al. (1990) results suggest that value orientations are stronger predictors for how the public perceives risk dealing with pollution in the Great Lakes (Steel et al. 1990).

Socio-demographic influences on management support are less important indicators than knowledge, personal benefits, and level of concern. However, variables such as age, gender, and proximity were significant in explaining variation in management support for several research projects. Resident's proximity to fires in Florida did not change opinions about the risk and benefits of prescribed burning or their intension to reduce the risk of fires by altering their landscape (Jacobson et al. 2001). A study on the reintroduction of wolves found that opposition was higher for residents living near the reintroduction site compared with residents in the broader geographic area. There was 20% of the sampled survey who were not well-informed enough to

have an opinion on the issue (Schoenecker and Shaw 1997). Proximity to a natural resource can influence attitudes, concern, and support of management practices on those lands. Residents living near a national park in Uganda had favorable attitudes towards the forest and wildlife conservation efforts and conservation education. When community attitudes varied they were influenced by socioeconomic factors, personal perceived benefits of conservation, exposure to educational efforts, and resource use conflicts (Oonyu 2009).

KNOWLEDGE AND BEHAVIOR RELATIONSHIP

While education may increase knowledge it might not necessarily change behavior. Several recycling studies have suggested that the information distributed was not sufficient to change behavior. Distributing information increased knowledge, but only a small percent of individuals changed their behavior (Oskamp 1998; Schultz 2002). Schultz (2002) highlights recycling behavior and suggests that the context of its occurrence can be conducive to motivation or restraining the action. Information campaigns can be ineffective because they ignore motives. Insufficient knowledge may restrict recycling behaviors, but knowledge in and of itself is not a motive for recycling (Werner and Makela 1998). Motives associated with recycling behavior include benefits derived, personal inconvenience, and external pressures from the community (Oskamp 1998). Although the relationships between information dissemination and behavioral responses are complex, research agrees that information provision alone is unlikely to motivate the adoption of new behaviors (Hungerfold and Volk 1990; Schultz 2002). While various forms of knowledge can complement each other to foster environmentally sound behavior, situational constraints can limit the influence of knowledge on behavior. Fore example social knowledge can constrain an individual even when all other forms of knowledge converge towards a common goal (Kaiser and Fuhrer 2003). Some research suggests that environmental experiences are a major indicator influencing environmental behavior. Finger's study suggests that environmental experiences are one of the main factors in predicting environmental behavior (Finger 1994).

CHAPTER III
FACTORS INFLUENCING RESIDENTS' KNOWLEDGE ABOUT THE URBAN WILDLANDS AND THE POTENTIAL FOR ALTERNATIVE DISSEMINATION STRATEGIES FOR INFORMING RESIDENTS

INTRODUCTION

The City of Austin Wildland Division manages and administers two categories of land, the Balcones Canyonland Preserve (BCP) and the Water Quality Protection Lands (WQPL). The Balcones Canyonland Preserve was established in 1996 for the purpose of protecting habitat for two endangered migratory songbirds, the Black-capped vireo (*Vireo atricapillus*) (BCV) and the Golden-cheeked warbler (*Dendroica chrysoparia*) (GCW). The BCP is the result of an incidental take permit issued to the City of Austin and Travis County by the U.S. Fish and Wildlife Service designed to offset any harmful effects to the endangered species. In addition, in 1998 the public voted on two separate utility bonds, which created the WQPL for the purpose of maintaining high quality water that discharges from the Barton Springs section of the Edwards Aquifer. Through these two programs the City of Austin has procured a total of 22,627 acres of land either by fee-simple purchase or through the acquisition of conservation easements on privately owned land.

As residential development continues around these protected lands, there is a knowledge gap about the extent to which residents are affecting or being affected by the two categories of wildlands. Additionally, there is limited information on residents' understanding of the land management practices used on the City of Austin's wildlands. Some human-associated changes that threaten the wildlands include misapplication of pesticides and fertilizers, introducing non-native and exotic plants, vandalism, and illegal trail creation that can result in loss of native vegetation, and soil erosion.

The purpose of this study is to better understand City of Austin's residents' knowledge about environmental issues pertaining to the Barton Springs section of the Edwards Aquifer region and the City of Austin's wildlands. Specific objectives were to

assess specific socio-demographic characteristics that influence residents' knowledge, to determine if previous participation in environmental programs increased residents' level of knowledge, and to evaluate the effectiveness of different information outlets to increase residents' knowledge.

Studies have been conducted to determine factors that influence residents' knowledge about the environment. Variables found to be important predictors of environmental knowledge include: income, younger age, males, higher education levels (Arbuthnot 1974; Van Liere and Dunlap 1981; Arcury 1987; Arcury and Johnson 1987; Mohai and Twight 1987; Arcury 1990; Schultz and Stone 1994; Theodori and Luloff 2002) and prior environmental organization membership (Maloney and Ward 1973).

Studies associated with prior information sources and their influence on resident's environmental knowledge can be categorized into formal (television, newspapers, radio) or informal (social networks) sources. Newspapers have been found to be a more important information source than television or radio (Bailey 1971). Some have found newspaper readership to have a significant positive relationship with environmental knowledge (Ostman and Parker 1987; Brothers et al. 1991). Earlier studies found that informal sources of information such as interpersonal communication increase citizens' environmental information pertaining to local issues (Greenberg 1964; Bailey 1971). A more recent study found that attending public meetings and living in a community with active local environmental groups were two statistically significant variables that led to increased information levels (Laurian 2003).

Based on information obtained from a pre-survey focus-group meeting with the City of Austin Wildland Division staff it was decided to focus the survey on three categories of information: 1) Knowledge about the general ecology of the Edwards Aquifer region, 2) Knowledge about the City of Austin's wildlands, and 3) Project specific operations. Another pre-survey focus-group meeting with selected residents was conducted for the purpose of gathering preliminary information regarding residents' knowledge about the Barton Springs section of the Edwards Aquifer and City of Austin's wildlands.

These meetings led to the development of two hypotheses: 1) Urban residents' knowledge about karst aquifer geology, endangered species, rangelands, and City of Austin's wildlands is positively related with well-educated males, who have lived in Austin for a longer period of time, reside close to the wildlands, and are members of homeowners associations: 2) Urban residents' knowledge about karst aquifer geology, endangered species, rangelands, and the City of Austin's wildlands is positively related to their participation in environmental organizations, level of interest in an environmental education program, their use of local media or Internet as an information source, and their receipt of notices from the city about the wildlands.

METHODS

A mail survey of 1,000 urban residents who live near the City of Austin's wildlands was conducted in June and July of 2009. Figure 2 shows the two categories of wildlands within Travis and Hays counties where the survey was conducted.

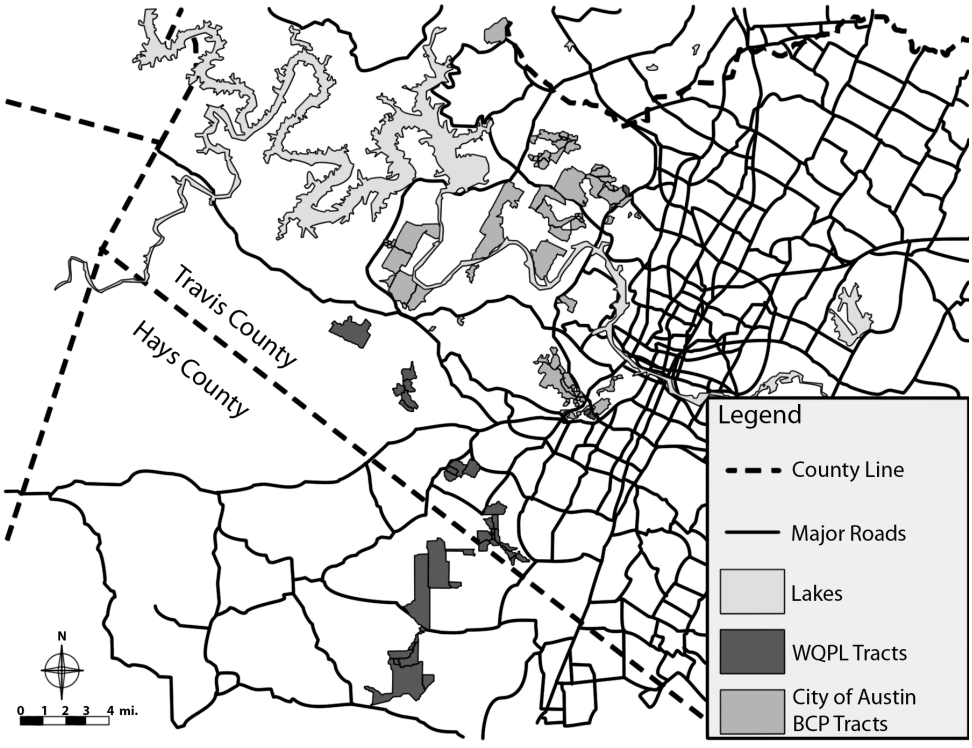

Figure 2. Map of the two categories of wildlands that are owned by the City of Austin.

The residents were randomly selected from within the half-mile buffer created around the fee-simple purchased WQPL areas and the City of Austin's units for the BCP. The population of the study was defined to be all residents living within the half-mile buffer created around the selected wildland tracts. The term survey participant refers to the 1,000 randomly selected urban residents. The study sample consists of the survey respondents from within the population who mailed back the questionnaire. The study area was located in the regions surrounding the BCP (13,577 acres) in Northwest Travis County and the WQPL (9,050 acres), which are located in southern Travis and northern Hays Counties (Austin 2008). For each category of wildland, 500 urban residents were randomly selected from the Travis and Hays county tax records.

The 12-page questionnaire consisted of five primary categories of inquiry. These included: (1) General information about survey participants and their property; (2) Knowledge about karst aquifers, endangered species, rangelands and the wildlands: (3) Knowledge about the purpose, use, management and issues of the wildlands; (4) Broader environmental awareness and education; and (5) Personal demographic information. Questions used in the data analyses were open ended, categorical, or provided the opportunity for the survey participant to select true/false or don't know.

The mail survey was administered using the Dillman multiple-contact technique, which is aimed at maximizing survey participant response rates (Dillman 2000). Over a time period of fifty days there were five mailings sent to each survey participant. The first step (day 1) to the procedure was a pre-survey letter that notified participants that they would be receiving a survey questionnaire. It also emphasized the value of them participating in the survey. On day 7 the initial survey questionnaire was mailed along with a cover letter. A thank you/reminder card was mailed on day 21. An additional questionnaire with a reminder letter was sent on day 35 and on day 49 a final reminder card to the non-respondents.

In addition to the primary survey, a non-response survey was conducted to explore if there were significant differences between respondents and non-respondents. To

conduct this second survey, a one-page non-response survey questionnaire was sent in the fall of 2009 to 300 randomly selected Austin residents from whom there had not been a completed questionnaire received from; of the 300 participants 54 submitted (18% of all non-respondents) completed the short questionnaire.

Data were entered into a Microsoft Excel spreadsheet and then transferred to and analyzed using the Statistical Package for the Social Sciences (SPSS). Statistics used to analyze the data include Mann-Whitney U test, crosstabs analysis, and multiple regression analysis to assess the extent to which dependent variables can be explained by the independent variables. The dependent variables for knowledge scores were based on a percentage of correct answers. Specifically, a score was calculated from the true/false section for karst aquifer, endangered species, rangeland ecology, and City of Austin's wildland segments of the questionnaire. Twelve multiple regression analyses were conducted; there were 4 dependent variables with 3 groups of independent variables for a total of 21 independent variables. The results are discussed by groups of regression analyses that include 3 regression analyses for each dependent variable. The discussion will summarize the results by grouping karst aquifers, endangered species, and rangeland ecology as environmental knowledge and then the City of Austin's wildlands. These independent variables can be grouped into categories based on socio-economic, demographic, information channels, and environmental behavior. Due to the exploratory nature of this study, statistical significant was determined when $p \leq 0.100$. This p-value was selected to avoid the risk of eliminating possibly significant variables that could aid further research efforts.

RESULTS

Of the 1,000 survey questionnaires that were mailed out, 36 surveys were returned because they were undeliverable and 450 survey participants, including 233 BCP and 217 WQPL participants, resulting in a 47% raw response rate. Of the questionnaires returned by survey respondents, 337 were completed and useable, producing a net response rate of 35%. The non-respondent bias analysis indicated statistically significant differences with respect to notification of prescribed fire ($x^2=5.74$, df=2,

p=0.057), observation of Austin personnel patrolling the wildlands (x^2=5.74, df=2, p=0.013), and perceptions that the wildlands increased their property value (x^2=7.73, df=2, p=0.021). The statistical differences suggest that respondents are more aware than non-respondents of the actions that take place on the wildlands and perceive that their properties are more valuable as the result of living near the wildlands. Past literature associated with surveys suggest that the only widespread finding between non-respondents and respondents is that respondents tend to be better educated than non-respondents (Kanuk 1975). Consequently the results are reported for respondents only and not the broader survey population. The results of this study are presented in three parts (1) predictors of knowledge (2) City of Austin's wildlands knowledge, and (3) regression analyses for knowledge scores.

Predictors of Knowledge

A summary of general socio-demographic characteristics of respondents is displayed in Table 1. There were statistically significant differences between the BCP and WQPL respondents for all the socio-demographic variables except for gender distributions. In general, BCP respondents had a higher level of education, more valuable property, and more had accessed the wildlands at least one time. By contrast, more WQPL respondents lived more than a block from the wildlands and had not previously heard of the wildlands, but more WQPL respondents had received prior mailings from the City of Austin wildlands due to the frequent use of prescribed fire on these lands.

On average, respondents had lived in or near the City of Austin for 20 years (SE=13.95) and resided at their current address for 10 years (SE=8.29) and 7% more respondents from the WQPL group had lived at their current address for less than 10 years. Almost all (99.7%) respondents owned their property and lived on a single house residential lot. With respect to property values and household income, half of the respondents owned a home valued greater than $350,001 (Median range, 6=$350,001 to $400,000) and an income greater than $125,000 (Median range, 5=$125,000 to $150,000). There were 83% of respondents that had at least a bachelor's degree and

57% of respondents were males. Additionally, 72% of respondents were members of homeowners associations.

Comparing residents' who lived near the selected WQPL and BCP lands there were statistically significant differences in respondents' knowledge about access points to the wildlands (x^2=22.66, df=1, p<0.001). More BCP respondents knew the access points than WQPL respondents. Also, significantly more BCP respondents had accessed the wildlands at least one time (x^2=6.48, df=1, p<0.011). With respect to frequency of accessing the wildlands around 42% of respondents had accessed the wildlands at least one time within the last year and there were 10% more respondents who had accessed the WQPL one to five times than that of the BCP.

One important aspect of the study was to evaluate how best to provide information to residents about the City of Austin's wildlands. When asked to indicate from which information channels they had previously heard about the wildlands, 38% of the respondents selected local newspapers, followed by local television (27%), City of Austin mailings (22%), and Internet (18%). Surprisingly only one-third of all homeowner's association members had previously received mailings from the City of Austin Wildlands Division.

Residents located near the BCP and WQPL had similar response patterns for questions regarding their previously used and preferred information channels (newspaper, Internet, local TV) and environmental behavior. However, there were statistically significant differences in the number of BCP and WQPL respondents that had received mailings from the City of Austin's wildlands (x^2=10.06, df=1, p=0.002). More WQPL respondents had received mailings from the City of Austin. Additionally one-forth of all respondents reported that they had not previously heard of the wildlands, and there were significantly more WQPL respondents who had not previously heard of the wildlands (x^2=3.67, df=1, p=0.055).

Table 1. Predictors of knowledge.

Demographic characteristic	BCP	SE	WQPL	SE	Difference	Statistic
Mean age of respondent	54.2	0.96	50.5	0.95	3.7	z=-2.79, **p=0.005**
Mean residence length in City of Austin	21.8	0.76	18.7	1.01	3.1	z=-2.15, **p=0.032**
Mean residence length at current address	11.4	0.46	8.5	0.57	2.9	z=-2.84, **p=0.004**
% Male respondents	58.8		59.4		-0.6	x^2=0.01, df=1, p=0.919
% Obtained at least a Bachelors degree	92.4		77.4		15.0	x^2=14.57, df=1, **p<0.001**
% Annual income > $125,000	62.6		44.4		18.2	x^2=9.88, df=1, p=0.002
% Property value > $350,001	73.9		40.1		33.8	x^2=37.07, df=1, **p<0.001**
% Own their property	100.0		99.4		0.6	x^2=1.06, df=1, p=0.304
% Homeowners association members	68.6		76.8		-8.2	x^2=3.51, df=1, **p=0.061**
% Located more than a block from wildlands	49.3		69.0		-19.7	x^2=10.95, df=1, **p=0.001**
% Knows points of access to wildlands	63.7		37.7		26.0	x^2=22.66, df=1, **p<0.001**
% Accessed wildlands at least once	41.3		28.0		13.3	x^2=6.48, df=1, **p=0.011**
% Received information from local newspaper	40.5		35.4		5.1	x^2=0.93, df=1, p=0.335
% Received information from local TV	27.2		27.4		-0.2	x^2=0.03, df=1, p=0.955
% Received information from City of Austin	16.0		30.7		-14.7	x^2=10.06, df=1, **p=0.002**
% Received information from Internet	15.6		20.7		-5.1	x^2=1.49, df=1, p=0.222
% Not previously heard of wildlands	20.8		29.9		-9.1	x^2=3.67, df=1, **p=0.055**
% Participated in environmental organization	30.2		24.4		5.8	x^2=1.39, df=1, p=0.238
% Participated in City of Austin program	4.7		5.6		-0.9	x^2=0.13, df=1, p=0.715
% Would participate in environmental class	51.5		45.6		5.9	x^2=1.13, df=1, p=0.288
% Would host an environmental class	19.4		8.1		11.3	x^2=8.76, df=1, **p=0.003**
% Would join an environmental program	33.1		23.3		9.8	x^2=3.93, df=1, **p=0.048**

This study also explored residents' past environmental behavior and environmental interest. Survey participants were asked to answer several statements about whether they had or would participate in an environmental education class, become a member of an environmental program, or host an education class. With respect to previous involvement in an environmental organization, only 5% of respondents had participated in an environmental program regarding the City of Austin's wildlands. Additionally, 27% of respondents had previously participated in any environmental organization at some time. The proportion of respondents who had previously participated in an environmental organization was similar to those willing to become a member of an environmental education program (27%). Not surprisingly, there were more respondents that thought environmental education programs were important (70.6%) than those willing to participate in a class (47%). However, there were differences between BCP and WQPL respondents' overall interest in an environmental education program. There were more BCP respondents willing to join (x^2=8.75, df=1, p=0.003) and host (x^2=3.93, df=1, p=0.048) environmental education programs. Only 14% of respondents were willing to host an environmental education class in their neighborhood. Additionally, one-third of respondents were undecided about whether or not they would become a member of an environmental education program.

City of Austin's Wildlands Knowledge

To understand their current knowledge level and major misconceptions about four categories of environmental issues pertaining to the Edwards Aquifer and City of Austin's wildlands, survey participants were asked several statements about karst aquifers, endangered species, and rangeland ecology. (1) Statements about karst aquifers focused on karst geology, limestone function, recharge features, beneficial characteristics within the contributing zones to increase discharge rates, direction of water flow, and identification of local discharge features. (2) Statements about endangered species addressed GCW's and BCV's preferred habitat features migratory songbirds' local predators, endangered salamander habitat locations, and the impact of chemicals on endangered species habitat. (3) Statements about rangeland ecology

focused on ecosystem services, role of fire on rangelands, grassland ecology, impact of soil erosion, and the effects of high populations of white-tailed deer and feral hogs. (4) Statements about the City of Austin's wildlands focused on knowledge of the funding sources that acquired these lands, managing partners, general location of the wildlands, and broad statements about how management practices influence endangered species habitat and water quality. Table 2 summarizes BCP and WQPL survey respondents' average percent correct response scores for each section.

Table 2. Mean knowledge score grouped by respondents' proximity to wildland type.

Dependent variables	BCP	WQPL	Difference	Statistic
Karst Aquifer	43.4	44.2	-0.8	z=-0.13, p=0.612
Endangered Species	52.5	49.5	3	z=-1.01, p=0.313
Rangeland	62.9	57.3	5.6	z=-1.77, p=0.077
City of Austin wildlands	36.2	37.3	-1.1	z=-0.51, p=0.612

There were no statistically significant differences between WQPL and BCP survey respondents' knowledge scores with respect to karst aquifers (z=-0.13, p=0.612) or endangered species (z=-1.01, p=0.313). The majority of survey respondents knew that fertilizers used with the recharge and contributing zone could affect the water quality. The major misconception about karst aquifers was that half of the survey respondents thought that limestone karst acts as a good filter for impurities in surface water percolating through it. With regards to endangered species, at least half of the survey respondents knew the habitat characteristics of the GCW and Barton Spring's salamander. However, more than half of the survey respondents were uncertain of the impacts of the brown-headed cowbird on these endangered migratory songbirds.

At least 60% of survey respondents correctly identified the definition of a rangeland and their associated ecosystem services such as carbon sequestration and water filtration. Approximately 75% of all survey respondents knew that a decrease in

perennial grasses tends to result in increased soil erosion. Survey respondents also knew that an increase in ground cover by grasses improves water infiltration (70%).

The survey section with true/false statements about the history of the City of Austin's wildlands resulted in the least amount of correct responses indicating widespread lack of knowledge about these protected areas. This section focused on the location and expanse of the wildlands, history of land procurement, use of conservation easements, effectiveness of different ecology management practices, and managing partners of the City of Austin's wildlands. About 75% of survey respondents correctly answered that water quality and endangered species habitat can be affected by land management practices on the wildlands. However, six of the ten statements had at least half of the survey respondents answered *don't know*. With respect to the BCP, majority of survey respondents were unaware of the counties where the BCP lands were located and whether or not the amount of land procured had met the federal permit requirements. Most survey respondents were unaware that the WQPL had been purchased through municipal bonds.

Regression Analyses

The regression analyses were conducted to better understand how socio-demographic and behavioral variables can explain the variation in knowledge pertaining to karst aquifers, endangered species, rangeland ecology, and City of Austin's wildlands. The dependent variables that measured knowledge were based on the main topics addressed: karst aquifers, endangered species, rangeland ecology, and City of Austin's wildlands. The four groups of independent variables included socio-economic, demographic, information channels, and environmental behavior factors.

The results of the first group of regression analyses are reported in Table 3. These regression analyses explored how much of the variation in respondents' knowledge about the ecology of the Edwards Aquifer and City of Austin wildlands can be explained by the socio-demographic variables. The results show that older survey respondents are more knowledgeable about karst aquifers, endangered species, rangeland, and City of Austin's wildlands. For every one year in age the knowledge scores increased by 0.59%

Table 3. Regression analyses results show how well socio-demographic variables can explain the variation in knowledge.

	Karst Aquifers ($p<0.001$, adj. $r^2=0.084$, n=280, F=6.132, df=5)			Endangered Species ($p=0.010$, adj. $r^2=0.035$, n=285, F=3.062, df=5)			Rangelands ($p<0.001$, adj. $r^2=0.101$, n=281, F=7.285, df=5)			City of Austin's wildlands ($p<0.001$, adj. $r^2=0.092$, n=280, F=6.696, df=5)		
Variables	b	t	p	b	t	p	b	t	p	b	t	p
Age of respondent	0.585	4.02	**<0.001**	0.407	3.266	**<0.001**	0.653	4.662	**<0.001**	0.458	4.065	**<0.001**
Male	9.945	2.725	**0.007**	1.908	0.617	0.538	10.582	3.049	**0.003**	8.442	3.00	**0.003**
At least a bachelors degree	-0.577	-0.113	0.910	-7.314	-1.681	**0.094**	0.069	0.014	0.989	-0.821	-0.207	0.836
Annual income > $125,000	2.393	0.589	0.556	5.699	1.642	0.102	1.551	0.401	0.689	4.193	1.322	0.187
Property value > $350,001	-7.646	-1.926	**0.055**	-1.651	-0.488	0.626	-2.116	-0.556	0.578	-8.055	-2.598	**0.010**

for karst aquifers, 0.41% for endangered species, 0.65% for rangeland ecology, and 0.46% for City of Austin's wildlands. Males' knowledge scores were 8 to 10% higher in all regression analyses except that gender was not a statistically significant variable in explaining the knowledge difference about endangered species. Surprisingly, survey respondents that had at least a bachelor's degree scored 7% lower on the endangered species section of the survey questionnaire than those without a bachelors degree. Additionally, survey respondents with a property market value greater than $350,001 scored 7% lower on the City of Austin's wildlands section.

The results of the second group of regression analyses are reported in Table 4. These analyses focus on the ability of demographic variables to explain differences in knowledge about environmental issues and City of Austin's wildlands. The results show that respondents who have lived in or near the City of Austin for a longer period of time are more knowledgeable about environmental issues and City of Austin's wildlands. Of greater interest is the ability of variables relating to previous information channels and past environmental behavior to explain variation in survey respondents' knowledge about environmental issues pertaining to the Edwards Aquifer and City of Austin's wildlands.

The results of the third group of regression analyses are reported in Table 5. Survey respondents who had previously received information about the wildlands from the local newspapers had significantly higher (8 – 15%) knowledge scores on issues pertaining to karst aquifers, endangered species, rangeland ecology, and City of Austin's wildlands. Additionally, survey respondents who had received mailings from the City of Austin Wildland Division had lower knowledge scores in the rangeland ecology regression analysis. Whether a respondent had previously participated in any environmental organization was a statistically significant predictor in all the regression analyses. On average they scored 14% higher on knowledge about karst aquifers and 6% higher on the City of Austin's wildlands.

Table 4. Regression analyses results show how well demographic variables explain variation in knowledge.

	Karst Aquifers ($p=0.032$, adj. $r^2=0.028$, $n=258$, $F=2.4805$, $df=5$)			Endangered Species ($p<0.001$, adj. $r^2=0.066$, $n=256$, $F=4.672$, $df=5$)			Rangelands ($p<0.001$, adj. $r^2=0.029$, $n=258$, $F=2.557$, $df=5$)			City of Austin's wildlands ($p<0.001$, adj. $r^2=0.053$, $n=255$, $F=3.879$, $df=5$)		
Variables	b	t	p	b	t	p	b	t	p	b	t	p
Residence length in City of Austin	0.446	2.931	**0.004**	0.485	3.713	**<0.001**	0.299	1.919	**0.056**	0.404	3.240	**0.001**
Residence length at current address	-0.095	-0.346	0.730	-0.048	-0.212	0.833	0.140	0.531	0.596	0.067	0.310	0.756
Property Owners	-3.166	-0.104	0.917	-2.894	-0.116	0.908	-8.194	-0.282	0.778	-10.969	-0.461	0.645
Homeowners Association members	-3.352	-0.743	0.458	-5.579	-1.538	0.125	-7.247	-1.713	**0.088**	-1.704	-0.484	0.629
More than a block from wildlands	3.439	0.895	0.372	2.998	0.957	0.957	1.395	0.383	0.702	4.786	1.587	0.114

Table 5. Regression analyses results show how well information sources, past participation in an environmental organization, and behavioral intension explains knowledge.

	Karst Aquifers ($p<0.001$, adj. $r^2=0.136$, n=300, F=4.945, df=12)			Endangered Species ($p<0.001$, adj. $r^2=0.172$, n=300, F=6.177, df=12)			Rangelands ($p<0.001$, adj. $r^2=0.172$, n=300, F=6.177, df=12)			City of Austin's wildlands ($p<0.001$, adj. $r^2=0.118$, n=299, F=4.319, df=12)		
Variables	b	t	p	b	t	p	b	t	p	b	t	p
Local newspapers readers	12.979	3.051	**0.002**	8.616	2.535	**0.012**	15.540	3.877	**<0.001**	11.026	3.279	**0.001**
Not heard of wildlands	-10.88	-0.156	**0.009**	-9.431	-2.809	**0.005**	-8.892	-2.251	**0.025**	-6.385	-1.967	**0.050**
Received notices from City of Austin	-3.890	-0.941	0.347	0.374	0.112	0.911	-10.107	-2.597	**0.010**	-0.014	-0.004	0.997
Received information from Internet	1.495	0.326	0.745	-0.864	-0.233	0.816	1.601	0.371	0.711	1.378	0.381	0.704
Received information from local TV	3.235	0.712	0.477	3.166	0.873	0.383	6.984	1.634	0.103	-0.651	-0.181	0.857
Participation in an environmental organization	14.455	3.681	**<0.001**	12.067	3.815	**<0.001**	8.914	2.379	**0.018**	6.164	2.006	**0.046**
Participated in City of Austin environmental program	-2.103	-0.263	0.793	-4.303	-0.685	0.494	1.904	0.260	0.795	1.478	0.244	0.807
Previously accessed wildlands	0.200	0.046	0.963	-0.786	-0.224	0.823	-0.968	-0.235	0.815	0.929	0.275	0.784
Knows public access points	3.598	0.899	0.370	5.072	1.564	0.199	6.426	1.689	**0.092**	4.542	1.449	0.148
Would participate in environmental class	5.486	1.378	0.169	6.725	2.105	**0.036**	1.583	0.420	0.675	6.620	2.115	**0.035**
Would host an environmental class	-7.482	-1.227	0.221	2.031	0.414	0.679	-6.289	-1.077	0.283	-7.879	-1.644	0.101
Would join an environmental program	-0.608	-0.126	0.900	1.974	0.507	0.613	4.323	0.935	0.351	0.406	0.105	0.916

DISCUSSION

The growth of the City of Austin together with resident's desire to live near open space leads to an increase the human-wildland interactions and the possibility for residents to be positively or negatively affected by the wildlands. Based on a moderate rate of growth, Austin's population is projected to increase 18% in the next 5 years (TSDC 2000). With respect to this rapid growth rate it is imperative to inform residents of the risks and benefits associated with living at the urban-wildland interface. Many landowners believe that Austin's wildlands increase their property value but have limited knowledge about the purpose of wildlands, inherent risks associated with living near them, and how residents' actions may undermine the mission of the wildlands. Outreach programs are an important element for increasing residents' knowledge about how to landscape to conserve water and to decrease the risk of fire. Additionally, local environmental organizations that promote the health of the Edward's Aquifer and endangered species habitat could collaborate with City of Austin to provide wide-ranging opportunities for urban residents to participate in environmental education programs.

The results from the study corroborated parts of both of the original hypotheses. The first hypothesis suggested that there would be positive relationships between increasing socio-economic and demographic factors with respect to environmental issues pertaining to the Edwards Aquifer and City of Austin's wildlands. Education level and property value were only significant in 1 of the 4 regression analyses, which implies that educational programs should be broadly administered regardless of socio-economic factors. The results corroborated the hypothesis that residence length in the City of Austin would be a statistically significant predictor of knowledge. This was the only demographic variable that was statistically significant in all the regression analyses pertaining to knowledge about the City of Austin. This implies that educational programs should target residents that are new to the City of Austin. The results showed negative associations between rangeland knowledge and homeowners association membership which did not corroborate the original hypotheses.

The second hypothesis suggested that there would be positive relationships between information sources and environmental behavior with respect to environmental knowledge issues pertaining to the Edwards Aquifer and City of Austin's wildlands. The results of the four regression analyses corroborated the hypothesis and survey respondents who had previously participated in any environmental organization were more knowledgeable about environmental issues pertaining to the Edwards Aquifer and City of Austin's wildlands. This suggests that it might be beneficial for the City of Austin to incorporate local organizations into their educational outreach strategy. Interest in participating in an environmental education class was positively associated with knowledge about endangered species and the City of Austin's wildlands. Additionally, survey respondents who had received previous information from local newspapers were more knowledgeable, but Internet and local television channels were not significant predictors. This implies that local newspapers are potentially effective methods for information dissemination. Respondents that had received notices from the city were significantly less knowledgeable about rangeland ecology issues.

Overall, survey results suggest respondents have relatively high levels of knowledge about rangeland ecology and low levels of knowledge about the City of Austin's wildlands. Respondents were knowledgeable about general issues pertaining to karst aquifers and endangered species, but unable to identify specific details pertaining to these two issues. Only one third of survey respondents had been previously involved in an environmental organization, but about 50% of survey respondents expressed willingness to participate in an environmental education class. McCleery et al. (2006) suggest that behavioral intention tends to be a good predictor of behavioral actions that are done voluntarily. If the Wildland Division desires to influence behavior the implications of the literature suggest that effective environmental education programs should consider the underlying motives behind behavior (Schultz 2002) and the internal and external barriers behind the targeted behavior (McKenzie-Mohr 2000).

The average knowledge score for those willing to participate in an environmental class was higher in the endangered species and City of Austin's wildlands regression

analyses. The role of information and behavior relationships are complex, but research agrees that information provision alone will not motivate behavior adoption (Hungerfold and Volk 1990; Schultz 2002). Research has found that personal and situational determinates also influence behavioral adoption. Situational determinants are characteristics of the context that affect behavior and include type, location, and quality of educational materials (Schultz et al. 1995). Personal determinants that have been found to predict behavior include individual beliefs, attitudes, and knowledge (Shultz et al. 1995). Attitudes encompass beliefs and behavioral intentions as a means of direct measurement of an individual's behavior (Thurston 1931; Green 1954; Schuman and Johnson 1976). Underlying beliefs direct the attitude that is followed by the behavior. Attitude refers to favor or disfavor of an object, idea, or behavior (Ajzen and Fishbein 2000). However, attitudes have also been found to be unrelated to behavior (Fisher et al. 1994; Fisher et al. 1996; Ajzen 2001). This suggests that behavior change can be encouraged through the quality of educational materials (situational determinants) and influencing personal determinants (beliefs, attitudes, knowledge) through environmental educational meetings via homeowners association meetings or environmental organizations.

Role of Socio-demographics and Experience

The relationship between socio-economic variables and environmental knowledge were statistically significant in the study, but some results do not support previous studies. Holbert et al. (2003) surveyed urban residents and concluded that males had higher levels of environmental concern. The study showed that older males who were more environmentally concerned spent more time watching nature documentary television shows. However, the same study found that older well educated females tended to adopt pro-environmental behaviors more readily than males (Holbert et al. 2003). This is similar to this study's results which suggest that older, males are more knowledgeable about environmental issues. In contrast, a study conducted by Reading et al. (1994) reported that younger females scored higher on questions pertaining to ecosystem management actions in the Greater Yellowstone area, while a study in 2003

did not find age, gender, and education to be statistically significant predictors of environmental awareness (Laurian 2003).

The survey results showed statistically significant negative associations between education and home value; specifically with respect to environmental knowledge the higher survey respondents' education the less they knew about endangered species and the higher the home value the less they knew about City of Austin's wildlands. Level of education is traditionally positively associated with environmental interest and knowledge (Arcury 1990; Schultz and Stone 1994; Theodori and Luloff 2002). However, Steel et al. (1990) found that the level of education was not relevant in explaining knowledge about specific issues such as industrial pollution near the Great Lakes.

An additional demographic variable, residence length was a statistically significant predictor of knowledge in all of the regression analyses. Residence period within or near the City of Austin was statistically significant predictor of knowledge, but residence length at current address was not. These findings are consistent with results from other studies. For example, a survey distributed to local communities living adjacent to Oregon forests found long-term residents were more knowledgeable about forest management terms and concepts (Shindler and Mallon 2006). Similarly, some studies found that residence length was positively associated with awareness of local toxic sites within the region (Laurian 2003) and survey respondents who had lived within the watershed area longer were more knowledgeable about the forest processes (Williams 2001).

By contrast, environmental knowledge about the City of Austin's wildlands was not influenced by respondents' proximity to the wildlands. Even though the study was directed toward residents that lived within a half-mile buffer of the wildlands it was hypothesized that residents living adjacent to the wildlands would be significantly different than residents that lived more than a block from the wildlands. Clearly the half-mile band selected for the study was insufficiently wide to detect a knowledge gradient. By contrast, some studies have found proximity to natural resources as a

significant factor influencing residents' environmental perception. Brody (2004) suggested that residents' proximity to water was significantly related to their knowledge and familiarity of the resource. Similarly, Larson and Santelmann (2007) found that proximity to water was statistically significant in explaining residents' support and concern associated with the natural resource.

Past participation with an environmental organization was positively associated with knowledge about the City of Austin's wildlands. This may be because this sample of survey respondents are more interested in environmental issues and well informed about local issues concerning the wildlands. Several previous studies have found that prior environmental organizational membership and higher education levels were associated with environmental knowledge or positive perceptions toward pro-environmental activities (Maloney and Ward 1973; Heer et al. 2003; Kreuter et al. 2008). The City of Austin could apply this information by using local environmental organizations as a conduit for wildland information dissemination. It might be beneficial to also contact a diversity of local organizations, to access citizens with little environmental interest, for the purpose of increasing residents' information levels about the wildlands. For example, organizations associated with club sports, educational facilities, religious activities, or business professional societies.

Role of Information Channels

The survey results revealed that many respondents had received previous information about the wildlands via local television channels, Internet, local newspapers, and mailings from the City of Austin's Wildlands Division. Most survey respondents knew that the water quality and endangered species habitat in Austin could be affected by rangeland management practices applied on the wildlands. However, the majority of survey respondents did not know that the BCP is a regional preserve system set aside for endangered species in Travis and Hays County. Additionally, most survey respondents did not know that the WQPL are restricted exclusively to the Edwards Aquifer recharge and contributing zones.

The results of the study suggested that local newspaper readership was a statistically significant predictor of environmental knowledge. Survey respondents' level of knowledge about karst aquifers, endangered species, rangeland ecology, and City of Austin's wildlands was much greater for survey respondents who had previously obtained information about the wildlands from local newspapers. This result supported previous studies that had found newspapers to be a more effective source of information than television or radio (Bailey 1971; Brother et al. 1991). As a whole the mass media can be an effective tool for information dissemination.

Local newspapers are useful information channels but they are limited in the amount of detailed information they present. For example, one study found that reading the local newspaper increased residents' awareness of toxic sites but did not increase their information level on the status of these sites (Laurian 2003). With respect to local newspaper readership and environmental knowledge a study found that newspapers were rated the most important information channel but readership did not correlate with knowledge levels (Steger et al. 1988).

Regardless of the type of information sources, environmental knowledge levels might be explained by familiarity of important concepts as a result of their usage in the media and the relative self-explanatory nature of a portion of the survey questionnaire. Public environmental knowledge about the City of Austin's wildlands was matched closely to the main issues identified by local media. For example, the application of fertilizers, herbicides, and pesticides can directly affect the water quality and impair the health of the endangered salamanders. Additionally, the majority of survey respondents knew that Barton Springs provides habitat for endangered salamanders. Several local newspaper articles mention the Barton Springs Salamander and how human actions influence their habitat. For example, The Austin Chronicle in 2002 published an article entitled "The Battle for the Springs: A Chronology." This article included statements about the negative impacts of chemicals as well as information about the Barton Springs Salamander. The author described the Barton Creek watershed hydrology by stating that, "…any rain that falls in this area makes its way to the creek, unless it soaks into the

ground and goes down to the aquifer, and any pollution…in this area will degrade the water quality in the creek" (Anonymous 2002). It concluded by stating that the City's conservation plan has sufficient ordinances, land acquisitions, and policies to adequately protect the Barton Springs Salamander In contrast, minimal articles have been published on the endangered species associated with the BCP. A quote from one of the few articles published in the Austin Chronicle in 2005 stated that, "the 13,035 acres city owned swath of BCP is designated as a sanctuary……for two endangered migratory songbirds (the GCW and BCV)…access in much of the BCP is totally restricted" (Mottola 2005).

Survey respondents who had previously received notices from the City of Austin's Wildlands Division were less knowledgeable about rangeland ecology. This might be because the notices were simply informing the residents of a prescribed fire that would occur rather than discussing the benefits and results obtained from previous prescribed fire applications. Contrary to this study's results, a survey in 2001 found that a public sample who had previously requested to received information about natural resource issues in their watershed were more knowledgeable than the general public (Williams 2001). This suggests that newsletters can be an effective method of information dissemination, but their effectiveness depends on the way in which informational messages are presented.

Several studies' found that interpersonal communication with agency personnel and interactive methods such as field trips and presentations were more useful information sources than newspapers, television, and environmental groups for providing detailed and relevant information (Force and Williams 1989; Wright 2000; Williams 2001). Toman et al. (2006) suggest that local media (newspapers, newsletters) are more effective at raising awareness of educational programs and interpersonal communication of environmental information is more useful for changing residents' behavior. More than half of the City of Austin survey respondents indicated that their preferred sources of information about environmental issues were newsletters, newspapers, and the Internet. The City of Austin Wildland Division should incorporate

both formal and informal methods in outreach programs aimed at enhancing public awareness about the purpose and function of the wildlands depending on their specific objective.

Traditional information dissemination programs are based on the assumption that increased availability of information will result in higher knowledge levels and influence perceptions and behavior. However, research on outreach activities influencing residents' knowledge, perception, and behavior agree that information provision alone is unlikely to motivate the adoption of new behaviors (Hungerfold and Volk 1990; Schultz 2002). Previous studies' results suggest information dissemination increase knowledge, but only a small percent of individuals change their behavior (Oskamp 1998; Schultz 2002).

The results suggest that survey respondents' who were willing to participate in an environmental education class were more knowledgeable about endangered species and City of Austin's wildlands. This might be because of their environmental interest or past involvement in environmental organizations raised their awareness on certain issues. Knowledge is not directly related to behavior change so other influencing factors such as attitudes and social norms should be considered when promoting pro-environmental behavior through an outreach program. For example, if environmental education programs were conducted through existing social networks within homeowners associations the residents might feel obligated to attend and this may be a motivating reason to participate. Additionally, if some type of incentive program were created in relation to the environmental education program, residents might feel that they would be missing out on valuable information and opportunities by not participating.

CONCLUSION

The study attempted to identify factors that influence knowledge to determine potential methods for alternative information dissemination strategies for increasing residents' information levels about the wildlands. Respondents' proximity to the BCP and WQPL showed no statistically significant relationships to knowledge about karst aquifers, endangered species, or City of Austin's wildlands. As a result, location of

residence cannot be used to identify less knowledgeable audiences for educational programs. However, older male residents that had lived in the City of Austin for a longer period of time were significantly more knowledgeable. Additionally, newspaper readership and previous participated in environmental organizations were also positive predictors of knowledge. This project identified several areas where the City of Austin staff can focus their efforts to improve communication with urban residents about the BCP and WQPL. This research identified target audience characteristics, preferred information channels, and major misconceptions and limited knowledge areas.

Results from this study provide useful information to the City of Austin personnel about the perspectives of urban residents in the urban-wildland interface. Statistically significant regression analyses associated with socio-economic and demographic variables provide information about the type of audience the outreach program should be targeted to for expanding knowledge about the wildlands. This study's results suggest that outreach programs should target new residents to the City of Austin and those active in homeowners associations.

An environmental education program will be designed based on these results to determine effective information dissemination techniques and targeted audience characteristics. Statistical significance suggests that local newspapers and environmental organizations are effective methods for disseminating information. However, it should be noted that information presented in local newspapers has been shown to increase overall environmental knowledge, but not specific environmental issues.

With respect to information dissemination, the survey results suggest that survey respondents' preferred channels for information about environmental issues included: newspapers, Internet, and newsletters. Although it was not a preferred source, it is important to note that face-to-face communication from land managers and researchers with the public is also a useful outreach technique. Some reasons why survey respondents were not interested in participating in an outreach program can be summarized by the two most cited reasons: lack of time or they felt like they would not

benefit from such a program. For this audience segment perhaps outreach methods could be newsletters facilitated through homeowner's associations. It is apparent that there are mixed information levels among urban residents about the City of Austin's wildlands. Creating successful outreach programs will mean providing a wide range of opportunities for participation in an education class and the use of a variety of information dissemination tools. It is also clear that citizens have limited time to invest in these activities, but there are many who are willing to participate and others who would perhaps consider it if they personally benefited from attending the educational class. From the additional survey comments results urban residents were concerned about the quality of the information as well as the presentation techniques within and environmental education program, so further evaluation of the structure of other urban environmental education programs as it relates to residential environmental knowledge could aid in developing an overall urban-rural interface program structure.

The survey results also suggest that information about the geology of karst aquifers should be provided in the outreach program to counter the idea that karst aquifers filter impurities from water. Information about the relationship between water quality and soil erosion would also help to redirect misconceptions. Specific examples about how leaving the land unmanaged are not an efficient way to protect the wildland areas representative ecosystems should be discussed within the outreach program. With respect to the City of Austin's wildlands, there seems to be some confusion about the managing partners, wildland locations, and method of how the lands were obtained.

Urban residents living near the wildlands also need some information about how to create a landscape that reduces their risk of fire and improves water conservation. This study recommends informing homeowners associations that are in close proximity to urban wildlands about the Sustainable Sites Initiative Guidelines and Performance Benchmarks created by the Lady Bird Johnson Wildflower Center, American Society of Landscape Architects and the United States Botanic Garden. The purpose of the sustainable sites initiative criteria was to create a point system that encourages sustainable landscape design and operations.

CHAPTER IV
ASSESSING FACTORS THAT INFLUENCE RESIDENTS' APPROVAL OF MANAGEMENT ACTIONS AND RECREATION ACTIVITIES IN THE CITY OF AUSTIN WILDLANDS

INTRODUCTION

In 2008, the six-county area of Austin, Texas led the nation in urban growth and this population is projected to increase 15 percent by 2012. Due to increasing citizen resettlement in Austin and land use changes, the City of Austin Wildland Division has faced pressure from the residential communities regarding deer, hogs, and other wildlife threats. The City of Austin Wildland Division manages two categories of land, one to maintain the high quality of water that discharges from the Barton Springs section of the Edwards Aquifer and the other to protect habitat for two endangered neo-tropical songbirds, the Black-capped vireo (*Vireo atricapillus*) (BCV) and the Golden-cheeked warbler (*Dendroica chrysoparia*) (GCW). These two categories of land are referred to as the Water Quality Protection Lands (WQPL) and the Balcones Canyonland Preserve (BCP).

The primary objective of this study was to identify factors that influence residents' approval or disapproval of land management actions and recreation activities on the City of Austin's wildlands. Approval about the use and management actions applied on the wildlands might be influenced by residents' level of concern regarding the effect of such actions or merely by observation of these actions on the wildlands. For example, the Wildlands Division has management practices for controlling populations of white-tailed deer, feral hog, and coyote. Theses actions may be unpalatable for some residents. In addition, management focuses on preserving the integrity of the WQPL through prescribed fire, removing Ashe Juniper, seeding grasses, and protecting karst features (caves, sinkholes) where surface water infiltrates into the aquifer (Thuesen 2008). Some of these actions may also be of concern to some residents.

In such, karst limestone geology soils are shallow and woody plant encroachment by Ashe Juniper (*Juniperus ashei Buchholz*) has been prolific. Karst aquifer systems are sensitive to developmental pressures because of the speed of water percolation which reduces the surface residence time for necessary biological processes to occur (Mahler et al. 1999; Vesper et al. 2001). Therefore management actions on the WQPL focus on maintaining healthy active plant communities and ground cover. By contrast, the BCP management objectives focus on vegetation manipulation to improve nesting habitat for the GCW and BCV as well as controlling the cowbird (*Molothrus ater*) population because they parasitize the nest of the two endangered species (USFWS 1991). The GCW's nesting habitat consists of large blocks of mature juniper-oak woodland and they forage in oak understory areas (Kroll 1980). The BCV prefers a mixture of low thick shrub-oak vegetation with moderate tree cover of irregular height and interspersed grasslands (Graber 1961; Grzybowski et al. 1994; Dramude 2003).

The literature on public support for land management actions suggests that approval of management actions may increase as a result of knowledge (Jacobson et al. 2001; Loomis et al. 2001) but decrease in response to the associated risks of the management actions (Riley and Decker 2000). Some have argued that technical knowledge influences citizens' judgment and acceptability of management practices; however, they also state that it is possible for citizens' opposition toward management practices to be reinforced as they acquire information and a better understanding of certain management actions (Stankey 1996). Other studies suggest that participants in educational programs who learn about the benefits of fire are more likely to support fire usage as a management tool (Jacobson et al. 2001; Loomis et al. 2001). A study in Montana that evaluated residents' perceptions toward reintroducing cougars found that the higher the perceived risk the less residents' accepted the management action that would allow for a viable cougar population size (Riley and Decker 2000).

Some studies suggest that personal experience, perceived natural resource benefits and educational efforts can influence support for management actions. For example, Colorado residents' personal experience with elk and desire to see elk were more

important than their level of concern of being negatively impacted by elk; furthermore, the results suggest that the majority of respondents desired the Colorado Division of Wildlife to make the final decision regarding wildlife management actions after a public comment period (Chase and Decker 1998). A similar study found that perceived conservation benefits were significant predictors of management support for communities living near a national park in Uganda (Oonyu 2009). As the result of educational efforts such as the Texas Master Naturalist (TMN) training program participants' environmental knowledge increased. The TMN program's results suggest that the program positively influenced participants' attitudes in such a way that they became more supportive of natural resource management (Bonneau et al. 2009).

Based on information obtained from a pre-survey focus-group meeting with the City of Austin staff it was determined to focus the survey on three categories of information: the knowledge of the City of Austin wildlands, perceptions about management actions on the wildlands, and knowledge about the biophysical aspect of the Edwards Aquifer region. A pre-survey focus-group meeting with selected residents was conducted for the purpose of gathering preliminary information regarding their knowledge about environmental issues pertaining to the Edwards Aquifer and City of Austin's wildlands.

This led to the development of four hypotheses: 1) Residents' support for management is positively associated with the perception that one of the purposes of the wildlands is to protect endangered species, environmental knowledge levels about the role of fire and negative impacts as the result of the overpopulation of deer and hogs, respondents' positive experiences with the wildlands, and pro-environmental behavior. 2) Respondents' approval of wildlife management actions is positively associated with the extent to which residents have been negatively affected by wildlife and their level of concern about wildlife impacts on their property. 3) Respondents' approval of vegetation management actions is negatively associated with the extent to which residents have seen smoke on the wildlands and their level of concern about wildfire. 4) Residents' approval of recreation activities is positively associated with perceived benefits from the

wildlands and negatively associated with their perceptions of the purpose of the wildlands is to protect endangered species.

METHODS

A mail survey of 1,000 urban residents who live near the City of Austin's wildlands was conducted in the summer of 2009. The residents were randomly selected from within the half-mile buffer created around the fee-simple purchased WQPL and the City of Austin's land units in the BCP. The population of the study was defined to be all residents living within the half-mile buffer created around the selected wildland tracts. The term survey participant refers to the 1,000 randomly selected urban residents. For each category of wildland 500 urban residents were randomly selected from Travis and Hays county tax records. The twelve-page questionnaire consisted of five areas of inquiry: (1) general information (2) karst aquifers, endangered species, rangelands and wildlands (3) purpose, use, and management of wildlands (4) environmental awareness and education (5) personal information. Some questions asked to the participants to use a seven-point Likert scale to indicate their level of agreement with certain statements. For example, this was used to obtain responses by 1=very unimportant/strongly disagree/very disinterested to 7=very important/strongly agree/very interested. Throughout this article the general term management support should be interpreted to mean respondents' approval of management actions or recreation activities on the wildlands.

The mail survey was administered using the Dillman multiple-contact technique (Dillman 2000). Over fifty days there were five mailings sent to the survey sample. The first step (day 1) was to mail a pre-survey letter that notified the participants that they would receive a survey and it also emphasized the value of them participating in the survey. Next, on day 7 the initial survey questionnaire was sent along with a cover letter. A thank you reminder card was mailed on day 21. An additional questionnaire in conjunction with a reminder letter was sent on day 35; then on day 49 a final reminder card to the non-respondents. A one-page non-response survey questionnaire was sent in the fall of 2009 to 300 randomly selected Austin residents from whom no response had

been received. Out of the 300 non-response surveys there were 54 completed questionnaires that were received.

Measure of Key Concepts

Data was entered into Microsoft Excel and then analyzed using the Statistical Package for the Social Sciences (SPSS). Statistics used to analyze the data include multiple regression analysis to understand the extent to which dependent variables can be explained by the independent variables. As the result of a small number of respondents for several of the management actions and recreation activities and a large number of predictors included in the analysis, the bootstrap technique was used on several of the regression analyses. The bootstrap technique is an internal replicability analysis that attempts to mimic true replication without requiring a new sample. This approach simply re-samples the given data and builds a sample distribution for a given statistic. The main assumption is that the sample results reflect the population. The z-value reported in the regression analyses tables is simply the notation for the test statistic value in a bootstrap regression (Thompson 2008).

The bootstrap technique was used on the public access regression analyses for intrusive recreation (sport fields, off-road vehicles, entertainment areas), non-intrusive recreation (walking trails, bike trails, horse riding trails), program support for environmental education, and access within endangered species habitat. With respect to the management support regression analyses, bootstrap techniques were applied to the regression analyses that included dependent variables dealing with fire, harvesting white-tailed deer, shooting feral hogs, and restricting public access.

The dependent variables for management support were based on a series of statements that asked survey participants to rank their level of support (7=strongly approve…..1=strongly disapprove) for certain wildland management actions and possible recreation activities. There were ten multiple regression analyses, eight dependent variables, and twenty-four independent variables. The dependent variables can be grouped into two categories, approval of management actions and approval of recreation activities. The regression analyses independent variables can be classified

into four areas: perceived benefits obtained from living near natural areas, residents' knowledge of the purpose of the land management practices, interest in environmental education programs, and level of concern regarding negative impacts associated with the land. Due to the exploratory nature of this study, statistical significant was determined when $p \leq 0.100$. This p-value was selected to avoid the risk of eliminating possibly significant variables that could aid further research efforts.

Results from the Principle Components Factor Analysis identified several clusters of similar responses within the 12 statements pertaining to support for management actions and recreation activities. These results are presented in Table 6. From this 2 potential management subscales and 2 potential recreation subscales were identified. Subscale I, which will be referred to as human exclusion included items such as limiting public access, restricting recreation to guided hikes/educational events, constructing fences to control human and wildlife access. With respect to approval of wildlife management actions, Subscale II included harvesting white-tailed deer and shooting feral hogs. The reliability analysis for the 2 additive scales pertaining to management actions had a Cronbach's alpha of 0.777 for Subscale I and 0.799 for Subscale II.

With respect to approval of recreation activities two potential additive subscales were identified. Subscale I, which will be referred to as intrusive recreation, included items such as allowing sports fields, off-road vehicles, outdoor theaters, and other entertainment areas. Subscale II, will be referred to as non-intrusive recreation included items such as walking trails for people with dogs, bike trails, and allowing horse trails. The reliability analysis for the 2 additive scales pertaining to approval of recreation activities had a Cronbach's alpha of 0.856 for Subscale I and 0.764 for Subscale II.

Table 6. Rotated component matrices extracted (Principle Axis Factoring with Varimax rotation) from responses to statements about five management practices and seven recreation activities. Bold values indicate the related indices.

	Component	
Management Action	I	II
	α=0.777	α=0.799
Limiting public access	**0.705**	0.028
Restricting recreation to guided hikes/educational events	**0.780**	-0.094
Constructing fences to control human and wildlife access	**0.723**	-0.055
Harvesting white-tailed deer	0.000	**0.815**
Shooting feral hogs	-0.084	**0.814**
Recreation Activities	I	II
	α=0.856	α=0.764
Soccer, football or other outside sports fields	**0.732**	0.257
Off-road vehicle trails	**0.437**	0.270
Outdoor theaters	**0.865**	0.203
Other entertainment areas	**0.931**	0.178
Walking trails for people with dogs	0.099	**0.585**
Bike trails	0.347	**0.686**
Horse riding trails	0.229	**0.783**

The dependent variables for management support incorporated perceptions about prescribed fire, harvesting white-tailed deer, shooting feral hogs, and human exclusion actions. Six regression analyses were conducted to assess management support, four of which focused on how perceived benefits and knowledge of the purpose of the wildlands explained the variation in support and two of which focused on level of concern about the negative impacts associated with the wildlands. The dependent variables dealing with approval of recreation activities included two indices that measured approval of intrusive and non-intrusive recreation activities. There were also two dependent variables addressing environmental education field days and public access within endangered species habitat.

Van der Eijk's measure of agreement was used to identify social norms by assessing the degree of consensus among residents in terms of opinions about management practices (van der Eijk 2001). The coefficient of agreement is used for ordered rating scales to measure the degree of agreement and disagreement among residents within a specific question. The measures of agreement were estimated using an Excel spreadsheet with an embedded macro that calculated univariate statistics of frequency distributions, because this test is not available in SPSS. The degree of agreement for a specific metric is the average agreement of its component parts. Each part is weighted according to the frequency of cases represented. The formula for agreement is:

$$A = U \bullet \left[1 - \frac{(S-1)}{(K-1)}\right]$$

where A is the coefficient of agreement, U represents the measure of unimodality, S is the number of non-empty categories, and K is the total number of categories in the rating scale (van der Eijk, 2001). The co-efficient of agreement is always between -1 and +1. Complete agreement is indicated by all responses in a single category of the scale and the A statistic is +1. If there is a uniform distribution of responses among all categories the value of A is 0. In the situation of complete disagreement the value of A is -1. This is a fairly new data analysis technique so the literature is sparse. Krymkowski et al. (2009) used the coefficient of agreement to analyze the general consensus in a recent study on outdoor recreation and management quality standards.

RESULTS

Out of the 1,000 Austin residents who were sent the survey there were 450 residents who responded. After subtracting out the 36 undeliverable surveys the result was an overall response rate of 47%. Of the questionnaires that were returned by survey respondents, 337 were completed and useable, producing a net response rate of 35%. The nonrespondent bias analysis indicated statistically significant differences with respect to respondents that had seen Austin personnel patrolling the wildlands (x^2=5.74, df=2, p=0.013) and perceptions that the wildlands increased their property value

(x^2=7.73, df=2, p=0.021). The statistical differences suggest that respondents are more aware of the actions that take place on the wildlands and perceive that their property is more valuable as the result of living near the wildlands. The difference in notification of prescribed fire can be explained by the statistically significant difference between residents that live near the WQPL and BCP (x^2=1.46, df=2, p<0.001); there are significantly more prescribed fires on the WQPL so residents that live near these properties have received more notifications than residents that live near the BCP. Past literature associated with surveys suggest that the only widespread finding between non-respondents and respondents is that respondents tend to have more of a formal education than non-respondents (Kanuk 1975). Since the study found significant differences between respondents and non-respondents, the survey results are limited and can only be applied to the respondents.

The results of this study are presented in three parts (1) predictors of approval of management and recreation actions on wildlands (2) level of support for management and recreation activities and (3) regression analyses results that show how well the independent variables explain variation in approval of the management and recreation actions.

Predictors of Approval of Actions on Wildlands

The independent variables used in the regression analyses can be grouped into four categories: perceived benefits obtained from living near natural areas, residents' knowledge of the wildlands, interest in environmental education programs, and level of concern regarding negative impacts associated with the wildlands. Table 7 and 8 show the descriptive statistics for the predictors. One section asked respondents about perceived benefits obtained from living near the City of Austin's wildlands. Respondents were asked to indicate their answer by circling the number that best represented their opinion on a 7-point scale (7=very positive factor….1=very negative factor). The top three statements that had the most positive influence on their opinion of living near the wildlands were water quality protection, open landscape and scenery, and open space protection for future generations.

Table 7. Perceived benefits of living near the wildlands (7=very positive factor…..1=very negative factor) grouped by respondents' proximity to respective wildland type. Respondents' associated mean response value for each variable is displayed.

Predictors	BCP	WQPL	Δ	Statistic
Perceived that the wildlands enhance their general quality of life	6.22 (0.081)	6.09 (0.087)	0.13	z=-1.24, p=0.213
Perceived that the wildlands enhance the general economy of the region	5.57 (0.104)	5.35 (0.111)	0.22	z=-1.52, p=0.127
Perceived that the wildlands increase nearby property values	5.74 (0.104)	5.65 (0.101)	0.09	z=-0.748, p=0.455
Open landscape and scenery are perceived benefits from the wildlands	6.48 (0.069)	6.28 (0.082)	0.20	z=-1.84, p=0.066
Open space protection for future generations are perceived benefits from the wildlands	6.43 (0.076)	6.25 (0.089)	0.18	z=-1.614, p=0.107
Water quality protection is a perceived benefit from the wildlands	6.47 (0.068)	6.37 (0.082)	0.10	z=-0.599, p=0.549
Endangered species habitat protection is a perceived benefit from the wildlands	5.85 (0.105)	5.81 (0.114)	0.04	z=-0.044, p=0.965
Interacting with wildlife is a perceived benefit from the wildlands	5.52 (0.109)	5.49 (0.116)	0.03	z=-0.012, p=0.991

Δ=difference

Table 8. Predictors of management support grouped by respondents' proximity to respective wildland type. Percent of respondents agreeing with statements for each variable is displayed. Variables include perception of the purpose of the wildlands, wildland knowledge, and interest in environmental education programs.

Predictors	BCP	WQPL	Δ	Statistic
Perceives protecting the Barton Springs salamander is an exclusive purpose of the WQPL	37.0%	34.7%	2.3%	x^2=0.114, p=0.735
Perceives protecting the Golden-cheeked warbler is an exclusive purpose of the BCP	57.1%	45.2%	11.9%	x^2=2.92, p=0.087
Perceives protecting the Barton Springs salamander is one of the main purposes for the WQPL and BCP	44.0%	44.9%	-0.9%	x^2=0.016, p=0.899
Perceives protecting the Golden-cheeked warbler is one of the main purposes for the WQPL and BCP	36.6%	47.3%	-10.7%	x^2=2.40, p=0.121
Knows wild hogs impact other wildlife even though they are native to Texas	68.6%	64.8%	3.8%	x^2=0.550, p=0.458
Knows long-term suppression of natural fires increases the probability of uncontrollable wild fire occurring	66.9%	68.1%	-1.2%	x^2=0.060, p=0.807
Knows high populations for deer do negatively affect other rangeland species	68.0%	68.8%	-0.8%	x^2=0.019, p=0.891
Would participate in environmental class	51.5%	45.6%	5.9%	x^2=1.13, p=0.288
Would host an environmental class	19.4%	8.1%	11.3%	x^2=8.76, p=0.003
Would join an environmental program	33.1%	23.3%	9.8%	x^2=3.93, p=0.048

Δ=difference

Respondents' knowledge of the wildlands included four variables associated with their perceptions' of the purpose of the wildlands, three *true/false* statements about rangeland management practices, and three questions about willingness to participate in environmental education programs. The section that focused on respondents' perception of the purpose for the wildlands had several statements that asked the survey participants to check which reasons the City of Austin decided to procure the BCP and WQPL. Of all respondents, 31.5% correctly indicated that the main purpose for the BCP land is to protect the Golden-cheeked warbler and 21.1% indicated that the main purpose for the WQPL is to protect the Barton Springs Salamander. The three dummy variables created from true/false statements about rangeland ecology dealt with prescribed fire, deer populations, and the negative impacts associated with overpopulations of hogs. Around 60% of all respondents' correctly answered these three wildland knowledge statements and around 30% selected *don't know* for these three wildland knowledge statements.

Respondents' interest in participating in an environmental education class, becoming a member of an education program, and willingness to host and education program were used to explain management support. Only 13.6% of respondents were willing to host and environmental education class in their neighborhood. However, there was a statistically significant difference between respondent groups in terms willingness to host and join an environmental educational program; approximately 10% more BCP respondents were willing to host and join an environmental education program than WQPL respondents. Additionally one-third of respondents were undecided on whether they would become a member of an environmental education program or not.

Survey participants were asked if they had ever been negatively affected by wildlife from the wildlands and 12.5% of respondents indicated that they had. Another section asked participants to rank several statements about the risks of living near wildlands on a 4 point scale (4=very concerned…..1=no concern). Table 9 shows the difference in BCP and WQPL respondents' level of concern toward wildlife and prescribed fire. Predictors used in the regression analyses were: level of concern toward wildfire, concern of deer eating plants, respondents' level of concern of feral hogs rooting in their yard, level of

concern toward rattlesnakes near your home, and level of concern toward loss of pets due to predators. These indicators were used based on predictors used in previous literature pertaining to approval of management actions. Awareness of smoke from fire was a dummy variable created and used in the prescribed fire regression analysis. Out of all the respondents 70% indicated that they had not seen smoke from the wildlands, but there was a significant difference between BCP and WQPL respondents' who had seen smoke from fires on the wildlands (x^2=2.71, df=1, p<0.001). There were more WQPL respondents that had seen smoke from fire on the wildlands.

Table 9. BCP and WQPL respondents' level of concern (4=very concerned…..1=no concern) toward several issues as the result of their property's close proximity to the wildlands. Respondents associated mean or percent negatively affected is given for each variable.

Predictors	BCP	WQPL	Δ	Statistic
Level of concern toward deer eating plants on your property	2.22 (0.093)	2.03 (0.088)	0.19	z=-1.56, p=0.119
Level of concern toward feral hogs rooting in your yard	2.41 (0.103)	2.17 (0.102)	0.24	z=-1.31, p=0.192
Level of concern toward rattlesnakes or other snakes near your home	2.46 (0.097)	2.75 (0.091)	-0.29	z=-2.27, p=0.231
Level of concern toward loss of pets due to predators	2.27 (0.092)	2.13 (0.087)	0.14	z=-0.934, p=0.350
Level of concern about Wildfire or smoke from fires	2.67 (0.092)	2.59 (0.086)	0.08	z=-0.655, p=0.513
% Respondents that have seen smoke from fires on wildlands	10.6%	31.3%	-20.70%	x^2=21.71, p<0.001

Δ=difference

Levels of Support for Management and Recreation Actions

Survey participants were asked a series of statements about their approval or disapproval of certain management practices on the wildlands. Table 10 shows the mean approval for management actions. The most supported management actions included those related to wildlife and vegetation management such as shooting feral hogs and application of controlled fire. Respondents were ambivalent about harvesting of white-tailed deer and the human exclusion actions. Figure 3 graphically displays the mean level of management support and respondents' degrees of consensus are indicated by the size of the bubble. The bubble size was calculated from subtracting the measure of agreement (MOA) value from one (i.e. 1 – MOA). It also shows that as management support increases the measure of agreement among respondents also increases (size of the bubble shrinks).

To understand respondents' opinion of recreation activities in the wildlands they were asked to address a series of statements. One of the most supported recreation activities with a high level of consensus was environmental education field days. By contrast the least supported recreation actions dealt with intrusive activities. The non-intrusive recreation activities were perceived to have a neutral effect. Figure 4 for recreation support had 5 statements with a measurement of agreement value of at least 0.60. This is relatively high considering that complete agreement is indicated by a co-efficient of 1.

Table 10. Mean approval of management actions. Survey participants were asked to what extent do you approve of the following wildland management practices by the City of Austin wildlands? (7=strongly approve….1=strongly disapprove). The variables that were scales do not have an associated measure of agreement.

Management Support	BCP	WQPL	Δ	Statistic
Shooting feral hogs	5.30 (0.139)	5.41 (0.129)	-0.11	z=-0.285, p=0.776
Application of controlled fire	5.08 (0.139)	5.38 (0.127)	-0.3	z=-1.47, p=0.141
Harvesting white-tailed deer	4.85 (0.130)	4.74 (0.138)	0.11	z=-0.516, p=0.606
Human exclusion actions	4.10 (0.117)	4.39 (0.124)	-0.29	z=-1.67, **p=0.095**
Recreation Support				
Environmental education field days	5.79 (0.107)	5.63 (0.113)	0.16	z=-1.24, p=0.216
Public access within endangered species habitat	3.42 (0.132)	3.25 (0.128)	0.17	z=-0.978, p=0.328
Intrusive recreation actions	2.72 (0.103)	3.23 (0.122)	-0.51	z=-3.15, **p=0.002**
Non-intrusive recreation actions	4.50 (0.116)	4.51 (0.116)	-0.01	z=-0.367, p=0.714

Δ=difference

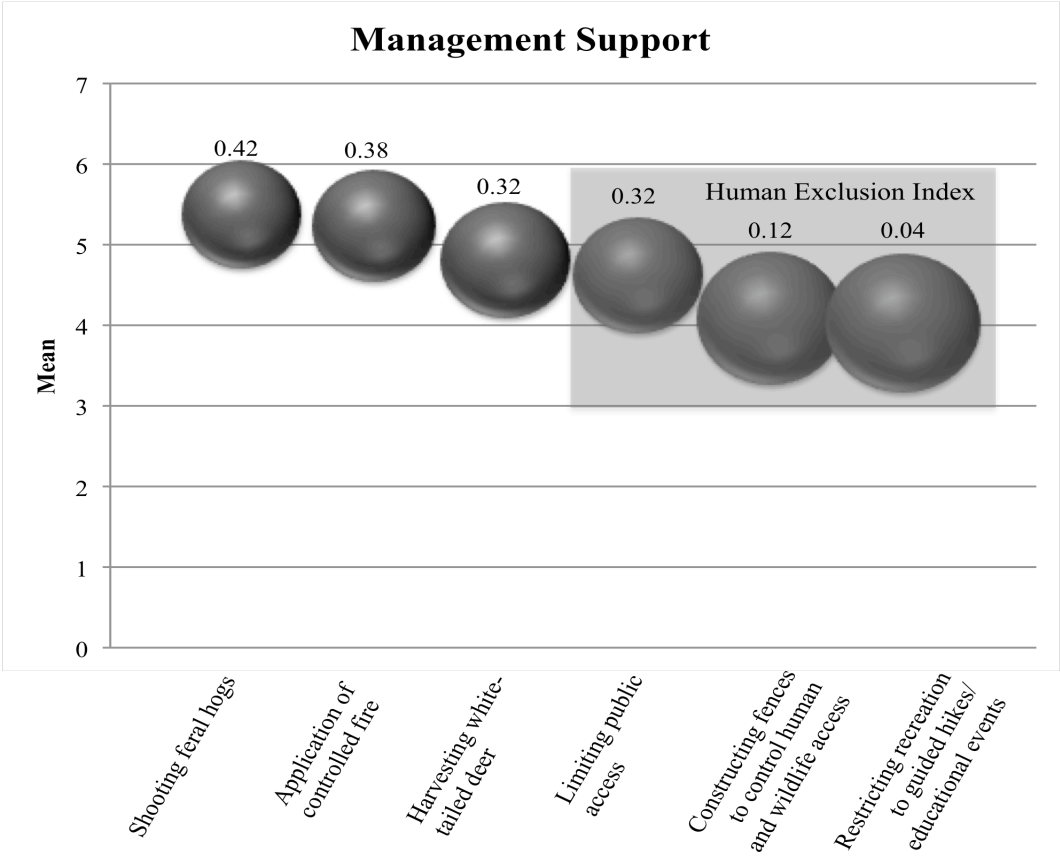

Figure 3. Respondent's approval of management actions on the wildlands. The management support statements are graphically represented by respondents' mean on the y-axis (7=strongly approve…1=strongly disapprove). The statements are ordered across the x-axis from greatest to least approval of management actions. The smaller bubble represents a higher measure of agreement among respondents and the largest bubble shows that the respondents' answers were more evenly distributed across the scale. (Adapted from Manfredo et al. 2003)

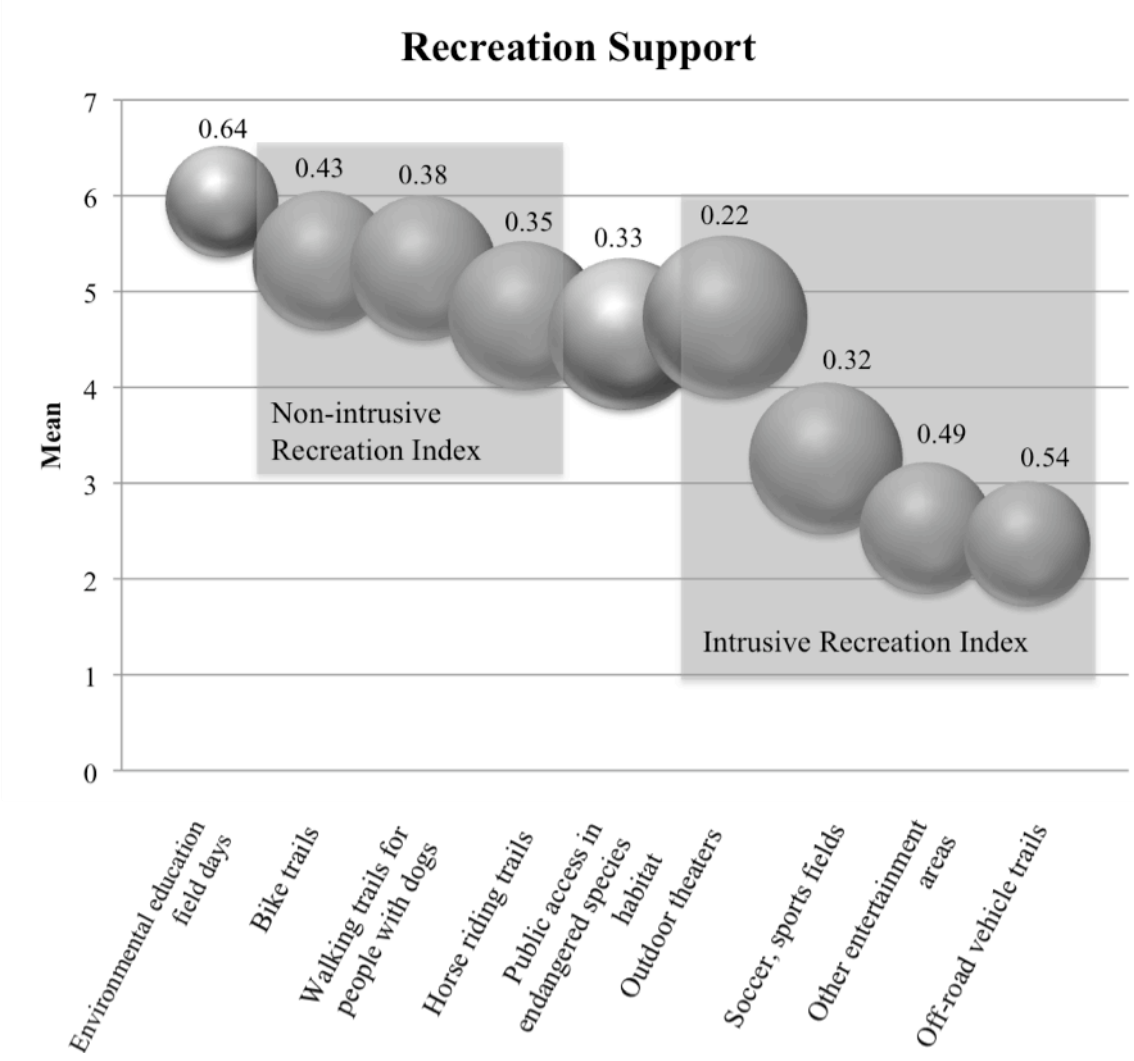

Figure 4. Respondent's approval of recreation activities on the wildlands. The recreation support statements are graphically represented by respondents' mean on the y-axis (7=strongly approve…1=strongly disapprove). The statements are grouped by indices and roughly ordered from across the x-axis from greatest to least approval of management actions. The smaller bubble represents a higher measure of agreement/consensus among respondents' answers. The larger bubbles indicate that respondents' answers were more evenly distributed across the scale. (Adapted from Manfredo et al. 2003)

REGRESSION ANALYSES

The results of the three groups of regression analyses are presented below. The first group included four regression analyses, that focused on how knowledge about perceived benefits of the wildlands explained response variation in terms of support for alternative management actions. The second group included two regression analyses focused on the level of concern about the negative impacts associated with the wildlands. The third group included four regressions dealing with approval of recreation activities; there were two stand alone dependent variables and two indices dealing with intrusive and non-intrusive recreation activities. These will be discussed with their relationship to the independent variables ability to explain management support.

Support for Management Actions

The first group of four regression analyses focused on how much variation in respondents' management support for prescribed fire, restricting public access, harvesting deer, and shooting hogs can be explained by respondents' perceived benefits of living near the wildlands, knowledge about the wildlands, and interest in environmental education programs. Table 11 shows that some of the perceived benefits from the wildlands were significant in the regression analyses on management support. The regression analysis pertaining to the human exclusion actions was not a statistically significant model (p=0.136, Adj. R^2=0.0044, n=175, Wald Chi^2=22.22, df=16) (see Appendix B). In the regression analysis pertaining to application of controlled fire, results suggest that respondents who perceived open space protection for future generations as a benefit of the wildlands approved more of this action (b=0.980, p=0.007). Respondents that perceived endangered species habitat protection as a positive factor influencing their opinion about the wildlands were less supportive of harvesting white-tailed deer (b=-0.261, p=0.072) and shooting feral hogs (b=-0.270, p=0.016). Additionally, respondents that viewed water quality protection as a perceived benefit of the wildlands were less supportive of the application of controlled fire (b=-0.526, p=0.046). Respondents who perceived that the wildlands increase their property value were less supportive of the application of controlled fire (b=-0.245, p=0.094).

Rangeland knowledge and perception of the purpose of the wildlands were statistically significant and explained a substantial portion of the variation in management support. The results suggested that respondents who knew long-term suppression of natural fires increases the probability of uncontrollable wildfires occurring were more supportive of the application of controlled fire ($b=1.02$, $p=0.002$). Additionally, respondents who knew that high populations of deer and hogs negatively affect other rangeland species were more supportive of harvesting white-tailed deer ($b=1.199$, $p=0.001$) and shooting feral hogs ($b=1.40$, $p<0.001$). Respondents that perceived that protecting the GCW is an exclusive purpose of the BCP were more supportive of shooting feral hogs ($b=0.869$, $p=0.042$). Results suggested that respondents who were interested in participating in an environmental education class were less supportive of shooting feral hogs ($b=-0.457$, $p=0.052$).

The results of the second group of two regression analyses are presented in Table 12. They focused on how level of concern about the negative impacts associated with the wildlands are able to explain the variation in management support. Results suggested that respondents who were more concerned about white-tailed deer ($b=0.352$, $p<0.001$) and feral hogs ($b=0.277$, $p<0.001$) negatively impacting their property were also more supportive of harvesting efforts. Respondents who reported seeing smoke from the wildlands ($b=0.887$, $p<0.001$) had higher approval ratings for the application of controlled fire. Respondents who were concerned about wildfire and smoke ($b=-0.312$, $p<0.001$) were not surprisingly, less supportive of the application of controlled fires.

Table 11. Results from the first group of regression analyses, which focused on how management support can be explained by perceived wildland benefits, knowledge, and interest in environmental education programs.

	Shooting feral hogs ($p<0.001$, Adj.$R^2=0.212$, n=170, Wald $Chi^2=65.47$, df=17)		Application of controlled fire ($p<0.001$, Adj. $R^2=0.181$, n=171, Wald $Chi^2=42.50$, df=17)		Harvesting white-tailed deer ($p<0.001$, Adj. $R^2=0.117$, n=171, Wald $Chi^2=43.64$, df=17)	
Variables	b	z	b	z	b	z
Perceived that the wildlands enhance their general quality of life	0.239	1.38	0.267	1.30	0.153	0.85
Perceived that the wildlands enhance the general economy of the region	-0.223	-0.13	0.215	1.21	0.109	0.78
Perceived that the wildlands increase nearby property values	-0.106	-0.71	-0.245	-1.67*	-0.185	-1.37
Open landscape and scenery are perceived benefits from the wildlands	0.472	0.18	-0.327	-1.06	0.189	0.65
Open space protection for future generations are perceived benefits from the wildlands	0.148	0.50	0.980	2.71**	0.108	0.29
Water quality protection is a perceived benefit from the wildlands	0.354	0.15	-0.526	-2.00**	0.001	0.00
Endangered species habitat protection is a perceived benefit from the wildlands	-0.270	-2.41**	-0.074	-0.53	-0.261	-1.80*
Interacting with wildlife is a perceived benefit from the wildlands	-0.696	-0.66	-0.201	-0.19	-0.139	-1.31
Perceived that protecting the Barton Springs salamander is an exclusive purpose of the WQPL	0.491	1.4	0.344	1.09	0.543	1.51

Table 11 continued.

Perceived that protecting the Golden-cheeked warbler is an exclusive purpose of the BCP	0.869	2.03**	0.331	0.67	0.774	1.53
Perceived that protecting the Barton Springs salamander is one of the main purposes for the WQPL and BCP	0.049	0.11	-0.217	-0.49	-0.262	-0.51
Perceived that protecting the Golden-cheeked warbler is one of the main purposes for the WQPL and BCP	0.577	1.04	0.711	1.09	0.908	1.42
Knows wild hogs impact other wildlife even though they are native to Texas	1.395	4.65***				
Knows long-term suppression of natural fires increases the probability of uncontrollable wild fire occurring			1.023	3.08**		
Knows high populations for deer do negatively affect other rangeland species					1.199	3.37***
Would participate in environmental education class	-0.458	-1.94**	-0.226	-0.89	-0.227	-0.87
Would host an environmental education class	0.236	0.61	-0.378	-1.03	0.313	0.72
Would join an environmental education program	-0.212	-0.63	0.166	0.56	-0.256	-0.74

* for pvalue,***≤0.001, **≤0.05, *≤0.10

Table 12. Results from the second group of regression analyses, which focused on how management support can be explained by level of concern about negative impacts associated with the wildlands. Wildlife management support was a scale that included support for harvesting deer and feral hogs.

	Wildlife Management Support ($p<0.001$, Adj. $R^2=0.112$, n=311, Wald $Chi^2=9.613$, df=5)		Application of controlled fire ($p=0.010$, Adj. $R^2=0.081$, n=311, Wald $Chi^2=14.642$, df=2)	
Variables	b	t	b	t
% of respondents that have been previously negatively affected by wildlife on the wildlands	0.051	0.196		
Level of concern toward deer eating plants on your property	0.352	4.495***		
Level of concern toward feral hogs rooting in your yard	0.277	3.941***		
Level of concern toward rattlesnakes or other snakes near your home	-0.119	-1.52		
Level of concern toward loss of pets due to predators	-0.187	-2.31**		
Level of concern about Wildfire or smoke from fires			-0.312	-3.83***
Respondents that have seen smoke from fires on wildlands			0.887	3.93***

* for pvalue,***≤0.001, **≤0.05, *≤0.10

Approval of Recreation Activities

The third group of regression analyses explored how much variation in residents' approval of alternative recreation activities and associated facilities can be explained by knowledge about the wildlands, the perceived benefits of the wildlands, and interest in environmental education programs. The four separate regression analysis associated with recreation support included the dependent variables: environmental education field days, public access within endangered species habitat, intrusive recreation, and associated recreation. The intrusive recreation (p=0.779, Adj. R^2=-0.0249, n=173, Wald Chi^2=10.62, df=15) and the non-intrusive recreation (p=0.141, Adj. R^2=0.0601, n=175, Wald Chi^2=31.45, df=15) regression analyses were not statistically significant models (see Appendix B). Table 13 shows how much variation the independent variables explained the recreation support.

In the regression analysis pertaining to support for environmental education field days, results suggested that respondents who value open space protection for future generations (b=0.561, p=0.045) and interacting with wildlife (b=0.179, p=0.063) as benefits from the wildlands were more likely to be supportive of this activity. Respondents who viewed endangered species habitat protection (b=-2.66, p=0.008) as a benefit of the wildlands were less likely to approve public access within endangered species habitat. While, respondents who perceived that protecting the GCW to be one of the main purposes for the BCP and WQPL (b=1.13, p=0.091) were more likely to be supportive of allowing public access within endangered species habitat. There were mixed results from the predictors associated with respondents' willingness to become involved in educational programs and their role in explaining the variation in support for management actions. Respondents who were interested in participating in an environmental education class (b=0.538, p=0.004) were more likely to support environmental education field days. Additionally respondents who were interested in participating in an environmental education class (b=-0.473, p=0.098) were less supportive of public access within endangered species.

Table 13. Results from the third group of regression analyses, which focused on how recreation support can be explained by perceived wildland benefits, knowledge, and interest in environmental education programs.

	Environmental education field days		Public access within endangered species habitat	
	$p<0.001$, Adj. $R^2=0.236$, n=176, Wald $Chi^2=74.82$, df=15		$p=0.045$, Adj. $R^2=0.050$, n=174, Wald $Chi^2=25.33$, df=15	
Variables	b	z	b	z
Perceived that the wildlands enhance their general quality of life	0.169	1.30	0.254	1.25
Perceived that the wildlands enhance the general economy of the region	0.031	0.30	0.110	0.66
Perceived that the wildlands increase nearby property values	-0.122	-1.59	-0.209	-1.25
Open landscape and scenery are perceived benefits	-0.075	-0.27	-0.161	-0.55
Open space protection for future generations are perceived benefits	0.561	2.00**	-0.275	-0.83
Water quality protection is a perceived benefit	-0.260	-1.26	0.413	1.24
Endangered species habitat protection is a perceived benefit	-0.057	-0.6	-0.453	-2.66**
Interacting with wildlife is a perceived benefit	0.179	1.86*	0.197	1.51
Perceived that protecting the Barton Springs salamander is an exclusive purpose of the WQPL	0.175	0.74	-0.238	-0.59
Perceived that protecting the Golden-cheeked warbler is an exclusive purpose of the BCP	0.429	0.81	0.612	1.22
Perceived that protecting the Barton Springs salamander is one of the main purposes for the WQPL and BCP	-0.124	-0.45	-0.66	-1.25
Perceived that protecting the Golden-cheeked warbler is one of the main purposes for the WQPL and BCP	0.59	0.99	1.13	1.69*
Would participate in environmental education class	0.538	2.87**	-0.473	-1.65*
Would host an environmental education class	0.028	0.12	-0.669	-0.17
Would join an environmental education program	0.196	0.92	0.089	0.28

* for pvalue,***≤0.001, **≤0.05, *≤0.10

DISCUSSION

The growth in interest of the City of Austin residents to preserve natural areas has led to an increase in public involvement in the decision making processes for wildland management plans. However, there has been limited information about residents' perception and approval of management actions on the wildlands. The objective of this study was to identify factors that influence residents' approval of certain management actions. The results will provide information about how to frame educational messages aimed at improving residents' awareness and understanding of the wildlands.

The results of this study corroborate portions of the first hypothesis that suggested positive associations between perceptions of the purpose of the wildlands, knowledge about the wildlands, positive experiences with the wildlands, and pro-environmental behavior. First, respondents that perceived protecting the GCW was the exclusive purpose of the BCP were more supportive of shooting feral hogs. Respondents' level of approval of the management action of the application of controlled fire was positively associated with knowledge that suppression of fire increases the probability of uncontrollable wildfires. Additionally, knowledge about the negative impacts of overpopulation of hogs and deer were positively associated with approval of harvesting hogs and deer on the wildlands. Surprisingly, respondents who viewed water quality protection as a positive factor that influenced their opinion of the wildlands were less supportive of prescribed fire. The results suggest that it would be beneficial to frame educational messages to improve residents understanding of how fire improves rangeland and soil health, which affects water infiltration and increases discharge rates and water quality. Also, respondents who viewed endangered species habitat as a positive factor of the wildlands were less supportive of harvesting hogs and deer. Respondents that were willing to participate in an environmental education class were less supportive of the management action of harvesting hogs and deer.

Similarly the results corroborated the second hypothesis, which suggest a positive association between support for wildlife management actions with residents' level of concern regarding wildlife impacts on their property. Respondents that were concerned

about hogs rooting in their yards or deer eating plants on their property were more supportive of harvesting hogs and deer. The results also supported parts of the third hypothesis which suggested respondents' approval of vegetation management actions would be negatively associated with the extent to which residents have seen smoke on the wildlands and their level of concern about wildfire. The results suggest that respondents who had seen smoke from fire were more supportive of fire, but their level of concern toward fire was negatively associated with their approval of fire. A similar study found that respondents who had positive perceptions about the effects of fire were more likely to use prescribed fire (Kreuter et al. 2008).

With respect to approval of recreation actives the results were contrary to this studies hypotheses that expected positive relationships between perceived benefits from the wildlands. Respondents who perceived endangered species habitat as a perceived benefit from the wildlands were less supportive of public access within endangered species habitat. The only significant variable within the results was that respondents who viewed open space protection as a perceived benefit from the wildlands were more supportive of environmental education field days. Also, contrary to this studies hypothesis, respondents' who perceived that protecting the GCW is one of the main purposes for the BCP and WQPL were more supportive of public access within endangered species habitat. The intrusive and non-intrusive recreation regression analyses were not statistically significant models.

Role of Knowledge

To determine potential methods for framing educational messages this study attempted to identify factors that influence support toward management actions needed to maintain the wildlands. The role of rangeland knowledge was the most significant predictor in the regression analyses. The respondents who had prior knowledge of how rangeland integrity would be impacted by the application of prescribed fire and overpopulation of deer and hogs were more supportive of the management actions. Additionally, knowledge regarding the role of fire on rangelands was statistically significant in the regression analysis on support for prescribed fire. These results are

supported by other studies. For example, a study involving the Texas Master Naturalist (TMN) training program found that participants' knowledge and attitudes about natural resource management became more supportive after participating in the TMN program (Bonneau et al. 2009). More specific studies supported this idea by reporting that participants of environmental educational programs were more supportive of prescribed fire as a management tool (Jacobson et al. 2001; Loomis et al. 2001). One study found that approval of lethal methods for controlling wildlife were positively associated with the level of ecological knowledge (Loker et al. 1999). This supports the results that knowledge of the impacts of over population of deer and hogs influenced respondents' management support.

However, it should be noted that information provision alone may increase knowledge but the relationship between knowledge, attitudes, and actual behavior is complex. Studies suggest that information provision alone may be a necessary but not sufficiently a motivating factor in changing attitudes or adopting new behaviors (Hungerfold and Volk 1990; Schultz 2002).

Respondents' perceptions regarding the main purposes of the wildlands showed mixed results about their support for management actions and recreation activities on the wildlands. With respect to management support, respondents' who perceived that protecting the GCW is an exclusive purpose of the BCP were more approving of shooting feral hogs. This suggests that respondents' knowledge of the purpose of the wildlands positively influenced their support for management actions. Regarding support for recreation activities, respondents' who felt that one of the main purposes of the WQPL and BCP is to protect the GCW were more supportive of allowing public access within endangered species habitat. The misperception that the main purpose for both wildlands was to protect the GCW displays the limited information level of some respondents. There is suitable habitat for GCW on both categories of wildlands; however, the BCP was procured for the specific purpose of providing habitat for the GCW and BCV. These results regarding management support and perception of the purpose of the wildlands suggest that some respondents were fairly knowledgeable about

the main purpose of the BCP and WQPL while others were only slightly informed. Framing educational messages in such a way that clearly states the main purpose for procuring each category of wildland, as well as additional managing objectives could help clarify these misperceptions.

Role of Perceived Benefits

Predictors that focused on perceived benefits from the wildlands and were associated with high disapproval ratings for certain management actions include: water quality, property value, and endangered species habitat protection. Specifically, respondents who viewed water quality protection and property value increase as a perceived benefit of the wildlands were less supportive of prescribed fire. Educational messages addressing the role of fire should include advice on how landowners landscape their properties to be so less susceptible to the spread of fire.

Contrary to managers' opinions of certain management actions, respondents that perceived endangered species habitat protection as a benefit of the wildlands were less supportive of lethal methods for controlling white-tailed deer and feral hog populations. This might be an indicator of respondents that enjoy viewing wildlife and perceive that all wildlife populations are decreasing or at risk of becoming endangered. This cluster of individuals could be categorized as having humanistic attitude towards nature; they are interested in animals and have strong affections for pets and large mammals (Kellert and Berry 1987). An additional study on how animal-related attitudes are affected by gender found that females have more emotional attachments to animals and tend to oppose harvesting animals or inflicting harm to animals (Keller and Berry 1987).

Similarly, respondents who were willing to participate in an environmental education class also disapproved of shooting feral hogs. A suggested method for framing educational messages is to provide information on the current state of the environment as the result of overpopulation of feral hogs and deer. Furthermore, it would also be beneficial to frame this in such a way that it explains how wildlife overpopulation impacts rangeland health and endangered species habitat. One study that focused on a similar issue framed the problem in such a way that it attracted a specific

audience to support the programs objectives. For example, a study dealing with applying lethal methods for the overpopulation of hogs suggested that hogs were out competing other animals for food, this motivated hunters to support the hog-removal program which also benefited endangered species and forest regeneration (Jacobson 2005).

Role of Perceived Risks Associated with Living Near the Wildlands

The independent variables dealing with personal experiences and level of concern of being negatively impacted by management actions were significantly associated with approval of wildlife management actions and disapproval of fire management actions. For example, respondents' level of concern toward deer or feral hogs impacting their landscape was a significant factor that indicated higher approval ratings for actions of lethal methods for controlling wildlife. Similar studies found approval of lethal methods for controlling white-tailed deer in urban areas related to level of concern about personal economic damage (Loker et al. 1999). By contrast, other studies suggest that as frequency of residents' interaction with deer increased the more urban communities perceived these deer to be no longer "wild" which contributed to their negative reaction toward hunting deer in a suburban environment (Leong 2010). Similarly, citizens' attitudes toward elk management in Colorado indicated that residents desired to see elk near their homes and were not concerned about the landscape-damaged cause by the elk (Chase and Decker 1998).

Respondents who were more concerned about being negatively impacted by fire were less supportive of the application of prescribed fire. A similar study found that regardless of proximity to wildfires residents' opinions about the risk of prescribed burning did not change (Jacobson et al. 2001). Additionally, this study's results suggest that residents who have seen smoke were more supportive of fire. The differences in approval of prescribed fire suggest that associated personal risk to be an influencing factor. A similar study found that Australian residents living near the Wombat State Park did not perceive smoke to pose any problem when practicing prescribed burning because they felt that prescribed fire was necessary for protecting their property (Bell

and Oliveras 2006). This study also found mixed results for support of the application of prescribed fire and attributed this to respondents' limited understanding of the role of prescribed fire (Bell and Oliveras 2006).

MANAGEMENT SUPPORT AND EDUCATIONAL IMPLICATIONS

Several methods for framing educational messages have been suggested to possibly improve management support. Perceived benefits of the wildlands and an understanding of how management actions enhance the mission of the wildlands were associated with higher approval ratings. It should be noted that educational programs are only one method to increase management support. A similar study on public perceptions of forest management practices found that although citizens were environmentally minded and supported environmental objectives over economic agendas their support of disturbance-based management practices were highly correlated with past experience with agency employees. Positive past experiences with agency employees were associated with support for prescribed burning, timber harvesting, and excessive stand thinning (Shindler and Mallon 2006). Additional personal experiences that influence management support that should be considered include direct public involvement in management activities on wildlands, environmental education tours on wildlands, and personal observations of management practices on wildlands.

Some respondents disapproved of certain management actions on the wildlands that actually improve the ecological integrity of the BCP and WQPL. By contrast, other respondents seemed to approve certain recreation activities and facilities that are not beneficial to the wildland's management objectives. The findings have several implications. First, limited management support suggests that citizens may not have full understanding of the benefits of the management actions. Second, residents may be knowledgeable about the general management practices but uncertain of the usefulness of these actions on the wildlands because lack of available progress reports of the success of management actions.

In developing an environmental education program, this study found several areas to consider with respect to support for human exclusion actions, application of

prescribed fire, and wildlife management actions. For example, knowledge that public access may negatively damage karst recharge features may increase support for limiting public access. Furthermore, communication about the complexities on improving water quality in a karst aquifer system should seek to provide data about the necessity of prescribed fire. Additional information should include how harvesting white-tailed deer and feral hogs improves endangered species habitat. Citizens not only need a working understanding of ecological issues pertaining to the City of Austin, but a broader sense of how these management actions directly relate to the future environmental integrity within Austin's urban-rural interface.

CHAPTER V
SUMMARY AND CONCLUSION

The purpose of this study was to answer the identified research questions and to inform the City of Austin Wildland Division about residents' perceptions about management actions applied on the Water Quality Protection Lands (WQPL) and the Balcones Canyonland Preserve (BCP). This research attempted to understand survey participants' perceptions by focusing on their knowledge about environmental issues pertaining to the Edwards Aquifer and on their approval of various management and recreation activities on the wildlands. The survey respondents as a whole were aware of which wildland they live near, but lacked the specific knowledge of the main purpose for those lands. Overall respondents were more knowledgeable about the environmental issues pertaining to the Edwards Aquifer than about the location of the wildlands, managing partners, and history of the City of Austin's wildlands. Respondents appeared to be well informed about rangeland statements but had limited knowledge regarding some statements about karst hydrology and endangered species habitat.

Support for management and recreation activities on the wildlands was examined by analyzing the extent to which respondents approve or disapprove of certain management actions and recreation activities. The two most supported management actions were the application of controlled fire and lethal control of feral hog populations. Respondent' were generally neutral about restricting recreation to guided hikes and constructing fences. Survey respondents viewed reducing the white-tailed deer population and removing juniper as neutral activities for the wildlands. Creating firebreaks near subdivisions/homes was rated as having a positive effect with respect to the wildland management goals.

As previously discussed, population growth within the six-county region surrounding Austin has led to an increase for urban residents who live near wildland areas. This type of development has created the potential for conflict between urban residents and land managers. To help alleviate such conflicts, a survey questionnaire

was used to gather information about the publics' perspective regarding the City of Austin's wildlands and to determine the most suitable channels of information dissemination for the city.

The results of this study support previous studies that illustrated that older, well educated, males, who had been involved in environmental organizations to be more environmentally oriented (Mohai and Twight 1987; Arcury 1990; Schultz and Stone 1994; Theodori and Luloff 2002; Heer et al. 2003). The survey suggested that the target audience should be composed of younger residents who are new to the City of Austin and information should be distributed via local newspapers, newsletters, and personal communication through environmental education seminars. Similar to the results of this study Laurian (2003) found that newspapers increased awareness but failed to disseminate detailed information. The mass media can be an important information dissemination method for raising awareness (Steger et al. 1988; Brothers et al. 1991; Laurian 2003); furthermore, newsletters or personal communication are more effective methods for distributing information for the purpose of increasing environmental knowledge (Brother et al. 1991; Williams 2001; George et al. 2006).

Literature pertaining to management support found that knowledge might enhance such support but that perceived risks of the management actions have a negative association with approval of management actions (Stankey 1996; Riley and Decker 2000; Jacobson et al. 2001). A recent study illustrated that risk perceptions of fire mediated the relationship of knowledge and risk reduction behaviors such as: creating a 30 foot defensible space around their home, planting fire resistant plants, using fire resistant undersides on decks/balconies, and working with neighbors to clear heavily vegetated areas (Martin et al. 2009). Various studies have found that approval of lethal methods for controlling wildlife can be influenced by ecological knowledge and publics' perceived wildlife threat (Chase and Decker 1998; Loker et al. 1999; West and Parkhurst 2002).

This study examined the factors that influence urban residents' environmental knowledge of the Barton Springs segment of the Edwards Aquifer and City of Austin's

wildlands as well as factors that influence management support. This study explored the relationship between of various information dissemination methods and environmental knowledge for the purpose of directing educational programs for residents at the urban-wildland interface. For further analysis this study analyzed factors that influence approval and disapproval of management actions and recreation opportunities on the wildlands.

CONTRIBUTION TO LITERATURE

Studies previously highlighted (Chapter II) suggest factors that influence environmental knowledge and management support; however, few have focused on the urban-rural interface in Texas. Factors previously identified as being significant predictors of environmental knowledge included gender, education, political orientation (Arcury 1990; Schultz and Stone 1994; Theodori and Luloff 2002), environmental organization membership (Heer et al. 2003), and living in an urban environment (Fransson and Garling 1999; Brody et al. 2004). To varying degrees, effective information channels for increasing environmental knowledge included newspapers and television (Brothers et al. 1991), field trips and presentations (Force and Williams 1989), and educational brochures (George et al. 2006). Factors previously identified as being significant predictors of management support include knowledge about the management practices (Bonneau et al. 2009), understanding how management actions benefit the ecosystem (Jacobson et al. 2001; Loomis et al. 2001), and perception of the management actions negatively influencing the resident (Loker et al. 1999; Riley and Decker 2000).

The results from this study supports previous studies. For example Chapter III showed that older males and survey respondents who had lived within the City of Austin for a longer period of time were more knowledgeable about karst aquifers, endangered species, and rangeland management practices on the City of Austin's wildlands. Additionally, local newspapers readership and prior participation in an environmental organization were positively associated with knowledge about environmental issues and the City of Austin's wildlands. Additionally Chapter IV examined support for the approval of lethal methods for controlling hogs and deer and the application of

controlled fire. The results suggest positive associations between knowledge of how management actions influence the ecological system and perceived benefits obtained from the wildlands. The study illustrated that level of concern of being negatively influence by deer and hogs were positively associated with approval of wildlife management actions. In contrast, level of concern toward being impacted by fire was associated with disapproval of the application of controlled fire.

This study not only addresses knowledge gaps within existing literature pertaining to residents within the urban-rural interface but also has practical implications for the City of Austin's Wildland Division. This study identified a target audience for the environmental education program, highlighted specific misperceptions pertaining to karst aquifers, endangered species, and management practices and suggested ways to frame educational messages to raise awareness and potentially influence behavior. This is important because most environmental education programs have their own predetermined approach without conducting an initial assessment of the target population to identify environmental misperceptions and opinions of current management practices. Similarly understanding urban residents' perceptions toward the management practices can be incorporated into the program for the purpose of possibly influencing approval of management actions.

PRACTICAL IMPLICATIONS FOR ENVIRONMENTAL EDUCATION PROGRAMS IN THE URBAN-RURAL INTERFACE

To be effective in the rural-urban interface, environmental education programs should not focus exclusively on providing information, but should address the threats that residents face if the process of environmental degradation of limited natural resources occurs (Baldassare and Katz 1992). Therefore, while environmental education has its foundation in the dissemination of ecological concepts, to be effective, it must consider the contextual economic, cultural, and social factors the affect environmental issues (Ramsey and Hungerford 2002). Specifically, it should acknowledge that people's orientation, attitude, and perceptions towards relevant issues are crucial for environmental challenges to be resolved. Possible variables associated with responsible

environmental behavior include: environmental sensitivity, ecological knowledge, knowledge of environmental problems, beliefs, values, knowledge of environmental action programs, and skill in applying strategies (Ramsey and Hungerford 2002). This section will highlight four main concluding principles from this research project and existing environmental education literature.

The first principle from this research is that prior to creating an effective education campaign it is important to understand the target audience's knowledge and beliefs toward the issues at hand (Jacobson et al. 2006). Environmental education programs succeed when targeting similar types of people. The survey results should enable the program designers to better understand the residents' perspectives for a more effective educational effort (Stern 2002). Responsible conservation behavior has been described as environmental literacy, whereby a person possesses the knowledge, skills, and motivation to act in a committed manner (Jacobson et al. 2006). There is the potential for environmental literacy to increase when outreach programs establish dialogue amongst citizens and managers (Fien et al. 2002). This study found that survey respondents with high levels of environmental literacy had previously participated in an environmental organization.

The second principle is that broad information sources such as newspapers or local TV channels are useful, but may be insufficient to increase knowledge levels or influence support for decisions or approaches regarding activities on the wildlands. The results directly support this principle; this study found that local newspaper readership was positively associated with general environmental knowledge pertaining to the wildlands, but survey respondents did not understand the specific purposes for the management actions on the wildlands. Incorporating information disseminations methods such as newspapers, homeowners associations, or presenting to local organizations is a way to raise awareness and possibly influence management support. Some conservation education techniques for improving citizen science include websites, community action programs, and other investigative opportunities (Jacobson 2006). Environmental education programs that encourage environmental literacy should

remember that the time period between an educational seminar and actual environmental experience should be short (Monroe et al. 2000). This could include such things as newsletters, public meetings, presentations of problems followed by field trips and personal participation in management activities. This study found that survey respondents top three preferred mediums for learning about environmental issues were newspapers, Internet, and newsletters.

The third principle identified within this study is that environmental education programs should consider updating the curriculum and diversifying dissemination methods of over time. This study did suggest a target audience composed of younger, new residents, who have no prior involvement in environmental organizations. Furthermore, broad dissemination across non-environmentally focused organizations could be an additional component for the educational program. The usual educational suggestions of developing a manual or curriculum should be updated to include relevance. This study found that relevant curriculum for the City of Austin should include not only definitions of the main purposes for the lands but details on how the management actions influence the ecosystem processed and work to support the mission of the wildlands. In context-based education, the learner has the opportunity to apply knowledge to the problem (Andrews et al. 2002). The purpose of community-based education is to strengthen citizen skill through education plans tailored to specific community needs. As information is distributed to a community, it improves their ability to promote environmental quality. Their behavior could change, which could lead to increased participation and environment improvements (Andrews et al. 2002).

The forth principle to remember is the difference between information provision for the purpose of increasing knowledge and behavioral change. Environmental knowledge creates awareness for natural resource management plans and policies; however, research agrees that information provision alone is unlikely to motivate the adoption of new behaviors (Hungerford and Volk 1990; Jacobson and Marynowski 1997; Schultz 2002). This study found that around half of the survey respondents were willing to learn and implement pro-environmental behaviors such as landscape practices

that preserve water, using native plants, and reduce their risk of wildfire. Personal attributes that may predict behavior include belief, attitude, and knowledge while situation or context dependent determinants of behavior include location of issue and quality of educational materials (Schultz et al. 1995). Furthermore, theoretical models have been created in an attempt to explain the complexities of the knowledge, attitude and behavior relationships (McCleery et al. 2006). Environmentally significant behavior is a response made by the individual and environment, and is a product of contextual factors as well as attitudes, incentives, and personal collaboration (Stern 2002).

PRACTICAL IMPLICATIONS FOR CITY OF AUSTIN WILDLAND DIVISION'S ENVIRONMENTAL EDUCATION PROGRAM

Future directions for increasing environmental knowledge and management support through various information dissemination techniques vary depending on the objectives determined by the City of Austin personnel. Before this study was conducted residents' awareness and knowledge of the City of Austin's wildlands, opinion toward management practices, and interest in environmental education programs was unclear. By identifying the baselines of residents' knowledge and the deficit areas of public knowledge, effective educational programs can be more easily developed. This study found that survey respondents as a whole were aware of which wildland they live near, but lacked specific knowledge for the main purpose for those lands. Additionally, the results showed that survey respondents supported the management action of the application of controlled fire and culling hogs but viewed reducing the deer population and removing juniper as neutral activities for the wildlands.

An important precursor to developing an educational campaign is to consider the internal and external barriers behind the targeted behavior (McKenzie-Mohr 2000). These barriers could include lack of communication between land management and residents, environmental education teaching methods or resources, inefficient information dissemination methods, or simply lack of available time. The City of Austin wildland Division visibility to the citizens along with public education could stimulate support for the management programs on these lands. Improving communication to

citizens about management goals and objectives may initiate the development of a residential stewardship perspective. Educational materials could include discussion of the relationship between management practices, benefits, and natural resource processes. Information should also be provided that identifies appropriate recreation activities on the wildland. The results of this study found that survey respondents approved more of non-intrusive recreation activities (walking trails for people with dogs, bike trails, horse trails) than intrusive recreation activities (sports fields, off-road vehicles, outdoor theatres). Developing an effective educational campaign depends on several factors, which includes concise messages about complex issues, selection of information dissemination medium, source credibility, and the art of framing the issues (Werner and Makela 1998).

The results from this survey would allow for an environmental education campaign to be created for the purpose of information provision and raising awareness as well as possibly increasing management support and promoting pro-environmental behaviors. One avenue to create more support for natural resource management is to create financial incentives for residents who are good stewards of their landscapes or report unauthorized access or vandalism on the wildlands. The survey results were insufficient to provide important information on predictors of support for alternative activities such as limiting public access. Ecosystem management at the Elgin Air Force Base in Florida has also been challenged to increase public recreation opportunities (Jacobson and Marynowski 1997). They concluded that acknowledging these social values and incorporating them into management was critical for the long-term success of a program (Decker 1990). Modifying the recreation behavior to meet management goals is one method for reconciling recreational demand and resource conservation (Duffus and Dearden 1990).

The results from this study are useful at directing an environmental education program but are insufficient for understanding or predicting participation in an environmental education program. For example, the majority of respondents thought that environmental education is important, but only part selected that they were willing

to participate. The results of this study should be integrated with the land managers' knowledge of residents' motivations and prior interactions with residents for the purpose of creating effective "outreach" programs for the community. Outreach implies meeting the community at their current level of understanding on their time schedule. For example, one idea could be contacting homeowners associations to find the most appropriate day and time to have an environmental education presentation. Additionally, effectiveness of educational campaigns is contingent on considering the motives behind behavior. A motivating reason for residents to attend the programs conducted within homeowners associations might be the residential social obligation. For example, residents may feel like they are expected to attend because of the existing social networks in the homeowners' association community. It should be noted that disseminating information through the educational programs increases knowledge regarding behavior; however, this is insufficient for obtaining long-term changes in behavior (Schultz 2002). A quote from Kaiser and Fuhrer's (2003) paper on knowledge and behavior provides an accurate summary. "Strictly speaking, knowledge is not sufficient for people to behave ecologically (Schahn 1993). Thus mediators such as incentives, perceived consequences of a behavior (Schahn 1993), behavior intention (Kaiser et al. 1999), environmental effects (Langeheine and Lehmann 1986), attitude (Grob 1995) and values (Ernst et al. 1992) are all proposed to be significant in conveying knowledge's influence on behavior."

FUTURE RESEARCH

This thesis provides several methods for directing environmental educational programs within the urban-rural interface. Even though the specific environmental knowledge levels are place based the regression analyses revealed certain socio-demographic variables, media, and prior involvement in environmental organizations to be significant predictors of knowledge. Environmental knowledge, perceived benefits, and associated level of concern toward management actions were significant predictors of approval of lethal methods for controlling wildlife populations and the application of controlled fire.

First evaluating the role of homeowners associations as an information dissemination method to assess whether it increases awareness or influences behavior could have valuable implications for environmental educational programs. This study has raised further questions about what would motivate urban-rural interface residents to participate in an environmental education program. Determining whether it would be perceived benefits, quality of the program, or available incentives for participating are important issues for future exploration. Evaluating the relationship between knowledge of the purpose of the wildlands, residents' management support and approval of recreation activities on the wildlands would be helpful for understanding what factors influence approval for various forms of recreation activities. Investigating factors that influence residents' approval for limiting public access on open space preserves in urban areas could aid in promoting restricted access needs.

There are various theories about behavior change and building environmentally responsible behavior, but the most appropriate for future research within the context of this study would be the Theory of Planned Behavior. An additional study should be conducted within the framework of the Theory of Planned Behavior to better understand the relationship between environmental knowledge, attitudes towards management practices, and compliance with the wildland management objectives. The Theory of Planned Behavior describes human action as guided by behavioral beliefs, normative beliefs, and control beliefs. Each belief produces an attitude, norm, or perception, which then forms the behavioral intention. Behavior is immediately preceded by intention (Ajzen 2002). This framework acted as a mechanism "for understanding how attitudes, norms, and experiences influence behaviors, instead of simply providing correlations between attitudes and behaviors" (Decker et al. 2001; McCleery et al. 2006).

In some behavioral change theories, knowledge is viewed as an important predecessor of a desired behavior, and in other theories, it is deemed unimportant for promoting a desired environmental behavior. The role of knowledge in the Theory of Planned Behavior suggests that knowledge about the consequences of choosing to not participate in a certain behavior may be influential in determining whether or not the

behavior is actually performed (Jacobson et al. 2006). For example, if an environmental educational program was developed it should highlight the consequences or opportunities residents would miss out on if they did not participate. One consequence residents may experience if they did not participate would simply be the lack of knowledge about the City of Austin wildlands. Another consequence may be the internal guilt felt from existing social networks within homeowners associations resulting from not participating.

Furthermore, future research should explore urban residents' personal self-identification as a recreationist, environmentalist, pro-development, or indifferent worldview as it relates to management support. This would aid in targeting an environmental education program and predicting behavior across socio-demographic variables. This idea stems from research conducted by McCleery et al. (2006) who summarizes the importance in acknowledging the attributing factors that surround knowledge, attitude, and behavior relationships.

SYNTHESIS

To better direct Austin's environmental education program in the urban-rural interface, this project assessed the attitudes of landowners in the vicinity of the City of Austin's wildlands. Data collected from the mail survey that was distributed to 1,000 urban residents living within a half-mile buffer of the wildlands suggests several key findings. (1) Survey respondents' knowledge levels pertaining to karst aquifers, endangered species, rangeland ecology, and City of Austin wildlands. (2) Effective information dissemination channels and target audience characteristics. (3) The identification of gaps in knowledge pertaining to the relationship between how management actions enhance the overall mission of the wildlands. (4) Survey respondents willingness to participate in environmental education programs and willingness to conduct other pro-environmental behaviors that would support the mission of the wildlands.

When working with human and natural systems, it is important to consider the timeline of each element. This perspective involves people coming and going from a

neighborhood; therefore the community's desires and vision for the surrounding landscape changes over time. Developing certain guidelines for homeowners associations may increase the communication between land managers and urban residents.

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APPENDIX A

MAIL SURVEY QUESTIONNAIRE

Residents' Perspectives about the City of Austin Wildlands

Department of Ecosystem Science and Management
Texas A&M University 2138 TAMU
College Station, TX 77843-2138

June 2009

This questionnaire should be completed by the individual in your household who is most knowledgeable about the City of Austin Wildlands.

If you have any questions about this survey, please contact Urs Kreuter at Texas A&M University by email (urs@tamu.edu) or phone (979-845-5583).

Your participation in the survey and your responses will be kept strictly confidential. The tracking number on the front of the questionnaire is used to remove you from the mailing list when we receive your returned questionnaire.

COMPLETING THE QUESTIONNAIRE

Please make sure that you answer all questions.

If you encounter a question that does not apply to your property, please indicate this by writing "NA" in the margin next to the question.

Some questions ask you to indicate whether a statement is true or false. Please check the box that you think is correct as shown in the example below.

	True	False	Don't Know
Texas is the largest state in the contiguous 48 states of the USA	☑	☐	☐

Some questions use a 7-point response scale. Please circle the number that best describes your opinion. For example, if you were asked to indicate the extent to which you agree or disagree with the statement that "Texas is the best state in the USA" and you strongly agree, you would circle 7.

7 = strongly agree … 4 = neutral … 1 = strongly disagree							
Texas is the best state in the USA	(7)	6	5	4	3	2	1

INITIAL QUESTION

First, we want to be certain that you should complete the questionnaire. Do you live in a community next to or near one of the City of Austin Wildland areas? These include the Balcones Canyonlands Preserve and the Water Quality Protection Lands.

☐ No Please check this box and return the uncompleted questionnaire to us in the enclosed postage-paid envelope. It is important we hear back from everyone who receives a questionnaire to avoid sending reminders. Thank you for taking the time to return the questionnaire.

☐ Yes Please go to **SECTION A** on the next page and complete the questionnaire.

SECTION A – GENERAL INFORMATION

In the first section we ask for some information about your property and whether you have heard about the City of Austin Wildland areas.

1. How many years have you lived in or near Austin, Texas? _____ years

2. How many years have you lived at your current address? _____ years

3. Which of the following best describes your residence type?
   ☐ Apartment/condo/duplex ☐ Single house residential lot ☐ Estate lot ☐ Acreage

4. Do you own or rent the property where you live? ☐ Own ☐ Rent ☐ Other

5. Are you a member of a homeowner association? ☐ Yes ☐ No
   If yes, what is the name of the association? _____

6. How far from the nearest Wildland area is your property located? (Please check one box only)
   ☐ Across the fence ☐ Within one block ☐ More than a block ☐ Don't know

7. To which type of Wildland is your property most closely located? (Please check one box only)
   ☐ Balcones Canyonlands Preserve ☐ Water Quality Protection Lands ☐ Don't know

8. Do you know the public access points on any of the Wildland areas? ☐ Yes ☐ No

9. During the last 12 months about how many times did you access the BCP and WQPL Wildlands?
   BCP _____times WQPL _____times

10. Please indicate from which sources you remember getting information about the Balcones Canyonlands Preserve (BCP) or the Water Quality Protection Lands (WQPL)? (Please check all that apply in each column or check the last row if you have not heard about BCP or WQPL)

	BCP	WQPL
City of Austin notifications received by mail	☐	☐
Local newspaper	☐	☐
Local TV channel	☐	☐
Home owner association	☐	☐
Internet	☐	☐
Other (please specify) _____	☐	☐
I can't remember	☐	☐
I have not previously heard of the BCP or WQPL	☐	☐

SECTION B – AQUIFERS, ENDANGERED SPECIES, RANGELANDS AND WILDLANDS

In this section we ask you to tell us how much you know about the geology, ecology and management pertaining to the City of Austin Wildlands. The following questions ask you to evaluate each statement as True or False or "Don't Know". Please check only one box for each item.

11. Karst Aquifers

	True	False	Don't Know
Karst geology refers to a network of chambers and channels in limestone that are created over time by water dissolving the underground limestone	☐	☐	☐
Limestone karst acts as a very good filter for impurities in surface water flowing down through it.	☐	☐	☐
Karst aquifers recharge rapidly after a heavy rainfall as surface runoff penetrates through features such as caves and cracks.	☐	☐	☐
Recharge features in karst aquifers are generally evenly distributed throughout the zone that catches rainfall entering the aquifer.	☐	☐	☐
It is very important to maintain good grass cover in the contributing zone to ensure that higher quality water is available to recharge karst aquifers.	☐	☐	☐
The application of nitrogen fertilizers to lawns in the contributing and recharge zones of karst aquifers can directly affect water quality.	☐	☐	☐
The direction of flow of underground water travelling through a karst aquifer is always the same as the direction of the surface water flow.	☐	☐	☐
The Edwards Aquifer is a karst type aquifer and Barton Springs is a typical karst aquifer discharge feature.	☐	☐	☐

12. Endangered Species

	True	False	Don't Know
The Golden-cheeked warbler is an endangered migratory song-bird that nests exclusively in the Texas Hill Country.	☐	☐	☐
Nesting habitat for Golden-cheeked warbler consists of areas with mature juniper/cedar trees mixed with oaks and other hardwood trees.	☐	☐	☐
Black-capped vireos are less affected than Golden-cheeked warblers by the brown-headed cow birds that lay their eggs in the nests of other birds.	☐	☐	☐
Ideal Black-capped vireo nesting habitat is often synonymous with good habitat for white tailed deer.	☐	☐	☐
Springs of the Edwards Aquifer, including Barton Springs, provide habitat for several endangered salamander species.	☐	☐	☐
The application of fertilizers, herbicides and pesticides in residential areas in the contributing zone can directly impair the health of salamanders.	☐	☐	☐
Endangered invertebrates living in karst caves depend on nutrient that are transferred from surrounding areas by water and animals into the caves.	☐	☐	☐

13. Rangelands

	True	False	Don't Know
Rangelands are grasslands and savannas that consist mainly of native grasses and forbs with some disbursed trees across the landscape.	☐	☐	☐
Rangelands provide important ecosystem services, such as carbon sequestration and water filtration.	☐	☐	☐
Grasslands and open savannas in Texas are the result of long-term exclusion of fire.	☐	☐	☐
Decrease in the abundance of perennial grasses (grasses with multi-year life cycles) tends to result in increased soil erosion.	☐	☐	☐
Increase in the density of woody plants, especially juniper/cedar trees, tends to lead to an increase in ground cover by grasses and forbs.	☐	☐	☐
Increase in ground cover by grasses and forbs tend to improve surface water infiltration into the soil.	☐	☐	☐
To ensure the delivery of high quality water, it is more important to prevent soil erosion in the lower part of a drainage basin than in its upper reaches.	☐	☐	☐
Long-term suppression of natural fires increases the probability of uncontrollable wild fires occurring.	☐	☐	☐
Because white-tailed deer are native to Texas, high populations do not negatively affect other rangeland species.	☐	☐	☐
Wild hogs are native to Texas and have little impact on other wildlife.	☐	☐	☐

14. City of Austin Wildlands

	True	False	Don't Know
Water Quality Protection Lands were purchased mainly through voter approved Municipal bonds.	☐	☐	☐
Water Quality Protection Lands include land owned by the City of Austin as well as private land on which the City owns a conservation easement.	☐	☐	☐
Water Quality Protection Lands are restricted exclusively to the Edwards Aquifer recharge zone.	☐	☐	☐
The amount of land included in the Balcones Canyonlands Preserve meets the obligations imposed by Federal permit that led to its creation.	☐	☐	☐
The Balcones Canyonlands Preserve is a regional preserve system set aside for endangered species in Travis, Hays, and Williamson Counties.	☐	☐	☐
City of Austin, Travis County, Lower Colorado River Authority, and The Nature Conservancy own land in the Balcones Canyonlands Preserve.	☐	☐	☐
Conservation easements always restrict traditional forms of land use such as cattle grazing.	☐	☐	☐
Water quality and endangered species habitat in Austin can be affected by the type of rangeland management practices applied on Wildlands.	☐	☐	☐
Leaving the land untouched and unmanaged is one of the best treatments for wildland areas to protect the ecosystems they represent.	☐	☐	☐
The Austin area has just about the right number of white-tailed deer per acre to represent a healthy population and sustainable population.	☐	☐	☐

SECTION C – PURPOSE, USE, MANAGEMENT AND VALUE OF WILDLANDS

In this section we want to know what you think about the existence, use and management of the City of Austin Wildlands as well as problems you may have experienced.

15. Please answer each of the following questions by checking the most appropriate box next to each item. Please check only one box per line.

	Yes	No	Don't Know
Have you received any information about the Wildlands from the City?	☐	☐	☐
Have you received any notification about controlled fire on the Wildlands?	☐	☐	☐
Have you ever seen City of Austin personnel patrolling the Wildlands?	☐	☐	☐
Have you ever seen smoke from fires on the Wildlands?	☐	☐	☐
Have you ever heard firearms being discharged on the Wildlands?	☐	☐	☐
Have you ever been negatively affected by wildlife on the Wildlands?	☐	☐	☐
Have you ever accessed the Wildlands for any reason?	☐	☐	☐
Have you ever placed feed for wild animals on the Wildlands?	☐	☐	☐
Do you feel your property is more valuable than similar properties in Austin that are not near the Wildlands?	☐	☐	☐

16. What do you consider to be the reason for the City of Austin's decision to procure land that is now designated as the Balcones Canyonlands Preserve (BCP) and Water Quality Protection Land (WQPL)? Please check as many boxes as applicable in each column to convey your understanding for each of the two categories of land.

	BCP	WQPL
Stop development along the outskirts of Austin	☐	☐
Retain open space in areas that are increasingly being developed	☐	☐
Provide recreation opportunities for Austin residents	☐	☐
Protect the quality and quantity of water reaching Barton Springs	☐	☐
Preserve wildlife habitat	☐	☐
Protect the Barton Springs Salamander	☐	☐
Protect the Golden-cheeked warblers	☐	☐
Provide educational opportunities	☐	☐
Other (please specify) _____	☐	☐
Don't know	☐	☐

17. To what extent do you think the following actions or activities have positive or negative effects with respect to endangered species management goals for the **Balcones Canyonlands Preserve (BCP)**? Please circle the number that best reflects your perspective in each row.

7 = very positive … 4 = no effect … 1 = very negative								Don't know
Enforce existing rules and regulations	7	6	5	4	3	2	1	☐
Allow unrestricted public access	7	6	5	4	3	2	1	☐
Allow all types of recreation activities	7	6	5	4	3	2	1	☐
Allow horse trails	7	6	5	4	3	2	1	☐
Allow hiking trails	7	6	5	4	3	2	1	☐
Allow unleashed dogs	7	6	5	4	3	2	1	☐
Remove juniper/cedar trees	7	6	5	4	3	2	1	☐
Apply occasional controlled fires	7	6	5	4	3	2	1	☐
Reduce white-tailed deer populations	7	6	5	4	3	2	1	☐
Reduce feral hog populations	7	6	5	4	3	2	1	☐
Create cleared areas (fire breaks) next to subdivisions	7	6	5	4	3	2	1	☐

18. To what extent do you think the following actions or activities have positive or negative effects with respect to management goals for the **Water Quality Protection Lands (WQPL)**? Please circle the number that best reflects your perspective in each row.

7 = very positive … 4 = no effect … 1 = very negative								Don't know
Enforce existing rules and regulations	7	6	5	4	3	2	1	☐
Allow unrestricted public access	7	6	5	4	3	2	1	☐
Allow all types of recreation activities	7	6	5	4	3	2	1	☐
Allow horse trails	7	6	5	4	3	2	1	☐
Allow hiking trails	7	6	5	4	3	2	1	☐
Allow unleashed dogs	7	6	5	4	3	2	1	☐
Remove juniper/cedar trees	7	6	5	4	3	2	1	☐
Apply occasional controlled fires	7	6	5	4	3	2	1	☐
Reduce white-tailed deer populations	7	6	5	4	3	2	1	☐
Reduce feral hog populations	7	6	5	4	3	2	1	☐
Create open fire breaks next to subdivisions	7	6	5	4	3	2	1	☐

19. To what extent would you approve or disapprove of the following wildland management and wildlife management practices by the City of the Austin? Please circle the number that best reflects your perspective.

7 = strongly approve … 4 = neutral … 1 = strongly disapprove							
Application of controlled fire	7	6	5	4	3	2	1
Application of herbicides to control brush/non-native plants	7	6	5	4	3	2	1
Harvesting of white-tailed deer	7	6	5	4	3	2	1
Shooting feral hogs	7	6	5	4	3	2	1
Limiting public access	7	6	5	4	3	2	1
Restricting recreation to guided hikes/educational events	7	6	5	4	3	2	1
Constructing fences to control human and wildlife access	7	6	5	4	3	2	1

20. To what extent do you approve or disapprove of the following recreation facilities/activities or developments on the City of Austin Wildlands. Please circle the number that best reflects your perspective in each row.

7 = strongly approve … 4 = neutral … 1 = strongly disapprove							
Hiking trails for people without dogs	7	6	5	4	3	2	1
Walking trails for people with dogs	7	6	5	4	3	2	1
Bike trails	7	6	5	4	3	2	1
Horse riding trails	7	6	5	4	3	2	1
Off-road vehicle trails	7	6	5	4	3	2	1
Soccer, football or other outside sports fields	7	6	5	4	3	2	1
Public access within endangered species habitat	7	6	5	4	3	2	1
Outdoor theaters	7	6	5	4	3	2	1
Other entertainment areas	7	6	5	4	3	2	1
Environmental education field days	7	6	5	4	3	2	1
Convert Wildlands to residential areas	7	6	5	4	3	2	1

21. What is your level of concern about each of the following issues as a result of your property's close location to the City of Austin Wildlands. Please circle the number that best reflects your perspective in each row.

4 = very concerned … 1 = no concern				
Deer eating plants on your property	4	3	2	1
Feral hogs rooting in your yard	4	3	2	1
Rattlesnakes or other snakes near your home	4	3	2	1
Wildfire or smoke from fire	4	3	2	1
Trespass or interference by people on the Wildlands	4	3	2	1
Loss of pets due to predators	4	3	2	1
Restrictions to your access to the Wildlands	4	3	2	1
Illegal dumping of garbage	4	3	2	1
Vandalism	4	3	2	1

22. To the extent that living next to or near the City of Austin Wildlands is a positive or negative experience, do any of the following factors influence your opinion of the Wildlands? Please circle the number that best reflects your opinion in each row.

7 = very positive factor … 4 = not a factor … 1 = very negative factor							
The mere existence of the Wildlands	7	6	5	4	3	2	1
General quality of life	7	6	5	4	3	2	1
Enhancing the general economy of the region	7	6	5	4	3	2	1
Increase in nearby property values	7	6	5	4	3	2	1
Open landscapes and scenery	7	6	5	4	3	2	1
Open space protection for future generations	7	6	5	4	3	2	1
Water quality protection	7	6	5	4	3	2	1
Endangered species habitat protection	7	6	5	4	3	2	1
Interacting with wildlife	7	6	5	4	3	2	1
Limited human access to the Wildlands	7	6	5	4	3	2	1
Exclusion of access roads through Wildlands	7	6	5	4	3	2	1
Occasional use of controlled fire to control brush	7	6	5	4	3	2	1
Having a government land as a neighbor	7	6	5	4	3	2	1
Setting aside Wildlands with limited public access	7	6	5	4	3	2	1

23. Indicate which of the following actions in your home you are doing or would be willing to do to enhance the missions of the BCP and WQPL Wildlands. Please check one box per row.

	Already doing	Willing to do	Unwilling to do	Don't Know
Garden with native plants only	☐	☐	☐	☐
Landscape in a way that reduces risks from wildfire	☐	☐	☐	☐
Refrain from dumping brush on the Wildlands	☐	☐	☐	☐
Install a water-wise landscape	☐	☐	☐	☐
Keep pets inside	☐	☐	☐	☐
Keep pet food inside	☐	☐	☐	☐
Refrain from feeding deer	☐	☐	☐	☐

SECTION D – ENVIRONMENTAL AWARENESS AND INTEREST

In this section we want to know how aware and interested you are about environmental issues related to the City of Austin Wildlands.

24. From where does the City of Austin get most of its drinking water? _____

25. From where do you get most of your information about environmental issues that concern you?

_____

26. How do you prefer to learn about environmental issues? (Please check all that apply)

☐ Friends or neighbors ☐ Television ☐ Internet
☐ Newspaper ☐ Newsletter ☐ Magazines
☐ Class or workshop setting ☐ Presentation at community/neighborhood meeting
☐ Other (please specify) _____

27. Have you previously participated in or are you currently participating in any environmental organizations? ☐ Yes ☐ No

28. During the last 12 months, did you participate in any environmental education/volunteer program regarding the City of Austin Wildlands? ☐ Yes ☐ No

29. Please answer each of the following questions about environmental education opportunities regarding the City of Austin Wildlands. Please check only one box in each row.

	Yes	No	Don't Know
Is an environmental education program for all Austin residents important?	☐	☐	☐
Would you become a member of an environmental education program?	☐	☐	☐
Would you participate in an environmental education class?	☐	☐	☐
Would you host an environmental education class in your neighborhood?	☐	☐	☐

30. If you answered "No" or "Don't know" to <u>all four</u> questions in 29 above, please indicate the reasons you are not interested in participating in environmental education opportunities about the City of Austin Wildlands. Please check all that apply.

I have little interest in environmental issues	☐
I have little interest in endangered species habitat protection	☐
I have little interest in ground water conservation issues	☐
I have little interest in the City of Austin Wildlands	☐
I am opposed to the concept of land protection by the City of Austin	☐
I don't have the time	☐
I don't think I would benefit by participating in such a program	☐
I already know as much as I need to know about the City of Austin Wildlands	☐
Other (please specify) _____	☐

SECTION E – PERSONAL INFORMATION

To understand the variations in residents' perceptions about and interest in the City of Austin Wildlands, we ask you to provide some personal information that is commonly obtained as background information in mail surveys. We assure you that **YOUR INFORMATIION WILL BE KEPT STRICTLY CONFIDENTIAL**. The information will only be used to develop demographic summaries and at no time will your identity be disclosed or your individual responses shared with anyone.

31. In which year were you born? 19 _____

32. What is your gender? ☐ Male ☐ Female

33. Please indicate your highest level of education. (Please check the most appropriate category)

☐ Less than High School ☐ High School diploma ☐ Vocational diploma
☐ Associate's degree ☐ Bachelor's degree ☐ Post graduate degree
☐ Other (please specify) _____

34. What is the approximate market value of your property? (Please check the appropriate category)

☐ Less than $150,000 ☐ $150,001 to 200,000 ☐ $200,001 to $250,000
☐ $250,001 to $300,000 ☐ $300,001 to $350,000 ☐ $350,001 to $400,000
☐ $400,001 to $450,000 ☐ $450,000 to $500,000 ☐ Greater than $500,000

35. Please check the category that best represents your household's total income in 2008. (Include net property income, income from wages, salaries, rental property, investments, retirement accounts, and other income sources).

☐ Less that $50,000 ☐ $50,001 to $75,000 ☐ $75,001 to $100,000
☐ $100,001 to $125,000 ☐ $125,000 to $150,000 ☐ Greater than $150,000

If you wish to obtain more information about volunteering to host and/or organize an environmental program about the City of Austin Wildlands please go to the following web page:

http://www.ci.austin.tx.us/water/wildland/volunteering.htm

Please provide any additional comments about the City of Austin Wildlands and any related educational programs that will be developed to help Austin area residents better understand the importance and management of the Balcones Canyonlands Preserve and the Water Quality Protection Lands.

THANK YOU FOR TAKING THE TIME TO FILL OUT THIS QUESTIONNAIRE.

Your participation is greatly appreciated!!!

Please return the completed questionnaire in the postage-paid envelope.

APPENDIX B

DATA TABLES

Table B-1. Non-significant models from the multiple regression analyses results from Chapter IV pertaining to explaining the variation in approval of management actions.

	Human exclusion actions p=0.136, Adj. R^2=0.0044, n=175, Wald Chi^2=22.22, df=16	
Variables	b	z
Perceived that the Wildlands enhance their general quality of life	-0.100	-0.56
Perceived that the Wildlands enhance the general economy of the region	0.0855	0.61
Perceived that the Wildlands increase nearby property values	0.236	0.17
Open landscape and scenery are perceived benefits from the Wildlands	0.355	0.97
Open space protection for future generations are perceived benefits from the Wildlands	-0.176	-0.53
Water quality protection is a perceived benefit from the Wildlands	-0.473	-2.04**
Endangered species habitat protection is a perceived benefit from the Wildlands	0.400	2.78**
Interacting with wildlife is a perceived benefit from the Wildlands	-0.087	-0.72
Perceived that protecting the Barton Springs salamander is an exclusive purpose of the WQPL	0.254	0.66
Perceived that protecting the Golden-cheeked warbler is an exclusive purpose of the BCP	-0.21	-0.4
Perceived that protecting the Barton Springs salamander is one of the main purposes for the WQPL and BCP	-0.201	-0.44
Perceived that protecting the Golden-cheeked warbler is one of the main purposes for the WQPL and BCP	-0.077	-0.13
Would participate in environmental class	0.023	0.09
Would host an environmental education class	0.597	1.37
Would join an environmental program	-0.287	-0.98

* for pvalue,***≤0.001, **≤0.05, *≤0.10

Table B-2. Non-significant models from the multiple regression analyses results from Chapter IV pertaining to explaining the variation in approval of recreation activities.

	Intrusive recreation (p=0.779, Adj. R^2=-0.0249, n=173, Wald Chi^2=10.62, df=15)		Non-intrusive recreation (p=0.141, Adj. R^2=0.0601, n=175, Wald Chi^2=31.45, df=15)	
Variables	b	z	b	z
Perceived that the Wildlands enhance their general quality of life	0.127	0.83	0.064	0.38
Perceived that the Wildlands enhance the general economy	0.037	0.29	0.159	1.22
Perceived that the Wildlands increase nearby property values	0.062	0.47	-0.130	-0.96
Open landscape and scenery are perceived benefits	-0.003	-0.01	0.123	0.41
Open space protection is a perceived benefits	-0.162	-0.61	0.232	0.81
Water quality protection is a perceived benefit	0.084	0.31	-0.162	-0.61
Endangered species habitat protection is a perceived benefit	-0.211	-1.58	0.129	0.84
Interacting with wildlife is a perceived benefit	0.131	0.9	-0.717	-0.59
Perceived that protecting the Barton Springs salamander is an exclusive purpose of the WQPL	-0.643	-1.92**	-0.102	-0.32
Perceived that protecting the Golden-cheeked warbler is an exclusive purpose of the BCP	0.237	0.52	-0.174	-0.38
Perceived that protecting the Barton Springs salamander is one of the main purposes for the WQPL and BCP	-0.619	-1.26	-0.569	-1.38
Perceived that protecting the Golden-cheeked warbler is one of the main purposes for the WQPL and BCP	0.359	0.59	0.637	1.19
Would participate in environmental education class	-0.055	-0.22	-0.179	-0.72
Would host an environmental education class	-0.217	-0.57	-0.757	-1.99**
Would join an environmental education program	0.3	0.97	0.641	2.24**

* for pvalue,***≤0.001, **≤0.05, *≤0.10

VITA

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