BLANCO RIVER VALLEY RIPARIAN RESTORATION PROJECTS: LOCAL VALUES AND DECISIONS FOR RIPARIAN HABITAT MANAGEMENT FOLLOWING THE 2015 MEMORIAL DAY FLOODS IN WIMBERLEY, TEXAS

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by

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San Marcos, Texas
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BLANCO RIVER VALLEY RIPARIAN RESTORATION PROJECTS: LOCAL VALUES AND DECISIONS FOR RIPARIAN HABITAT MANAGEMENT FOLLOWING THE 2015 MEMORIAL DAY FLOODS IN WIMBERLEY, TEXAS

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Preface and Acknowledgements

This thesis is written in partial fulfillment for graduation in the Texas State University Honors College. The research and writing process was conducted over a duration of five months with the requirement that it is to be completed within the spring semester. The primary group involved in the study were land owners, and/or their representatives, who individually or jointly own property directly along the Blanco River in Wimberley, Texas. Their identities have been withheld for confidentiality purposes. Input from state and non-profit organizations directly involved in the restoration process was utilized to determine the various programs and resources available to assist landowners in the restoration process. Onsite interviews and visits to private properties were solely completed by the author to document riparian restoration. Secondary research was used as supporting evidence throughout this document and efforts to credit others work is cited in the Reference Section. My thesis supervisor for this project is Dr. Kimberly Meitzen, Assistant Professor in the Texas State Geography Department.

I undertook this project to gather insight into the human geography component of habitat conservation and restoration. Throughout my experience volunteering and interning with conservation and outdoor recreation organizations, leaders frequently stated that the lack of education was the problem for why some people do not consider the environment in their daily lives. I approached this thesis with the intention of gaining insight into the people's perspective. I wanted to investigate how their experience with nature and the role of education has an influence on their values and in turn on their land management decisions.

This thesis is directed toward any audience that desires a better understanding of local constraints to habitat management and complexities of the human/ecosystem interaction. It is meant to encourage conservation leaders and others alike to develop and/or adopt innovative ideas to promote, educate, and demonstrate daily habits compatible with environmental needs. It is also meant to help disseminate an accurate and unbiased understanding of the role of stakeholders in the land management process (i.e. habitat conservation, restoration, preservation and management), which is something I have gained from this experience.

Data collection, especially from interviews with land owners, was the most enjoyable. Writing has never been my strong suite, so I found the process arduous and emotionally demanding. I would like to extend my deepest gratitude and appreciation to my thesis supervisor for helping me keep my sanity. Her support and guidance was invaluable in successful completion of this thesis and in my academic growth. I also want to thank all the land owners and their representatives for their contribution to my research. Their input is the crucial center point of this thesis and it would not exist without them. Thank you to the Society of Geographic Information Science (SOGIS) and to two of their members, Ritchie M. Jose and Keagan McNew for designing my land cover and study area maps. Their geographic information system (GIS) skills and professional demeanor are impeccable. It was a pleasure to work with them. I would also like to acknowledge my writing tutor, Jon Beaubien at the Texas State University Writing Center. Your critiques and recommendations on my drafts are greatly appreciated. I have learned so much from you. Finally, I would like to extend my gratitude to Ryan McGillicuddy with the Texas Parks and Wildlife Department (TPWD), Rachael Ranft

with The Texas Nature Conservancy (TNC), Andreina "Ina" Alexatos with Treefolks, Grady McGahan with ReTreet and to the Texas State University Outdoor Recreation Center. Their efforts and passion to protect our regional ecosystems is one of the greatest measures of love for our environment and the people who inhabit them.

Enjoy,

Andrea Elaine Pinon
Austin, Texas
April 14, 2016

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Abstract

Do natural disasters shift public attitudes and values towards riparian habitat conservation? Central Texas experienced one of the most devastating floods in Texas history over the 2015 Memorial Day weekend. The result was profuse destruction of vital riparian habitats as numerous trees and other species were uprooted and carried downstream by torrential flood waters. The absence of riparian vegetation, in areas converted to lawns and impervious surfaces, may have exacerbated the flood's impacts resulting in significant property damage. Following this natural disaster, a multitude of Blanco River restoration projects went into effect. Some with the initiative to rehabilitate riparian zones back to their ecological health and others with a more antagonistic approach to habitat recovery. This study examines whether public attitudes and opinions towards riparian habitat conservation have changed following the experience of this natural disaster. Blanco River valley restoration projects will be used to understand the attitudes and values of the various stakeholders involved. A comprehensive and comparative analysis weighs local recovery actions to the perspectives of landowners. Qualitative interviews were conducted to investigate whether or not attitudes have shifted from aesthetic value to that of habitat conservation and restoration values. This study also investigates the role of education in the restoration process to determine to what extent land owners have adopted a science-based (SB) approach to habitat recovery. Research highlights a spatial perspective of riparian habitat fragmentation along the Blanco River after the Memorial Day floods and correlates them with stakeholder values.

Key words: riparian, habitat, restoration, stakeholder, natural disaster, flood, conservation

I. Introduction & Background Significance

"Thousands of insignificant tributaries

Contribute their relatively minor aqueous deposits

Into rills, which become rivulets, then creeks

That finally feed into larger watercourses to become rivers-Major arteries

conveying the essential element of life across the land

As they wind their way toward the Gulf"

-Dan Caudle, Liquid History

(Hardy and Davis 2015)

Riparian habitats, riparian zones (Wentzel, Davis, Hardy, Phillips, Jacob Duke and Nelle 2015), hydrologic buffers (Phillips et al. 2015), or riparian ecotones (Malanson 1993) are some of the terms often used to refer to the unique characteristic boundaries that make up river bank landscapes. They vary spatially and temporally forming aquatic-terrestrial gradients (Malanson 1993) that connect landscapes. This function makes them significant within their respective ecoregions. Wentzel et al. (2015) defines riparian habitats as land areas along, but outside the banks, of a stream or river that are significantly influenced by flow conditions and, in turn, have an influence on environmental conditions within the stream or river. Riparian zones (RZ) are especially important to ecosystem management because their spatial distribution encompasses a fraction of the total terrestrial landscape, but they are highly sensitive to how the surrounding territory is managed.

I.1 Riparian zones and goods and services

Extensive research across multiple disciplines recognizes that RZ functions (Table 1) provide for the goods and services people value and contribute to healthy ecological integrity. Although societies may not immediately experience the benefits of protecting RZs, the long term advantages are essential for humans.

Function	Goods and Services Valued by Societies
Short term storage of surface water.	Reduced flood damages.
Maintenance of water table.	Diverse habitats that contribute to biodiversity.
Accumulation and transport of sediments.	Production of floodplain habitats.
Organic carbon production.	Healthy species populations.
Promotion of biodiversity.	Biocomplexity.
Cycling and accumulation of chemical constituents.	Improved stream water quality.
Sequestration of carbon in soils.	Improved air quality.
Maintain streamside vegetation.	Suitable habitats for organisms.
Support characteristic terrestrial animal species.	Animals for bird watching, wildlife enjoyment, and hunting.
Support characteristic aquatic animal species.	Fish for food and recreation.

Table 1. Riparian function and good and services valued by societies. (Wentzel et al. 2015) Research has shown that riparian habitats contribute to good and services people depend on. Protecting these vital ecosystems benefits the communities that co-inhabit them.

Flood mitigation, for example, is a valuable benefit that results from protecting riparian habitats. Vegetation within river channels and floodplains slow down water and allow deposition of nutrient rich sediment (Forzieri, Moser, Vivoni, Castelli and Canovaro 2010). If vegetation is removed then the role of the RZ is degraded and does not function to its potential. The magnitude and frequency of floods during wet seasons is increased as well as the impacts from these natural disasters. Extensive property damage can occur as well as the risk of death.

I.2 Values and the human-ecosystem interaction

Private landownership is an integral part of environmental management. RZs are considered territory and therefore can be privately owned (Florez-Diaz, Castillo, Sanchez-Matias and Maass 2014). For this reason, habitat protection becomes especially challenging because the decision-making process is held with the private landowner. Conflicting values drive contrasting land management decisions which result in a fragmented or transformed riparian landscape (Figure1). A thorough understanding of the socio-economic characteristics involved, leads conservation planners to develop innovative approaches to guiding land owner's decisions. This is accomplished with analysis of what Kaufmann et al. (1994) refers to as, the human-ecosystem interaction (HEI), defined as a relationship where humans influence and are influenced by ecosystems. Florez-Diaz et al. (2014) argue that human decisions on land management at the local level are significantly influenced by how people understand and value the place where they live. The way people construct and manage landscapes is correlative to how we look at them; in other words, what we see, know, and feel (Florez-Diaz et al. 2014). Such influences include an individual's experience with nature and the role of education in guiding a property owners land management decisions. An individual's experience during natural disasters, specifically flooding, and the method for dissemination of riparian restoration information are the central aspects addressed in this study.

Figure 1. TPWD Conservation Demonstration Program Site1
Riparian zone fragmentation along the Blanco River is common. This is one of the most privatized rivers in central Texas.

I.3 The education dilemma

Ecologist Aldo Leopold argued that conservation efforts have not extensively progressed because of what he termed, the 'education dilemma' (1949). This is the long held position that argues the volume of education is both the impetus and hindrance for advancement in conservation land ethics. In other words, the reason why some societies do not practice these ethics is only because there isn't enough education. On the contrary, there are many organizations (and individuals) in Texas who are responsible for environmental programs, volunteer events, and educational workshops dedicated to informing citizens on local issues. Eco-USA and the Metropolitan Austin Interactive Network (MAIN) list a combined total of approximately 87 (eco-usa and MAIN 2016) non-profit organizations in Texas that are dedicated to habitat education, preservation, and conservation. The Hill Country Conservancy (HCA) invested $500,000 into

conservation easements and education over the last decade (2015). This value was appraised at $64,000,000 (HCA 2015), making it a significant impact for conservation initiatives. In 2003, The Nature Conservancy (TNC) launched their Blanco River Project with the goal of conserving biodiversity within a 400-square mile area. This program includes complimentary onsite technical support, educational workshops and habitat protection plans (TNC 2016). The Wimberley Valley Watershed Association (WVWA) was responsible for preserving some of the Hill Country's most iconic landscapes. Jacobs Well, a critical area for ground water recharge, was in threat of massive development which would have included a mobile home park and condos (WVWA 2016). In addition, the Texas Association for Environmental Education (TAEE) exists to develop and support educators state wide in order to advance environmental literacy. In order to extend their reach, the TAEE has divided the state into 20 regions each with its own Environmental Education (EE) Regional Service Providers, and partner organizations. They are also responsible for developing the Texas Natural Resource Environmental Literacy Plan (2016). These organizations along with many others have integrated a learning component within their operations in order to further strides towards conserving and protecting Texas habits. The challenge of advancing conservation efforts is not only associated with the volume of education, as some environmental advocates contend, but with how organizations engage Texas residents. Outreach mechanisms become increasingly important as the state population grows and includes a diversity of backgrounds and values.

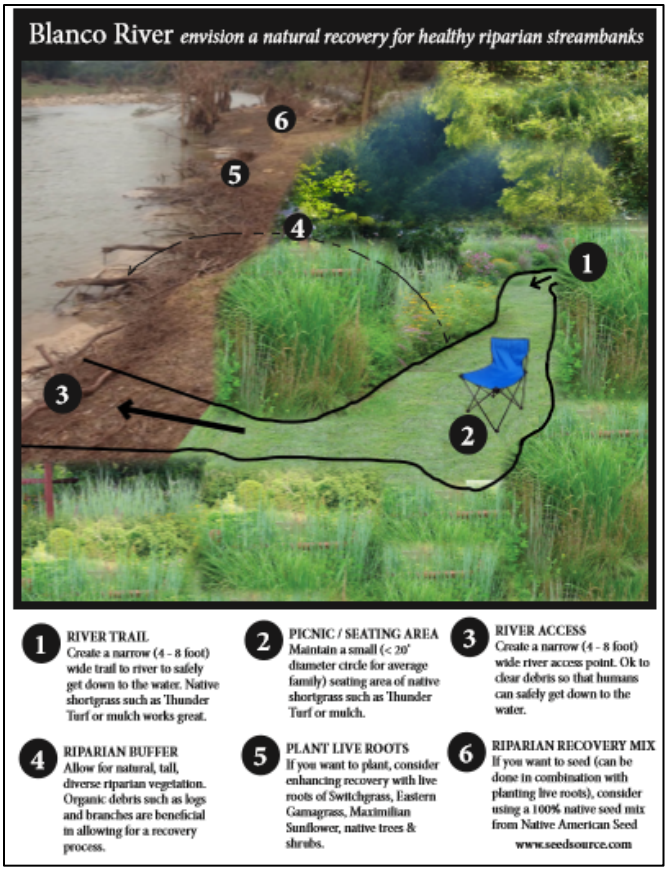
Leopold (1949) countered the 'education dilemma' argument and challenged environmentalists to look at the content of conservation education. This includes

analyzing the compatibility of information with the HEI of local populations. Socio-economic spheres which include values and perceptions of the landscape should be important considerations in the goal of advancing conservation. Because humans influence ecosystems and are influenced by them (Kauffman et al. 1994), education should include the role of landownership in habitat management. This means analyzing the methods in which organizations disseminate information. Telling private landowners what they should do is not as effective as showing them how to do it, how it contributes to their daily lives, and what the end result could look like.

Yu and Belcher (2011) analyzed landowner's willingness to adopt riparian conservation within the Prairie Pothole Region of Saskatchewan in the Canadian Province. Land cover in this region had been transformed for agricultural use which contributed to extensive riparian habitat destruction. The loss of ecosystem services and goods provided by RZs raised concern among local governments and environmental groups. Yu and Belcher (2011) considered the amount of compensation that would be required for private landowners to conserve RZs. Land owner attitudes towards conservation decisions were also analyzed. Economic incentive programs were developed and found effective in overall objectives. Organizations also discovered that when focus shifted away from conservation to the benefits of crop production associated with riparian retention, landowners were more willing to preserve them. In this case, local values and needs were advocated for in order to further conservation goals.

The current research addressed in this study considers the role of private landowners who own property along the Blanco River in Wimberley, Texas. The HEI and the influence of local values was considered in RZ restoration following a flood

disaster that devastated the town in May 2015. Aesthetics and investment values were stated among the top priorities from participants in this study. Landowners indicated that their decision to remove native RZ vegetation and install turf lawns was dictated by their desire for their property to "look pretty." Environmental groups capitalized on these local values and created new ways to engage with the community. They developed a visual model design (Figure 2) of a RZ landscape that incorporated both native vegetation and turf grass. Access trails were added as well as small areas cleared to accommodate river bank recreation. The goal was to show landowners how their values and the needs of the RZ come together to look aesthetically pleasing while maintaining RZ function. Other methods to engage landowners are discussed in the later portion of this paper.



I.4 Restoration and cooperative riparian management

The region's physical geography (i.e. thin soils and steep/rugged topography) and seasonal high precipitation make it prone to flash floods (LCRA 2016). In 2015, Central Texas experienced one of the most devastating and destructive floods in Texas history. Memorial Day brought heavy rains causing the Blanco River to rise and overflow. The result was profuse destruction of vital riparian habitats as a number of trees and other terrestrial species were uprooted and carried downstream by torrential waters. The initial absence and emanate loss of these critical habitats exacerbated the flood's impacts resulting in thousands of dollars in property damage. Residents lost their homes and some, their lives. Following this natural disaster, a multitude of Blanco River restoration projects went into effect. Two general approaches were adopted. The first, with the initiative to rehabilitate riparian zones back to their ecological health. The second, is a more antagonistic approach to habitat recovery. The first approach allows debris to remain, thus giving way for natural recovery process to take place. The later, has removed all vegetation and debris essential for river channel rehabilitation. Following the flood, there are still river front landscapes that continue to remain devoid of essential terrestrial species and remain susceptible to natural disasters in the future.

Nelle et al. (2015) emphasizes the necessity of cooperative riparian management (CRM) for the success of RZ conservation. This is the voluntary commitment of multiple stakeholders to comply with a set of environmental goals and the land management

Figure 2. Hill Country Alliance riparian restoration model (HCA 2015)
The objective of this diagram is to provide landowners with an example of how to incorporate native vegetation into RZ landscape design.

techniques that help to achieve them. Land owner independence and private property rights are high priority values in the state of Texas so achieving CRM can be a challenging task (Nelle et al. 2015). Environmental organizations (Table 2) involved in riparian restoration in Wimberley have managed to make progress with CRM by incorporating local values into RZ restoration demonstration sites. These sites are located on properties where land owners have willingly allowed organizations to come onto their

Organization	Classification	Initiatives
Texas Parks & Wildlife Department (TPWD)	State Agency	Riparian habitat: resiliency, function, conservation.
The Nature Conservancy (TNC)	Non-profit organization	Riparian habitat: resiliency, function, conservation.
TreeFolks	Non-profit organization	Re-vegetation: Trees
Hays County	County	Re-vegetation: Trees, public safety
Wimberley Strong	Non-profit organization	Emergency aid/relief, emotional support
Federal Emergency Management Agency (FEMA)	Federal Agency	Debris removal, emergency aid/relief, public safety
ReTreet	Non-profit organization	Re-vegetation: Trees

Table 2. Organizations involved in riparian restoration in Wimberley, Texas
The table lists all organizations most actively involved in riparian restoration. Land owners most likely adopt RZ methods that comply with their values and needs.

property and guide and manage their RZs. The purpose is to move beyond the 'education dilemma', integrate local values by considering the HEI, and advocate for riparian conservation.

The feasibility of achieving CRM is greatest when land owners communicate with each other and build plans for mitigating conflicts. So called, 'river parks' are

collectively owned river front properties and shared among stakeholders and their families. They are managed by a Property Owners Association (POA) comprised of elected board members who are charged with land use and land management decisions. Like the rural communities studied in central Mexico, Florez-Dias et al. (2014) discovered that access to local assembly gave private land owners the opportunity to express their ideas, objections and opinions on collectively owned property. Specially selected individuals acting to mitigate conflict can also be highly valuable in the process. These same principles apply to POAs or stakeholders who jointly own property in Wimberley and who take advantage of the complimentary services provided by environmental organizations. Any objections or conflicts involving restoration plans are addressed using internal mediators. Once a compromise is established, information is then communicated to the organizations via a project leader. This system has proven successful because it gives landowners a voice, establishes a method for problem solving and resolution, and organizations can manage restoration projects with only a few individuals instead of the entire POA.

As previously mentioned, values and educational factors influence the decision making process on how landscapes are managed. There are a number of organizations actively involved in the RZ restoration process in Wimberley – each with its own initiatives and influence within the community. Data collected during this study supports that for the majority of their actions, landowners implemented restoration methods most closely related to their values and perspectives towards the RZ. Whichever organization they allow to guide them in the process, there are three methods of restoration. These include (1) passive and (2) active riparian restoration and the (3) combination of both

(Table 3). The National Oceanic and Atmospheric Administration (NOAA) defines passive restoration as a change to management practices or land use (2016). Participant 6 described it as, "letting the river heal itself." Active restoration is a, "boots on the ground" (NOAA 2016) approach that involves any soil/vegetation moving activity. Among others, it includes artificial revegetation, and invasive species management (WPD 2016). There are advantages and disadvantages for both methods but they give land owners flexibility to decide which strategies work best for them. The conservation demonstration program established by environmental organizations is a mechanism to help educate landowners

Restoration Method	Description	Activity
Passive riparian restoration	spontaneous succession	Reduce/eliminate source of degradation, allow recovery time, restrict/eliminate access to recovery site, restrict/limit activities that degrade riparian area
Active riparian restoration	technical strategies	Artificial re-vegetation, invasive species management, weed management, mulching, native plant transplanting, irrigation

Table 3. Riparian restoration methods (Naiman et al. 2005)
Landowners can implement these strategies independently or jointly in order to restore their riparian landscapes.

on the value of SB riparian restoration. It has also been an avenue to encourage RZ habitat management practices conducive to environmental needs.

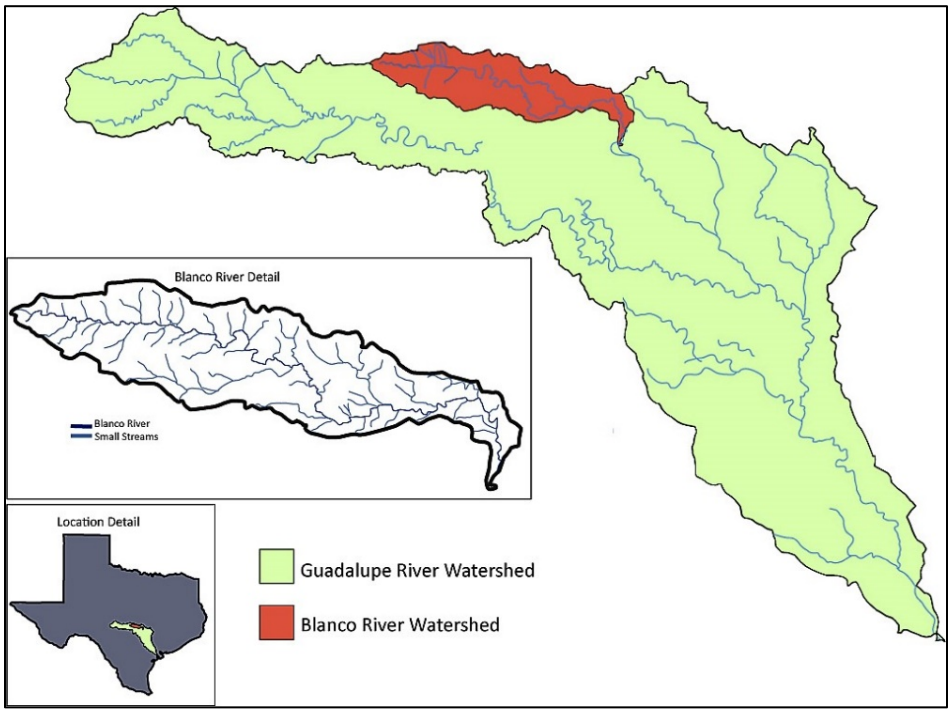
Research supports that value-systems influence the decision-making process and they are developed from sensory and informational inputs. From this basis, it can be hypothesized that value-systems can shift from aesthetic values towards SB habitat restoration values. For this study, SB restoration is the implementation of active and/or

passive riparian restoration that considers the role of riparian ecotones in sustaining ecological and hydrological processes along these aquatic-terrestrial riparian landscape gradients.

This study investigates the various Blanco River riparian restoration projects that went into effect following the 2015 Memorial Day floods that devastated the Hill Country town of Wimberley, Texas. Qualitative interviews were conducted to investigate the human-ecosystem interaction within riparian corridors with respect to the influence of stakeholder values and education on riparian habitat management. The objective is to determine whether there is a shift in stakeholder values towards science-based restoration that accounts for riparian zone hydrological and ecological sustainability following flood natural disasters.

II. Study Area

" All too often, in our rush to protect or exploit the waters that flow down our rivers & streams, or in our determination to "improve" our river banks by manicuring them for recreation & aesthetic reasons, we forget that the riparian communities alongside them are themselves a critical component of the ecosystems-in the water & on the landscape."



-Andrew Sansom

(Davis & Hardy 2015)

Figure 3. Guadalupe-Blanco River Watershed Map (Jose, Ritchie M.)
The Blanco River is a sub-basin with the Guadalupe River watershed. This river is one of the most privatized rivers in Texas.

The Blanco River watershed (BRW) is located in central Texas (Figure 3). It is a sub-basin within the Guadalupe River watershed and drains 440 square miles (GBRA 2008). The Blanco River reaches approximately 87 miles (TPWD 2016) southeast through four counties: Kendall, Comal, Blanco and Hays. The BRW is part of the Edwards Plateau ecoregion which encompasses 24 million acres (TPWD 2016) of Hill Country. This region was formed 100 million years ago during the Cretaceous period from marine deposits when this part of the state was covered by an ocean (TPWD 2016). Limestone ridges, hills and deep canyons are what form the basin's steep and rugged terrain. The climate is semi-arid (Cfa) with cool winters and hot summers. The average annual rainfall is between 15 inches in the west (TPWD 2016) and 31 inches in the east (GBRA 2008). These precipitation gradients frequently result in prolonged droughts and seasonal flash floods (TPWD 2016). Vegetation types (Table 4) vary throughout the basin although a large extent is dominated by Ashe juniper (*juniperus ashei*) and

Redberry juniper (*juniperus pinchotii sudw*) also known as Cedar (TPWD 2016). Texas Parks and Wildlife Department documents 400 endemic plants of which 200 occur within the Edwards Plateau ecoregion (2016). Habitat within the BRW supports various federally endangered, threatened, and endemic species. Among others, include the Golden-Cheeked Warbler (*setophaga chrysoparia*) and the Blanco River Spring Salamander (*eurycea pterophila*) (TPWD 2016). Elevation varies through the upper watershed (1,980 ft.), downstream through Wimberley (1,013 ft.) and into the lower watershed in San Marcos, Texas (650 ft.). Over the last decade, the flood plain has exhibited a vast degree of land use and land cover change (LULCC) from the rising human population in the Texas Hill Country. Urban development, agriculture, and manufacturing are some of the land classifications that have made significant impact.

This research study considers only the portion of the Blanco River that flows through Wimberley, Texas (Figure 4) which is approximately a 15 mile reach. The city and this portion of the BRW was selected to scale down the study area to a manageable study area so that research could be completed within five months. It was also selected because of the considerable RZ restoration projects that commenced following the 2015 May floods. The LULCC that has been extensively documented before the natural disaster was determined to be a significant baseline in which to conduct research.

Vegetation Type	Species
Trees	Pecan, Sugarberry, Big-toothed maple, Black walnut, Plateau black cherry, Chinkapin oak, Texas red oak, Texas persimmon, Yaupon, Red mulberry, Texas pistache, Carolina buckthorn, Texas redbud, Mexican plum
Confiers	Ashe juniper, Remote pinyon pine, Bald Cypress
Shrubs	American beauty-berry, Elbowbush, Lantana, Spicebush, Fragrant sumac, Autumn sage
Succulents	Red yucca, Twist-leaf yucca
Vines	Trumpet-creeper, Coral honeysuckle, Virginia creeper, Yellow passion vine, Mountain grape
Grasses	Silver bluestem, Canada wildye, Big muhly, Little bluestem, Indian grass
Wildflowers	Columbine, Butterfly weed, Engleman daisy, Shrubby boneset, Turk's cap, Cedar sage, Standing cypress, Brown-eyed susan, Greenthread

Table 4. Plants for the Edwards Plateau (TPWD 2016)
The variety of flora within the Blanco River watershed helps to support biodiversity within the flood plain.

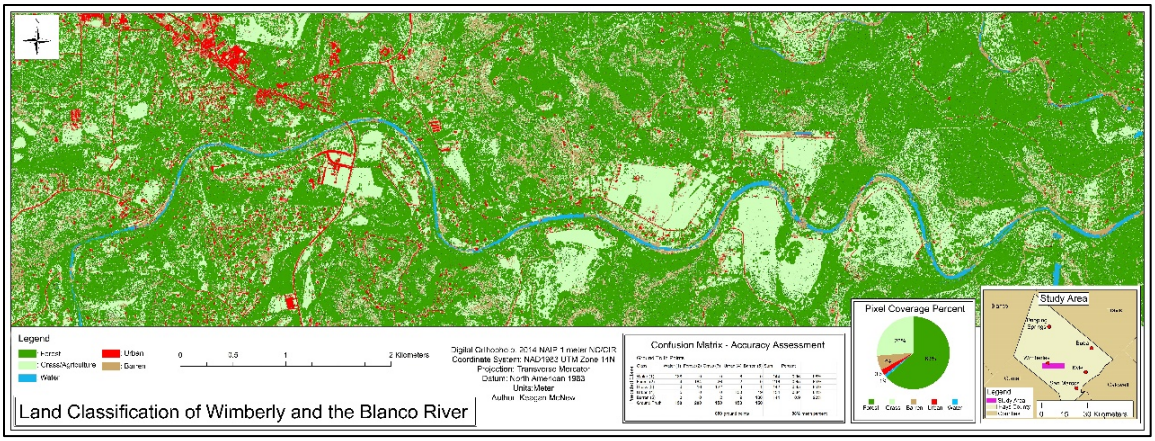


Figure 4. Land classification of Wimberley and the Blanco River (McNew, K.) Population growth in the Texas Hill Country has led to an increase in land cover change. Conservation initiatives to protect RZs is important to retain that natural vegetation.

II.1 Population and sample size

The sample population for this study consists of Wimberley residents only. Participants are willing volunteers and include private landowners (and/or their representatives) who independently or jointly own property along the Blanco River. The properties included are show in Figure 5. The names and addresses of participants are withheld for confidentiality purposes. Instead, pseudonyms have been used to identify each individual. The 2010 United States Census Bureau (USCB) reports 2,626 residents with approximately 30 percent between the age of 50 and 64 years of age. 75 percent of privately owned homes are occupied by their owners with 24 percent consisting of renters (USCB 2010). A total of eleven individuals were interviewed for this study. Four of them were retired, one of them was a representative for the Texas State University Outdoor Center University Camp, two were representatives of the private landowners, one individual was a business owner, another individual recently inherited land through a deceased family member and the final two held joint ownership (along with eight other landowners) of a river park.

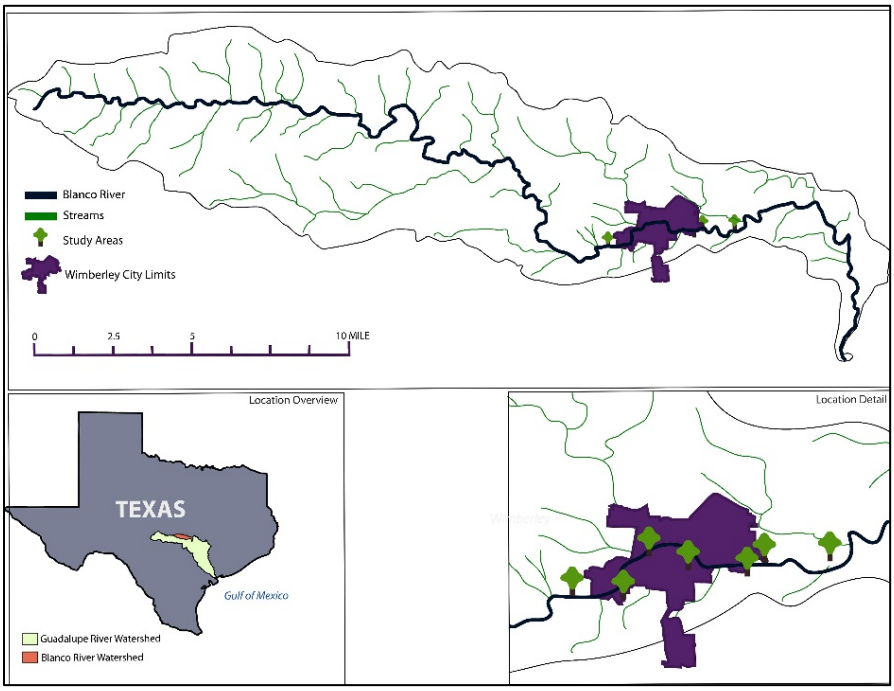


Figure 5. Study area map (Jose, R.M)
Properties included in this study are indicated in green.

II.2 Land use and land cover change

Sansom and Xia (2010) documented approximately a four percent annual population growth between 1990 and 2000, ranking Wimberley as one of the fastest growing communities in Texas. Their researched focused on the effects of LULCC on streamflow and non-point source pollution from surface water runoff. The aim was to correlate this data with urban expansion among major cities within the BRW. Information obtained from the 2001 National Land Cover Dataset was used to produce LULCC models (Figures 6 through 8) to demonstrate landscape transformation within the flood plain. Land classifications (i.e. agriculture, urban, grass/shrubs, tree cover, water and

barren) were designated by known historic land uses within the region. Data analysis determined that grass/shrub land was among the classifications most converted to urban areas. Sansom and Xia (2010) also found, as neighborhoods matured, trees became the primary feature. The daily discharge data retrieved from USGS station 8171000 (Blanco River at Wimberley) displayed an increase in frequency and magnitude of river discharge between 1990 and 2000 (Figure 9). The data presented by Sansom and Xia (2010) further substantiates the interrelationship between hydrological regimes and LULCC. It is not surprising that the 2015 flood disaster resulted in catastrophic impacts for the city of Wimberley.

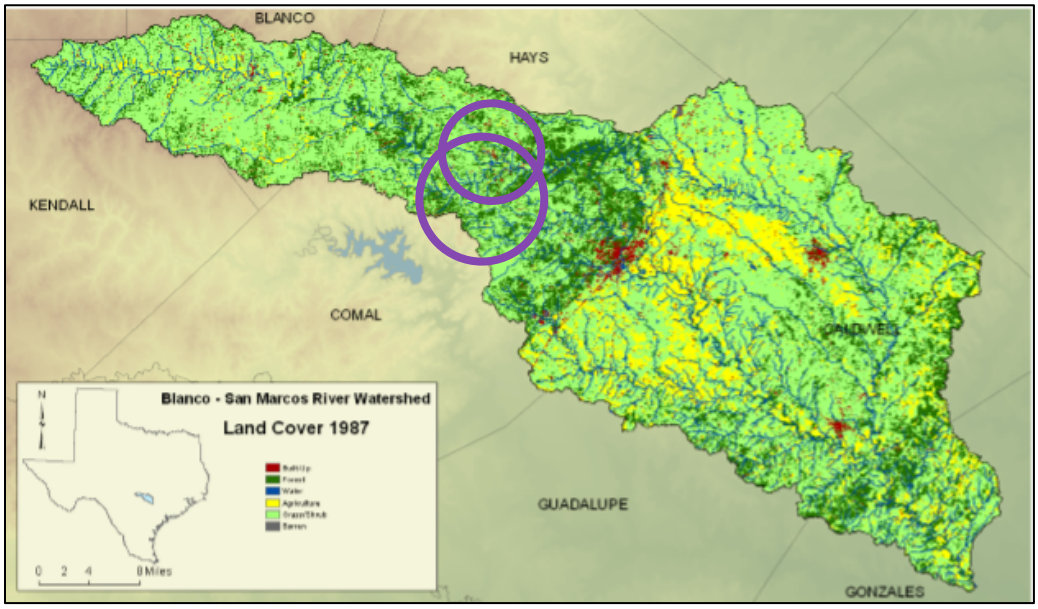


Figure 6. Blanco-San Marcos River watershed land cover 1987 (Sansom and Xia. 2010) City of Wimberley highlighted in purple.

Figure 8. Blanco-San Marcos River watershed impervious cover 2001 (Sansom and Xia 2010)

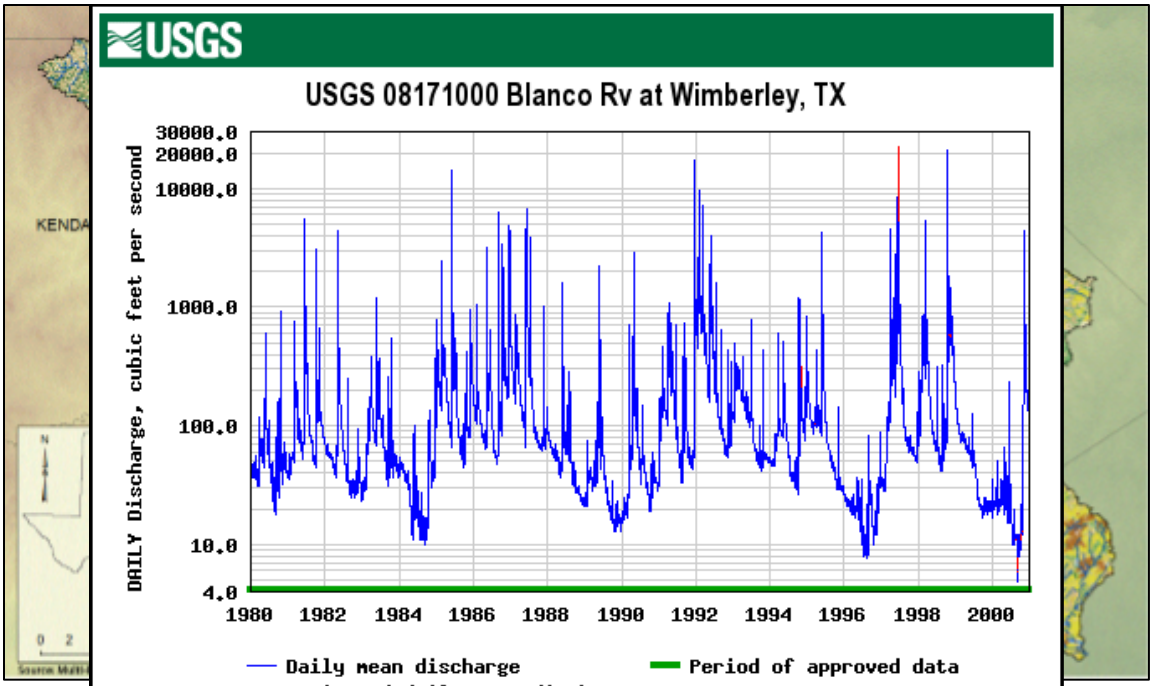
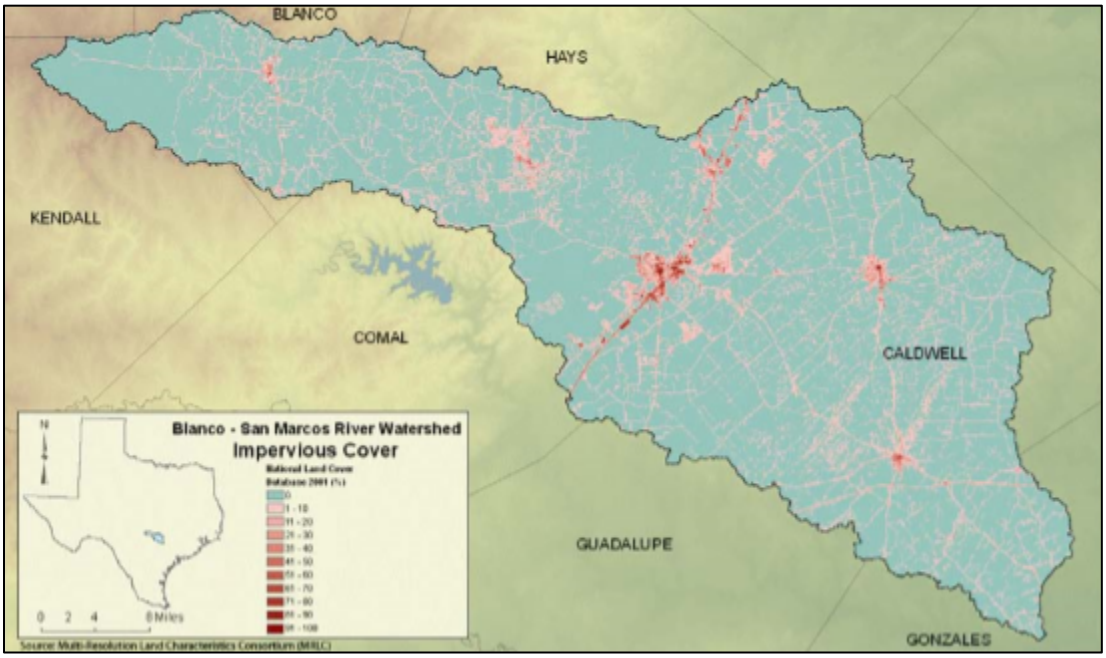


Figure 7. Blanco-San Marcos River watershed land cover 2001 (Sansom and Xia (2010)



Data produced from Sansom and Xia (2010) is concerning for two reasons. The

Figure 9. Blanco River at Wimberley discharge data 1980-2000 (USGS 2016)

first is riparian vegetation is gradually being removed or transformed thus degrading its flood control functions. Naiman et al.(2005) contend that the structural patterns associated with a mosaic of RZ flora helps to slow down water thus mitigating the impacts of overbank flow. The LULCC change in Wimberley exhibits an upward trend in urban land cover and loss of vital RZ vegetation. It is no surprise that LULCC within the BRW contributed to the catastrophic impacts of the floods in 2015. The second cause for concern is with the population's special selection of what RZ vegetation to keep and remove. As discussed in the later portion of this paper, the decision-making process is influenced by individual values and perceptions of the landscape. Qualitative data collected from participant interviews and photographs supports that the majority of landowners favor riparian trees over grasses and shrubs. Aesthetic values and preference for visual uniformity (Gerstenberg and Hofmann 2016) helps to explain the psychological

phenomena involved with favored selection of one riparian species over another. Innovative techniques to engage private land owners on the ecological benefits of biodiverse RZs is a vital step in habitat conservation.

II.3 Climate and weather data

The National Oceanic and Atmospheric Administration (NOAA) reported May 2015 to be one of the wettest months in Texas history (NOAA 2015). The impacts that ensued during the Memorial Day weekend were the product of the region's physical geography, LULCC and record precipitation leading up to the flood. The area's shallow, thin rocky soils (TSHA 2016) became quickly saturated from heavy rainfall that began during the beginning of the month. Additional rainfall, after these soils were saturated, would become overland flow surface water runoff draining directly into rivers and streams. Most of the precipitation during the Memorial Day event was concentrated at the headwaters of the BRW, an area characteristic of steep terrain and extreme changes in elevation (Figure 10). Increasing volumes of overland runoff drained into the Blanco River heading downstream. The Blanco River nearly rose to 41 feet when it received an even greater amount of water (NOAA 2015) at the confluence with Cypress Creek located in Wimberley (Figure 11). The National Weather Service reported that the portion of the river in Wimberley rose five feet every fifteen minutes, equating to a twenty foot rise in an hour (2015). The LULCC that had taken place prior to the flood further exacerbated the impacts by leaving residents defenseless with no terrestrial vegetation to help reduce the velocity of the flood water.

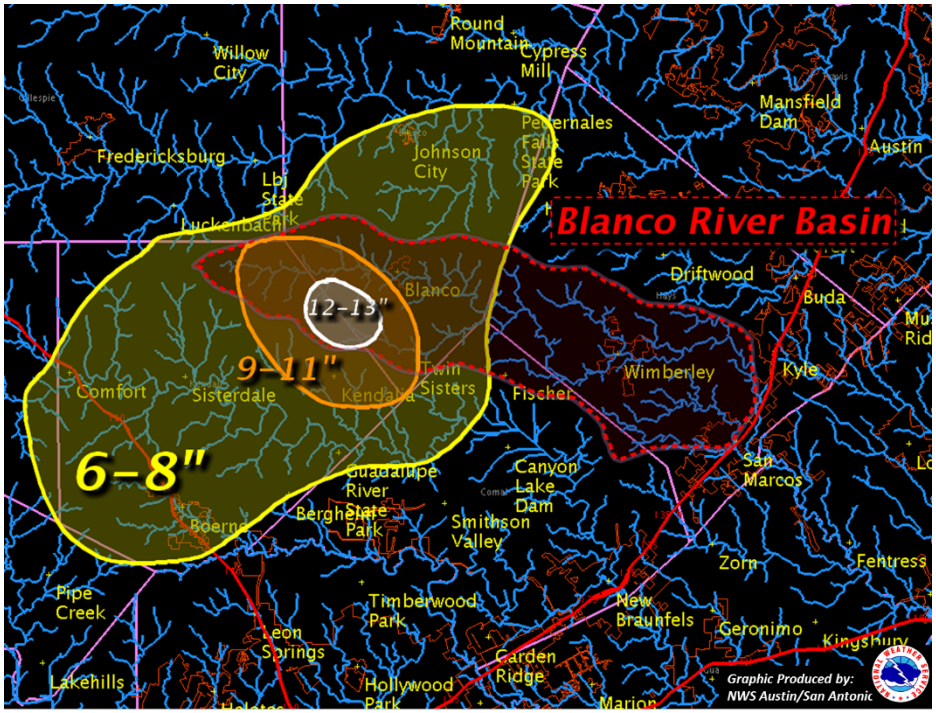


Figure 10. Blanco River basin precipitation in inches (NOAA 2015)
Most heavy down pour was concentrated at the headwaters of the BRW.

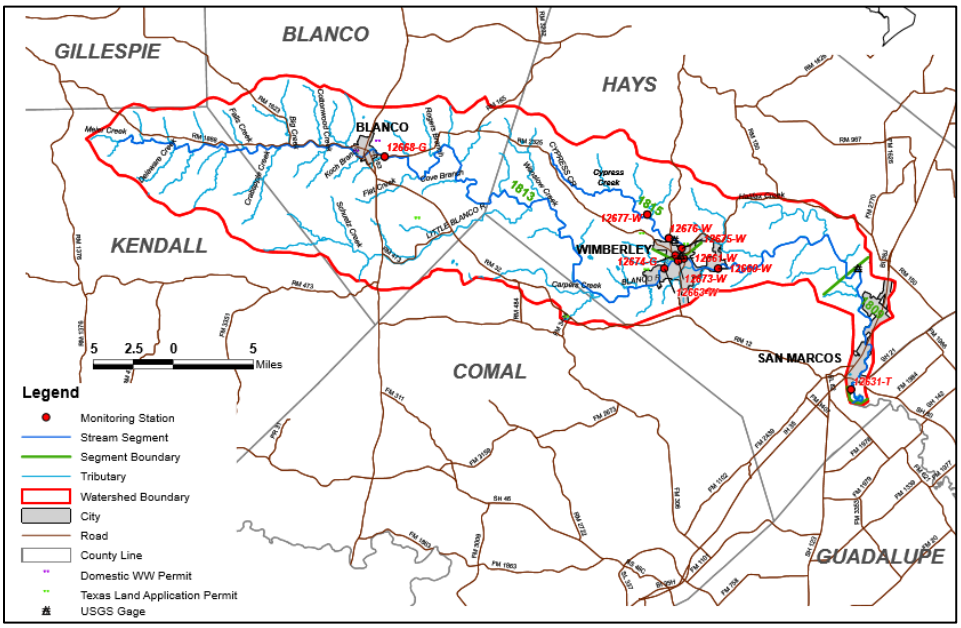


Figure 11. Blanco River watershed (GBRA 2008)
The Blanco River-Cypress Creek confluence is located in Wimberley, Texas.

III. Research Approach & Methods

"Man often becomes what he believes himself to be. If I keep on saying to myself that I cannot do a certain thing, it is possible that I may end by really becoming incapable of doing it. On the contrary, if I have the belief that I can do it, I shall surely acquire the capacity to do it even if I may not have it at the beginning."

-Mahatma Gandhi (1927)

Data collected during the course of this research study was solely completed by myself and is primarily qualitative. Quantitative data was derived from a small test survey completed by six attendees at an informational workshop hosted by the Texas Parks and Wildlife Department. Photographs were taken by the author to document RZ restoration projects. Pre-flood photos of the RZ were provided by landowners at my request as well as permission to use them. A total of three maps were designed for use in this paper and poster presentations by two members of the Texas State University SOGIS organization. Literature review was also completed by myself. Data was stored on a combination of sources. These include a USB flash drive (which was accidently destroyed during the course of this study), the file hosting service-Dropbox, on a Hewlett Packard (HP) laptop computer and on an Apple I-Pod device. I used my own vehicle for transportation to and from the study area. This research was fully funded by a scholarship from the Terry Foundation.

III.1 Qualitative research

I created a Facebook account under my nick name, "Andy Pinon", with the purpose of soliciting landowner participation from the 'Blanco River Valley Restoration Project' page. This is a closed group which means it requires permission to join by an administrator. Once I was approved to join, I posted a brief invitation to contribute to my research on the group 'wall' (Figure 12). It included an introduction of myself, the purpose and goals of my study as well as my contact information. I communicated with the initial group of landowners via a private Facebook chat room and by email correspondence. I organized a convenient time and date in which to either meet in person or speak over the phone for an interview. Landowners I met in person, was in Wimberley at their private residences. I dedicated a significant amount of time (minimum of two hours) for onsite interviews. Participants who preferred to talk over the phone were allotted one hour. The average amount of time for onsite interviews was 45 minutes and for phone interviews, 30 minutes.

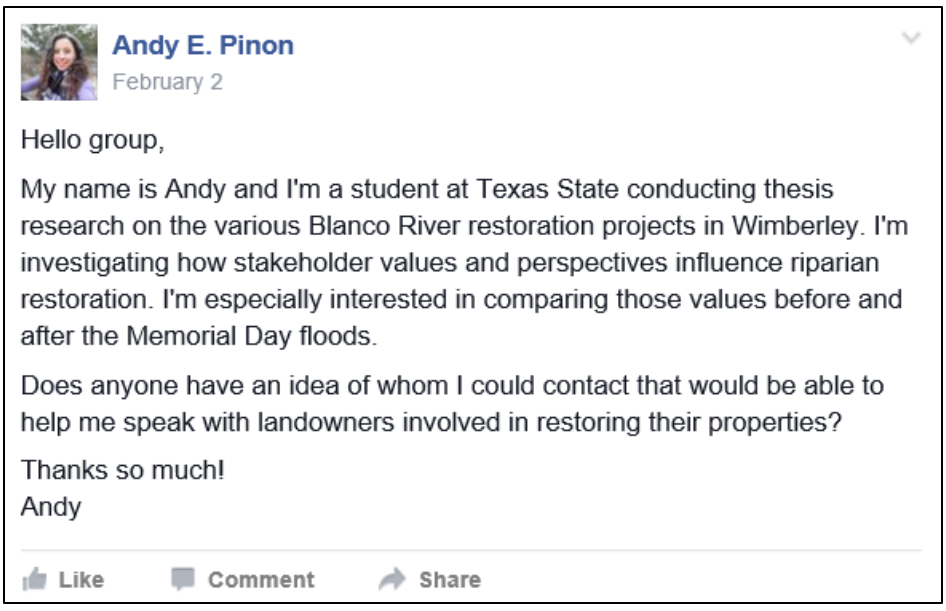


Figure 12. Facebook post to solicit participation for study (facebook.com)

Before any interview began, I asked the permission of each landowner to record the conversation. The number of participants who agreed to be recorded are equal to the total number of individuals who are included in this study. Onsite interviews consisted of walking with the landowner along the section of the RZ within their property lines. I asked them questions very similar to those found in Appendix G. My goal was to ask the most relevant questions but also keep the interview as organic as possible. Landowners led me to areas within the RZ that were heavily impacted by the flood. They also described their restoration projects in detail to include any multi-phase plans, what and where they have re-vegetated the landscape as well as the obstacles they face with their projects. Landowner challenges are addressed in the later portion of this paper.

Participants were asked to describe their experience during the Memorial Day flood and elaborate on the values and influences that have led them to their RZ management decisions. During the duration of the interview, I took photographs to document their restoration methods (active, passive or both) and the damage from the flood. This was also to gain a visual perspective of shifts in land management practices pre and post flood. At the end of the interviews, I requested if landowners would send me pictures of their RZ before the flood and also to use them in my study. I affirmed my commitment to confidentiality and promised to protect their identities.

Interviews were recorded and stored on an Apple I-Pod device. Interviews were backed up onto the Apple I-Tunes program. I also inquired, with each participant, any other landowners who would be willing to speak with me or who they thought would be beneficial to my research. A follow up email was sent to each landowner within two

business days to thank them for their time, request pre-flood photos of the RZ and contact information for those individuals they recommended I speak with.

Phone interviews were conducted with an average duration of 30 minutes. I requested permission to record the conversation after I introduced myself. A total of two landowners preferred to speak over the phone and both agreed to the recorded conversation. The interview was organized to include a brief introduction of myself and my research. Each participant was asked similar questions to those found in Appendix G. My goal was to obtain the information I needed but keep the conversation as organic as possible. Interviewees were asked about their experience during the flood, their ongoing restoration projects and the values and influences that have impacted their RZ habitat management decisions. At the end of the interview, I thanked each person, requested pre-flood photos as well as permission to use them in my study. A follow up email was sent within two business days thanking the interviewees for their time and to provide them with my email contact information.

Interviews were also conducted with representatives from three active non-profit organizations involved in local restoration efforts. These are Texas Parks and Wildlife Department, Treefolks, and ReTreet. The purpose of these interviews was to obtain an idea of the riparian habitat conservation challenges unique to Wimberley and how they are being addressed. Also, to get a clear idea as to what outreach mechanisms environmental groups are taking to elicit SB restoration. I also used these interviews as a networking opportunity to become involved in the process (i.e. participate in informational workshops in order to reach more landowners).

I was invited to participate in the March 5th Texas Parks and Wildlife Restoration workshop that was held in Wimberley at the town's community center. The workshop agenda is found in Appendix F of this document. With funding from the Terry Foundation, I purchased supplies (e.g. clip boards, pens, small table displays, poster board, markers, table cloth, donuts and decorative flowers) and created a list of test survey questions to distribute to attendees at the workshop. During the workshop lecture breaks, I spoke with many landowners on their values and perspectives towards riparian habitats and the influences that drive their land management decisions (Figure 13).

Figure 13. Talking with Steve Nelle, workshop speaker, at the TPWD riparian restoration workshop

I created a sign-up sheet for landowners who wanted to schedule an onsite interview.

III.2 Quantitative research

Quantitative research is comprised of data collected from a single test survey that was completed by a total of six participants. The survey was distributed at the March 5th TPWD restoration workshop and distributed to attendees. Participation was voluntary

and no personal information was requested. The test survey is found in Appendix G of this document. A total of seven surveys were distributed and a total of six were returned. The results of the survey are found in the Results and Discussion section of this paper.

III.3 Secondary research

Secondary research was conducted solely by myself and was comprised of various current event articles from online sources, peer-reviewed articles found on the Texas State University library electronic database and various textbooks checked out from the Texas State University Alkek library. I used the Facebook 'Blanco River Valley Riparian Restoration Project' page to stay current on restoration initiatives, volunteer events, Hays County news and land owner concerns. My thesis supervisor was also very helpful in emailing me current information she found as well as putting me in touch with representatives from TPWD. I checked out a total of three textbooks from the university library for the entire spring semester (five months). I read many articles relevant to my research and book marked those on my HP laptop computer. I exhaustively used the Google search engine to research weather data, riparian restoration, and regional physical geography for the study area. All sources used within this paper are cited to the best of my ability in the References section of this document using the Annals of the Association of American Geographers (AAG) citation format. The website 'RefWorks' was used to compile a bibliography.

III.4 Study area maps

A total of three GIS maps were designed for this research project with the help of two members of the Texas State University Society of Geographic Information Science (SOGIS) organization. Reimbursement for their services was funded by the Terry Foundation scholarship. The first map, entitled, 'Guadalupe-Blanco river watershed map' (Figure 3) was designed by Ritchie M. Jose. The second, entitled, 'Land Classification of Wimberley and the Blanco River' (Figure 4) was designed by Keagan McNew. The final map, entitled, 'Study Area Map' (Figure 5) was designed by Ritchie M. Jose. Both are junior level students in the geography department. Their membership in SOGIS ranks them among some of the top skilled GIS students within their respective majors.

The methodology used to design the first and third maps was requested but is not available. Per Mr. McNew, the second map was designed using the geospatial processing program, ArcMap. The five land classifications designated for the study area include: forest, water, grass/agriculture, urban, and barren. By using ArcMap, the study area was extracted from a National Agriculture Imagery Program (NAIP) aerial image, and classified through the supervised classification method. Two methods exist for classifying an image, the unsupervised and supervised classification methods. Unsupervised classification is the process by which the computer chooses which clusters of pixels are sorted into which classes. The supervised classification method requires user input on which pixels are categorized into which classes, essentially training the computer on how to classify the image. A confusion matrix was created which results in a percentage of how accurate the classification was and used to assess the output. Finally,

the map was created in ArcMap and charts and graphs were edited into the map through Photoshop (McNew 2016).

IV. Results & Discussion

"Insanity: doing the same thing over & over again & expecting different results."

-Albert Einstein

(Hanson and Sansom 2013)

The objective of this study is to investigate if value-systems shift away from aesthetic value and towards SB habitat restoration value following a flood disaster. Major factors considered are the role of education and an individual's experience during a natural disaster and their influence on the decision-making process. As discussed in the beginning of this paper, individual values and perceptions of the landscape are shaped by people's interaction with the environment and also by what we understand (i.e. know, see, and feel) about it (Kaufmann et al. 1994). Research included a random selection of participants in order to obtain diverse perspectives.

I found evidence that people have moved away from RZ degrading aesthetics to SB land management practices. Out of the eleven individuals interviewed, two exhibited this shift in values. One landowner showed no change and continued the same RZ management practices before the flood. One particular individual was determined as an outlier for this research study. Details on her situation are discussed in the later portion of this section. Test survey respondents and interviewees identified quite a few challenges for implementing their RZ restoration. These are also discussed later.

My participation in the TPWD workshop and my discussions with non-profit organizations has provided data to demonstrate that environmental groups are making strides towards addressing the 'education dilemma'. Their mechanism to engage private landowners within the community is also addressed in this section. Overall, I found that an individual's decision to manage landscapes with consideration to environmental needs varies among groups and people. Some may simply not care. Some lack information and in this case, more education is required. For others, there may be personal reasons or they lack the authority to practice SB habitat management. The results outlined are meant to provide some insight into this complexity so that further collaboration on behalf of environmental advocates could take place. The need for fresh and innovative engagement techniques is vital if conservation initiatives are to be successful when considering the role of private land ownership.

IV.1 Shift in values: Aesthetics to science-based restoration

Participant one (P1) and six (P6) demonstrated a change in their land management practices (LMP). Pre-flood photos provided by each individual displayed LMP degrading to RZ function. These include excessively mowed turf lawns down to the river bank, and removal of RZ vegetation except trees. The transcribed interviews with each individual along with before and after photos are found in the Appendices section of this document.

The restoration project managed by P6 is a demonstration site for TPWD's Conservation Demonstration Program (CDP). More on this program is discussed later. It has been designated "Site 1". This river front property is jointly owned and managed by

ten home owners. P6 is the self-designated project manager. There is an appointed group of members that serve on the Property Owners Association (POA) and charged with the responsibility of using donated funds to restore the neighborhood's river front property. P6 is the primary contact for the project and is also a member of the POA. This individual is one of the most recent landowners to move into the neighborhood. In an onsite interview, he explained to me that when he first moved to Texas, one of the initial land management decisions proposed was to landscape the area to represent more of a "park-like setting". Pre- Memorial Day photos showed a significant area of the landscape had been manicured throughout the area. Following the flood, he proposed to the POA board to restore the area back to its prior condition. While conducting online research on riparian restoration, he found the TPWD and TNC Blanco River restoration workshops. He has attributed the substantial regrowth along the riverbank to the help and resources made available by both organizations and other non-profits involved.

Furthermore, P6 made clear that he understands that the decision to manicure the property was a contributing factor to flood damage in their neighborhood. He stated that the majority of joint property owners value responsible restoration decisions and will continue to adopt these practices moving forward. During the onsite interview, P6 explained to me that, "at first [he] kept saying, no" to organizations who told him to, "leave everything as natural as you can." His initial response was that he, "didn't want to" because it, "looks ugly." He further explained to me that as he, "began to pay attention to these guys [organizations] and the more [he] listened, [he] began to realize, that just because [he] wants it to look pretty, doesn't mean that's the way it should be."

Participant 1 also demonstrated a significant change in RZ management practices. This property is also jointly owned by eight landowners and has a POA with authority to make land management decisions. Following the flood, P1 met with the POA board to propose reaching out to The Nature Conservancy (TNC) to help design a restoration plan for the property. Upon approval from the POA, P1 began collaboration with Rachael Ranft, Director of Northern Hill Country River Projects, and the TNC to design the 'River Road Circle Draft Plan' (Appendix J). Via email correspondence with Ranft, she informed me that this early draft was designed to introduce landowners in this POA to the idea of having small areas that would be mowed while leaving the rest of the riverside in a more natural state. She stated that this was not the final plan. In an interview with P1, he stated that he has been successful at, "getting all of [the] property owners to agree to…try to turn it [RZ] around from where it used to be, get rid of the grass and try to recreate a more native riparian habitat". The combination of his statements, the TNC draft plan and photographic evidence of SB LMP makes this a strong case that values do shift toward environmental needs.

IV.2 Outliers

A change in values away from aesthetics and towards SB restoration doesn't always result in SB land management practices. In an onsite interview with Participant 2 (P2), it was found that the authority to implement SB practices in some cases, are out of stakeholder control. All respondents who voiced this challenge also stated that their POAs held the authority to make decisions on LMPs. Participant 2 stated that her POA bought the river front property and just like the situation with Participant 1, only the

neighborhood owners could use it. She added that the POA made homeowners, "responsible for mowing the property" even though nobody actually owned it. P2 stated that she had knowledge of how the RZ functioned but that it wasn't her ultimate decision of how the river front area was managed. She also mentioned that the POA allowed her to keep some debris that was deposited on a tree in her yard but that she is receiving pressure from her neighbors to remove it because they told her it looked ugly. In this case, an individual's land management decisions don't always correlate with their values. Their unique circumstance may not allow them to implement SB habitat management as the final word may not lie with them but with organizations such as POAs.

IV.4 Challenges to SB restoration

The test survey distributed to workshop attendees were the following:

Challenge of Riparian Zone Restoration	
Challenge	**Responses**
Money	4
Emotional	2
Rebuilding House	1
Social Pressures	0
POA	2
Need more education	2
Other	2

Table 5. Challenges of Riparian Zone Restoration

Survey and participant interviewees reported that money was the biggest barrier to restoring their river front properties. The majority of individuals stated that this was

because they were investing money into re-building their homes and replacing destroyed property. Participant 1 stated that the non-profit organizations such as TNC, TPWD, Treefolks and ReTreet were a method for which people can obtain donated RZ vegetation (i.e. trees and grasses) for replanting. TPWD representative, Ryan McGillicuddy, stated to me that the riparian restoration workshop they held in March was the largest involving heavy participation of other non-profit organizations. Their attendance rate was also the biggest compared to other events they have hosted. Out of the six survey respondents, only two reported that they needed more education on how to restore their RZ. I was able to speak with both individuals and they stated that it was the first time they had attended a workshop. Although no one reported social pressures as a barrier, interviewees stated that they had received phone calls, letters and emails requesting that debris be removed from their properties. Respondents further stated that their neighbors pressured them either because their vacation home businesses were struggling or it was too traumatic to look at debris that had been deposited from the flood. For landowners who rent their properties as vacation homes, they receive complaints from clients about debris and tall grasses on neighboring properties. As stated by interviewees, it is these business-homeowners gave the most pressure.

IV.5 Overcoming the education dilemma

Texas Parks and Wildlife Department (TPWD) has responded to the education dilemma by creating the Conservation Demonstration Program (CDP). TPWD has partnered with two properties along the Blanco River to help restore their RZ with the goal of creating opportunities for other land owners in Wimberley to witness the benefits

of SB restoration. CDP Site 1 located off Cliffview and River Road is highly significant because of the frequent traffic that passes the site. This area spans approximately 300 yards of river front property but is important because of the amount of exposure it receives from its location near the town center of Wimberley Square.

CDP Site 2, located on Little Arkansas Road, is significant because it demonstrates how landowners can restore their RZ if they have either a limited or a considerable amount of money to expend on restoration. The RZ was divided into two parts. The section north of Little Arkansas Road serves the purpose of demonstrating what land owners can do if they have a lot of money. The southern section shows what people can do if they have limited money. On the northern end of the RZ, a combination of passive and active restoration methods were used. A variety of trees, grasses, and shrubs were planted to artificially re-vegetate the area. Large boulders were brought in and placed along the river bank as well as a significant amount of soil to refill holes and areas degraded from erosion. During an onsite interview with Participant 5, I was informed that the next phase for this section of the RZ includes using rebar and chains to anchor down the boulders so that they are not swept away in future floods. Passive methods were predominantly used on the southern section of the RZ. Debris deposited from the flood was intertwined together to create multiple berms. These were placed parallel to each other reaching from the river bank and extending upland. Very little re-vegetation was done instead, grass seed (e.g. little blue stem and switch grass) was distributed throughout the section. In addition, the benefits of woody debris are emphasized with strategically placed down wood in order to protect young trees and low lying riparian grasses.

The CDP (Figure 14) has proven to be successful in advancing RZ habitat conservation initiatives. Landowners not only learn SB restoration techniques but they can also visit the demonstration sites to get an idea of what the results could look like.