BLUE INDEX SAN MARCOS: EMOTIONAL EXPERIENCES, VALUES, AND USE PATTERNS OF WATERSCAPES IN SAN MARCOS, TEXAS

by

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DEDICATION

I dedicate this thesis research to Jeffery Vu.

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LIST OF ABBREVIATIONS

Abbreviation	Description
SES	Social-Ecological System(s)
SMR	San Marcos River
COVID-19	Coronavirus Pandemic
IWRM	Integrated Water Resource Management
UGS	Urban Green Space(s)

ABSTRACT

Waterscapes can have profound benefits on people's well-being and mental health, such as helping people feel calmer and more connected to nature. The COVID-19 pandemic impacted the ways we use and relate to urban waterscapes. The San Marcos River and its tributaries provide economic, social, and environmental benefits to the surrounding community of San Marcos, Texas, USA. I designed a study to answer the following research questions: (1) How do emotions and values associated with waterscapes relate to behavior and patterns of use? (2) How are experiences of waterscapes spatially distributed and how do waterscape characteristics influence this distribution? (3) How has the COVID-19 pandemic influenced people's experiences of waterscapes in San Marcos? Using 10 photo stations with QR codes, I collected online survey data from 567 volunteer participants across various waterscapes in San Marcos. I aim to quantify and spatially represent the emotional benefits, valuations, and patterns of use of San Marcos waterscapes through measures of emotions experienced at a site, what is important about that site, and reason for visiting. People valued waterscapes for ecological benefits and in terms of relationships with place, rather than for recreation and tourism. 87% of participants perceive waterscapes as refuges from stress and social isolation, and 57% of participants use them more frequently. This study establishes a framework of non-contact landscape reporting through remote photo and survey data collection that amplifies the voices of the community and provides valuable citizen science data to city planners and resource managers.

1. INTRODUCTION AND MOTIVATION

Water resources are not only essential to human and natural systems; they have profound benefits on people's wellbeing and mental health. Being in or around a blue space helps many people feel calmer and more connected to nature. Blue spaces are defined as "health-enabling places and spaces, where water is at the center of a range of environments with identifiable potential for the promotion of human wellbeing" (Foley and Kistemann, 2015). The terms blue spaces and *waterscapes* are used interchangeably in this study, as I attribute the definition of blue spaces to all examined study areas. Research has shown that exposure to blue spaces can change brain chemistry, reduce stress, increase creativity and energy, and provide opportunities for physical wellness (Nichols, 2014), and the benefits of these spaces can be received through relatively small doses of outdoor time (Meredith et al., 2020).

Urban blue spaces, or waterscapes, can regulate urban temperature, promote community health, and ensure equitable access to ecosystem services within a city. Alterations to and management of waterscapes affect not only the ecosystem services they provide, but their capacity to provide mental, physical, and community health benefits. While several studies have documented the mental and physical benefits of blue spaces (Grellier et al., 2017), cultural and cognitive aspects of human interaction with water (e.g., emotions, values) are rarely quantified and even less frequently incorporated into meaningful action or policy (Arias-Arévalo et al., 2017; Muradian and Pascual, 2018). These aspects of interaction, however, are meaningful, and can guide sustainable management of urban blue spaces (Misiune et al., 2021). Understanding relationships between people and nature is essential to the sustainable management of social-ecological

systems (SES) (Julian et al., 2018; Sander & Zhao, 2015; Arias-Arévalo et al., 2017; McGinnis & Ostrom, 2014). SES refer to the systems formed through complex and dynamic interactions and interrelations between people and nature (McGinnis & Ostrom, 2014). Studying the ways local people and tourists perceive, value, and use various waterscapes can help inform local government and resource managers when managing ecosystem trade-offs or incorporating stakeholder perspectives into policy.

Increasingly, watershed planners are incorporating strategies that facilitate relevant stakeholders, including users of urban green and blue spaces, to have a voice in the planning process (Lee et al., 2018; Sabatier et al., 2005; Brils et al., 2015). Community surveys provide an opportunity for interested community members to share feedback or opinions. Public participation and mobilization in water planning processes has been shown to increase trust in public officials and promote engaged communities (Hartley, 2006). Using community survey data, this project expands methods of public participation in conversations about the management and protection of local water resources. One way the public can do this is by completing assessments that measure their emotional reactions to and perceptions of local waterscapes. This project facilitates communication between the users of blue spaces and park and resource managers and uses a mixed-method approach to quantify emotional experiences, values, and patterns of use while exploring perceptions and impressions of waterscape through comments left by participants. My study design uses remote photo and survey collection to help planners maximize resource allocation through remote communication with stakeholders, identification of problems or maintenance requirements, and spatially represented data on emotional and recreational experiences.

Hays County grew by 55% from 2000 to 2010 (US Census Bureau, 2010) and by another 54% from 2010 to 2020 (US Census Bureau, 2020). Development in San Marcos has similarly skyrocketed since 2000, with the city and Hays County being among the fastest-growing areas in the country. This rapid population increase has encouraged opportunities for development to facilitate incoming people and businesses. The San Marcos River (SMR) and its major tributaries are waterscapes that represent sources of provisional, cultural, and regulating ecosystem services that benefit the surrounding communities. Recreation activities and several popular river access points attract tens of thousands of tourists to San Marcos annually, supplementing economic growth through tourism. This spring-fed river system is habitat for several endangered species and possesses important biodiversity (Kimmel, 2006; MCWE 2021; Julian et al., 2018). With many locations for visitation on the City and Texas State University property on the San Marcos River, measuring the ecosystem services and the perceived value of various sites may be beneficial to inform their management and demonstrate their community value. As development and population growth in San Marcos continue over the coming decades, the relative benefits of waterscapes in San Marcos should be evaluated to prioritize the maintenance of landscapes that provide environmental and cultural services to the surrounding community. Water management will always include trade-offs and measuring the properties or characteristics of water that are most valuable to the community may help policymakers prioritize certain aspects of public land and water management.

2. PURPOSE STATEMENT

The purpose of this study is to measure the use, emotional experience, and perceived value of various waterscapes in San Marcos to quantify relationships with blue spaces and facilitate communication between community members and public officials. Using 10 photo stations located along the San Marcos River system (Figure 1), I quantified and spatially represented momentary emotional experiences, value attributions, patterns of use, and perceptions of waterscapes. This 9-month assessment included photo submissions, questions about emotional experiences, reasons for visiting, why a place is most important, and measures of physical and social waterscape characteristics. These spatially and temporally distributed data provide insight into the relationships between the community and waterscapes and how protecting or maintaining these sites can improve people's emotional, recreational, cultural, or relational experiences. Additionally, the shock of the COVID-19 pandemic provides an opportunity to assess how people use the natural environment to cope with collective stressful events, and how the pandemic has changed the way people use, value, or perceive waterscapes in San Marcos. The protection and maintenance of healthy waterscapes is crucial to managing SES and is valuable for people's physical and mental wellbeing. This study quantified and spatially represented emotional experiences and behaviors at various spots along the river to provide data on the values of waterscapes that often go unaccounted for in environmental science research. The photo database created through this project documented landscape change over time and may provide helpful information to resource managers about seasonal changes or extreme events, such as floods.

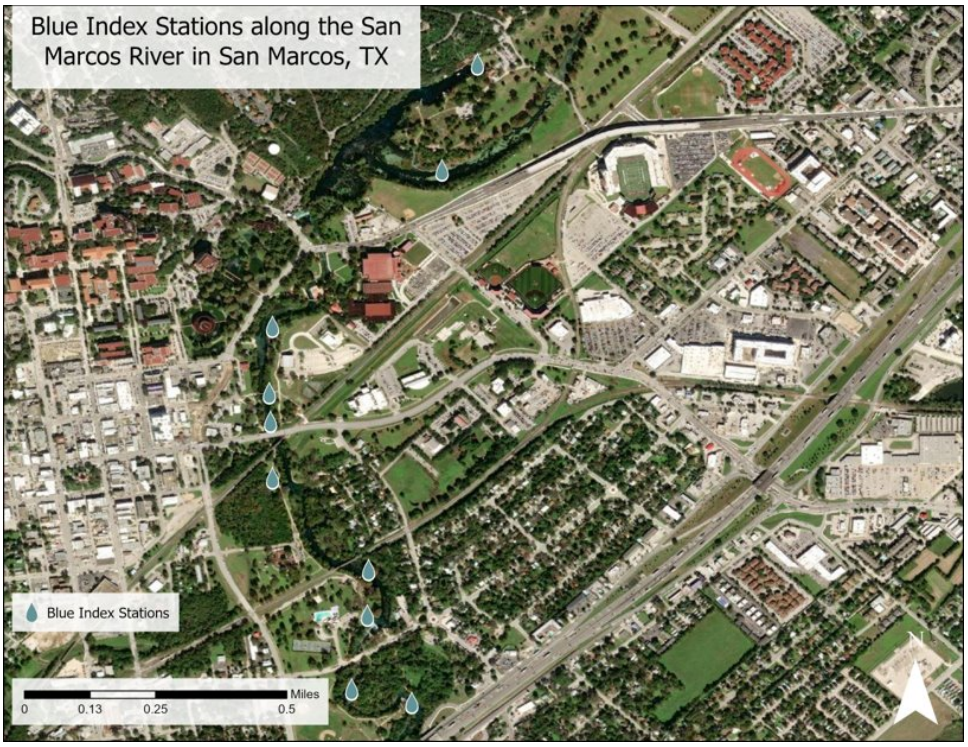

Figure 1. Map displaying location of Blue Index photo stations at waterscapes in San Marcos, Texas, USA.

3. RESEARCH QUESTIONS AND HYPOTHESES

As I investigated and assessed relationships with waterscapes in San Marcos, I hoped to contribute to a growing body of research demonstrating the emotional, cultural, and social benefits of healthy and maintained waterscapes. I aimed to quantify experiences that are not often considered in ecosystem services assessments, including emotions, relaxation, and values. Quantitative analysis and description of data were used to reveal relationships between waterscapes and human experiences. Questions that I hope to answer are:

1. How do emotions and values relate to behavior and patterns of waterscape use?
2. Which qualities of a waterscape create the most positive experience overall?
3. How has the COVID-19 pandemic influenced experiences of waterscapes in San Marcos?

I hypothesized that the following relationships would be identified.

(1) Value orientations influence interactions with landscapes: those that choose relational values as most important engage with activities that promote interaction with and reflection on the waterscape (Relaxing/Stress Relief/Meditation); while those that choose intrinsic values engage more with wildlife viewing; and those that choose utilitarian values engage with recreation activities.

(2) Perceptions of waterscape characteristics are spatially variable and negative emotions are associated with lower perceptions of naturalness, cleanliness, accessibility, and stream flow.

(3) Participants' self-reports of patterns of use before and after the COVID-19 pandemic reveal that people are using nature to cope and relax more than they did in the past, and that they value these places for their restorative potential.

4. LITERATURE REVIEW

4.1 Blue Spaces and Community Health and Wellbeing

Humans have evolutionary ties to nature, especially landscapes that include a water element—*blue spaces* or *waterscapes*. Because water was essential to our evolutionary progression and remains the necessary ingredient in the recipe of life, our ties to blue spaces go beyond our need to survive. Humans also have an emotional connection to water, whether positive, negative, or a complex combination of conflicting feelings. These emotional responses come from the oldest parts of our brain, and often kick in before any area of the brain responsible for cognition does (Nichols, 2014). This means that we tend to make decisions based on affect or emotions rather than mental calculations of the potential outcomes of a situation (Kahneman, 2011; Klain et al., 2017). Our brains are complex and *plastic,* meaning the chemistry and functions of our brain are largely shaped by our subjective experiences, perceptions, and sensory inputs. The neural structure and functions of the brain are reinforced through repeated use of those pathways. Structure and associated neural function can change due to emotional experiences, cognitive reinforcement, psycho-social needs, or sensory attention (Nichols, 2014). This means that while our perceptions are often grounded in experience, they are subject to change if we gain new experiences, change our environments, or learn and believe new information. In this way, our individual relationships with place are subjected to and mediated or negotiated by our past experiences.

The connection people have with places, especially natural places, can have measurable effects on people's overall well-being. Greater spatial extent of urban green space within a city and proximity of residency to green space has been shown to increase

the restorative potential of landscapes and reduce negative emotional experiences (Westley et al., 2013; Gascon et al., 2018; Dzhambov et al., 2018; Smith et al., 2021). Exposure to nature and emotional well-being has been widely researched, although mediators of this relationship (e.g., type of activity and restorative experience) are less documented (Korpela et al., 2014). Additionally, most research on nature and health has investigated the role of green spaces (WHO, 2016). Far fewer studies have explicitly examined the additional benefits provided by blue spaces (Grellier et al., 2017).

Recreational or leisurely use of blue spaces and physical and mental health has revealed measurable benefits to community health through opportunities for physical activity and connection with nature through water (Grellier et al., 2017). Water can make us calmer and happier (MacKerron and Mourato, 2013), meaning that blue spaces may affect mental health in different ways than green spaces (Haeffner et al., 2017). The emotional and cognitive reactions humans have to water have been conceptualized by Nichols (2014) as *Blue Mind*, the neural response to water that causes us to feel something. Typically, Blue Mind refers to feelings of relaxation, peace, refuge, or joy that are often experienced in blue spaces. It has been shown that people prefer blue spaces to green spaces when seeking relaxation or restoration (Roe and Aspinall, 2012). In an environmental psychology study by White et al. (2010), scenes with water produced a more positive emotional response and were preferred to those without water.

The health benefits of water come not only from the activities people engage in, but from people's embodiment of the landscape, their feeling of interconnectedness, and from the meaning they derive from these places (Foley and Kistemann, 2015). Foley (2011) used a quantitative approach to reveal how the cultural and symbolic ties to water

affect physical and mental health. He found that the therapeutic benefits of place are variable and subjective and are largely determined by the symbolic meaning of place (Foley, 2011; Völker and Kistemann, 2013). According to Foley (2011), therapeutic landscapes are contingent on sense of place and personal significance. In this way, blue spaces mean different things to different people and perceptions can be reinforced through interaction with the land and sensory or emotional experiences (Nichols, 2014, p. 20). In addition to emotional and therapeutic benefits, exposure to water results in higher cognitive functioning (Nichols, 2014) and higher self-reports of physical health (White et al., 2013). In this way, sustainable management of urban blue spaces represents a nature-based pathway toward cost-effective preventative community mental health care (van den Bosch & Sang, 2017).

Several studies have revealed that aquatic therapies, including surfing and fly fishing, can be effective therapeutic tools for treating mental illness and improving social interaction. Aquatic therapies have been employed with vulnerable populations, including those with cognitive disorders, such as attention deficit disorder and depression, and veterans suffering from PTSD (Marshall et al., 2020; Caddick et al., 2014). Aquatic therapies that include physical activity also produce endorphins, which affect the areas of the brain responsible for emotional processing, creating a sensation known as “runner’s high” (Linden et al., 2011). While degree of benefits derived from interaction in SES varies by the mode of interaction and type of landscape, systematic analyses of blue space proximity and public health have revealed that, overall, proximity to urban blue space is related to positive public health outcomes. Smith et al. (2021) published a review of studies on urban blue spaces and public health. They found evidence that blue spaces

can improve general health (Garrett et al., 2019; Völker et al., 2018), reduce obesity and mortality rates (Witten et al., 2008; Wood et al., 2016), reduce symptoms of depression and anxiety (Gascon et al., 2018; Helbich et al., 2019), increase self-reported mental health (Völker et al., 2018) and wellbeing (Garrett et al., 2019; Mavoa et al., 2019), and improve emotional functioning and social interaction (Amoly et al., 2015; Ashbully et al., 2013). Despite this evidence, few have quantified measures of emotional benefits derived from being in and around water, much less incorporated into policy (Smith et al., 2021). By quantifying and evaluating the public health benefits of blue spaces, research can inform policy that promotes sustainability and preventative community health initiatives.

Aquatic ecosystems and their associated benefits, including regulating, provisional, and cultural ecosystem services, are being degraded at a rate much faster than others (Lee and Diop, 2009). A range of threats to freshwater ecosystems, including land use change, groundwater pumping, and impoundments have resulted in an 83% loss of overall freshwater biodiversity from 1970 to 2014 (Reid et al., 2019). The protection of these ecosystems is essential to ensuring both their ecological function and their ability to support and improve human life. Quantifying and documenting relationships with place can help inform policy that addresses necessary trade-offs with the goals of promoting environmental, economic, and social sustainability. While trade-offs are a necessity of water management, it is important to have a holistic view of what is being lost when decision-makers compromise the elements of a waterscape that positively contribute to overall wellbeing.

4.2 Ecosystem Services and Beyond: Quantifying Relational Values

Ecosystem services refer to the benefits humans receive from functioning and healthy ecosystems (Martin-López et al., 2012). First discussed by George Perkins Marsh in his 1864 book, *Man and Nature*, the concept has been adapted and expanded by Aldo Leopold, Paul Sears, and Raymond Lindeman (Postel et al., 2012). The modern introduction of this concept can be seen through Gretchen Daily's 1997 pinnacle work, *Nature's Services*, which outlines the goods and services essential to human existence that healthy ecosystems provide. The framework grew to include not just provisional and tangible benefits, but indirect benefits derived from healthy systems, including the regulation of the air and climate, as well as the mental benefits that derive from having a sense of connectedness to ecosystems.

The Millennium Ecosystem Assessment was a comprehensive and innovative study of human-nature relationships that set out to establish the connection between the health of ecosystems and the wellbeing and sustainability of human societies. The assessment, which was carried out from 2001 to 2005, established four categories of ecosystem services: provisional services including fresh water, food, wood and fiber, and fuel; regulating services such as climate regulation, flood regulation, disease regulation, and water purification; cultural services such as aesthetic, spiritual, recreational, and educational services; and supporting services such as nutrient recycling, soil formation, and primary production (Lee and Diop, 2009). Since then, the ecosystem services framework has been used to inform the management of water resources, including blue spaces in urban settings (Brils et al., 2015; Church et al., 2015; Corral-Verdugo et al., 2015). Ecosystem services can be thought of as the provisional, cultural, and regulating

services that an ecosystem provides to the natural and social elements of a community (Martin-López et al., 2012). Ecosystem services are typically evaluated by measuring people's preference for or value of them. A diverse combination of ecosystem services is important to uncovering their value and the ways in which bundles of services interact (Bartkowski, 2017; Castro et al., 2016).

There is an increasing social demand for interaction with waterscapes and the ecosystem services they provide, but this increased demand includes necessary trade-offs between various bundles of services (Misiune et al., 2021; Ellis et al., 2019). Trade-offs are often determined through power dynamics of various stakeholders. Collecting community survey data can ensure that underrepresented stakeholders and heard in the planning process. Managing trade-offs according to community values and preferences may promote the sustainable management of these waterscapes. Reported preference for these services depends on demographic factors as well as the type of landscape (Martin-López et al., 2012; Julian et al., 2018; Misiune et al., 2021). Ecosystem services assessments may draw different or contradictory conclusions on the best path forward based on the involved stakeholders and the framework of valuation (i.e., monetary, cultural, or biophysical) (Twedt et al., 2019; Brils et al., 2015). These limitations to the application of the ecosystem services framework has led many, especially human geographers, to consider expanding the scope of information that is considered in human-nature relationships (Carpenter et al., 2009; Himes and Muraca, 2018).

As the ecosystem services framework was increasingly implemented to quantify ecosystem values, the framework became synonymous with quantifying values of place, whether monetary, sociocultural, or biophysical. The application of the framework to

various geographic and cultural contexts led to critiques of ecosystem services to fully represent human-nature relationships. Many argue that the boxed-in categories of services neglect to account for all the emotional, cultural, and relational benefits derived from interaction with ecosystems. Although cultural services, including spirituality and education, are included in the framework, a review of indicators of cultural services found little consensus in the methods of measurement or definitions of the various categories of cultural services (Hernandez-Morcillo et al., 2013). Ecosystem services applications claim to use accessible language (Niasse and Cherlet, 2017; Kumar et al., 2013), but laypeople and scientists often have different conceptions of what these services are, especially cultural services that are dynamic and geographically linked (Hernandez-Morcillo et al., 2013). The emphasis on connectedness between people and ecosystems led to the development of the social-ecological system (SES) framework, in which aspects of environment and society are considered in a system and are understood to interact and exert influence on one another (Ostrom, 2009; McGinnis & Ostrom, 2014). SES research focuses on the interconnection and interdependence of human and natural systems to inform policy and sustainable management of systems (Biggs et al., 2022). Management guided by SES framework considers how stakeholder perspectives, modes of interaction, and goal orientation influence their interactions with the landscape.

Social demand is a collective term that refers to people's behavior/use, preferences, perceptions, and values (Martín-López et al., 2012; Julian et al., 2018). The management of blue spaces can require trade-offs between social demands, and therefore between the interests or values of community members (Kronenberg et al., 2021). Quantifying social demand for ecosystem services in blue spaces can help weigh these

trade-offs (Castro et al., 2016). Values of specific ecosystems may be related to the services derived from these places, but ecosystem valuation (EV) may have a deeper significance to people than just what they perceive the benefits are to themselves or society. For example, a review of cultural ecosystem service measurement techniques found that spiritual and cultural symbolism and meaning of place is often underrepresented in ecosystem services valuations (Hernandez-Morcillo et al., 2013). Literature regarding EV has long been stuck in a dichotomy of intrinsic vs. utilitarian values. Utilitarian values are those assigned to an ecosystem for a specific means to an end, usually a direct benefit to humans like recreation, and are often derived from self-serving or human-centered motivations for using or visiting a place. Intrinsic values, on the other hand, are attributed because of the value of the ecosystem as an end in itself. They often come out of biospheric motivations. This EV dichotomy has led to a battle in conservation that pit benefits to people vs. benefits to nature (Klain et al., 2017; Kareiva et al., 2011). This divide, however, is not reflective of the ways humans make decisions and interact with the world (Kahneman, 2011; Chan et al., 2011), and fails to resonate with laypeople (Klain et al., 2017). We need a better way to represent how humans think about, feel about, and interact with nature.

Relational values have been proposed as a "third class of values" alongside intrinsic and utilitarian values (Chan et al., 2016). Relational values highlight the restorative nature and responsibilities that exist in socio-ecological systems through relationships and modes of interaction with place. Relational values highlight the interaction between humans and the environment and the responsibilities of humans as a part of SES (Arias-Arévelo et al., 2017). Rather than assigning EV based on benefits

provided to humans or the environment, relational values highlight the multidirectional and complex influences of humans and the environment. This framework considers the modes of interaction and motivations of social demand to create better representations of human-nature relationships (Muradian and Pascual, 2018). The acknowledgment of this relationship's existence has been shown to make people feel more connected or related to nature (Arias-Arévalo et al., 2017). Relational value statements depend on aspects of identity, kin, responsibility, community, health, or a combination of these factors (Klain et al., 2017). Depending on the type of statement used, different meanings of relational values may be expressed. Relational values go beyond traditional monetary quantification and are essential to capture non-Western conceptions of EV (Piccolo, 2017).

A goal of relational value assessments is to move beyond concrete definitions and toward a more accurate representation of the ways humans perceive their relationships with nature. People may value a place not just for the personal benefits it provides, but for a deeper relationship with nature as a part of an SES. However, studies measuring EV tend to determine values based on preferences for ecosystem services or bundles of ecosystem services, rather than framing the question in terms of individual or collective importance (Martin-López et al., 2012). Other approaches include measures of social demand, including life experiences and patterns of use, and perceptions of why places are important (Julian et al., 2018; Smith et al., 2021). Some argue for relational values to be considered as an epistemological framework, rather than an ecosystem value frame, as relational values tend to situate personal relationships within a framework of meaning, rather than through a strict definition. Situating questions about relational values in terms of why a person finds a place most important (individual) or why a place should be seen

as important (normative) may change the role of relational values in the EV conversation (Stålhammar and Thorén, 2019). In this way, relationships with place are dynamic and dependent on many individual experiences and perceptions (Foley, 2011; Voker and Kistemann, 2015).

Relational values promote the shared responsibility and sustainable use of urban landscapes. Blue spaces represent opportunities to promote "urban commons," by encouraging shared and equitable access and responsibilities toward waterscapes (Perrotti et al., 2020). Measuring subjective experiences and ecosystem value attributions may uncover common motivations within communities for using or protecting spaces. Relational value measurements can also be used to create educational content that can increase connectivity to nature and promote altruistic motivations for visiting waterscapes.

Relational values are a beneficial path toward Integrated Water Resource Management (IWRM), which also uses a systems framework to approach water management in terms of environmental, economic, and social sustainability. IWRM emphasizes the role of engaged community stakeholders in identifying and remedying local water challenges. Both IWRM and ecosystem services frameworks have evolved concurrently to be widely applied in a variety of settings. In 2012, over 80% of countries had IWRM principles in water law, and over two-thirds had developed an IWRM plan (Niasse and Cherlet, 2017). The two paradigms share a goal of contributing to decisions about trade-offs in natural resource management and planning. Both aim to foster connections with ecosystems through a recognition of interactions and benefits. While ecosystem services focus on the interdependence of services provided to humans, IWRM

focuses on all interactions between humans fostering connection between people and ecosystems through emphasizing the interactions, benefits, and effects of the two. While ecosystem services highlight benefits to humans, land/water resources, and natural ecosystems (Niasse and Cherlet, 2017), IWRM is a natural steppingstone from frameworks that aim to move beyond ecosystem services to involve stakeholders in planning processes. IWRM is focused on stakeholder participation and community engagement. When people are informed and passionate about water issues, they may behave in a way that promotes sustainability of water resources. Engaged communities also have a better chance lasting long-term in the process of cooperating in watershed management and planning processes (Sabatier et al., 2005; Brils et al., 2015). Interaction with blue spaces can help increase awareness of the challenges and benefits these places represent as well as increasing a sense of connectedness with place, and therefore sense of responsibility to behave in a way that protects that place (Julian et al., 2018; Perotti et al., 2020; Fox et al., 2021).

4.3 COVID-19 and dynamics of Social-Ecological Systems

The Coronavirus pandemic (COVID-19) has provided researchers with a unique opportunity to make observations about the ways people use nature to cope with stressful events, particularly when normal opportunities/practices are removed or unavailable. Literature published on how much time spent in nature in response to COVID-19 has produced mixed results. While the frequency of outdoor excursions and distance traveled to experience the outdoors has declined in some places because of COVID-19 restrictions (Rice et al., 2020), some studies showed that the use of local urban greenspaces has increased (Venter et al., 2020). People are increasingly exploring nature closer to home,

and this exploration may have profound abilities to mitigate stress and assist in coping with disaster. It is understandable that COVID-19 has shifted collective perceptions of and relationships with nature (Jackson et al., 2021), and these shifts may be dependent on geography, personal experience, or feelings of connectedness with nature (Samus et al., 2022). Results from this study indicate that most people view urban waterscapes as opportunities for refuge from the stress and isolation caused by the COVID-19 pandemic, and over half of participants visit blue spaces more often now than they did before COVID-19. These results support my hypothesis that the COVID-19 pandemic would influence perceptions of and interactions with blue spaces in San Marcos.

Several studies documented the mitigating effects of green and blue spaces on stress and isolation from the COVID-19 pandemic. One study found that spending time outdoors helped mitigate the decrease in mental wellbeing experienced by many during the pandemic (Jackson et al., 2021). That is, those that spent more time outdoors experienced a significantly smaller reduction in self-reported mental wellbeing. Two international surveys found that there is a global increase in the frequency of using blue/green spaces and an increased appreciation for these spaces (Pouso et al., 2020; Ugolini et al., 2020). Meredith et al. (2020) found that university students' mental health improved from spending an average of just 10 minutes in blue/green spaces every day. Similar studies investigating doses of blue/green space time to mitigate negative mental health outcomes found relatively short periods of time spent in nature can improve mental wellbeing outcomes (Gascon et al., 2018; Gascon et al., 2013; Britton et al., 2018; Tillmann et al., 2018).

This additional evidence of the power of natural landscapes to mediate conditions of psychological stress and improve brain function represents a unique opportunity to study the changes in use, value, and emotional experience of waterscapes during COVID-19. While research on COVID-19 and human-nature interactions is emerging, initial studies concluded that certain relationships predict the effect of blue spaces on community wellbeing during COVID-19. Samus et al. (2022) found that those that expressed a closer sense of connectedness to nature expressed more positive emotions than those that indicated they were less connected. In this way, personal relationships, and symbolic meaning of blue spaces, in addition to subjective experiences, may predict blue spaces' ability to mitigate any negative mental effects brought on by the pandemic.

It is important to note that the pandemic has increased feelings of negativity, stress, grief, and economic loss (Cullen et al., 2020; Holmes et al., 2020). Most of the studies regarding COVID-19 and mental health symptoms or general wellbeing express the effects of blue/green spaces in terms of *mitigating* or *minimizing* negative outcomes caused by the pandemic, rather than claiming to improve people's net happiness during a global catastrophic event. Medical research has called for interventions that offer preventative care to reduce the potential for negative mental health outcomes due to isolation and stress caused by the pandemic (Galea et al., 2020). The nature of the pandemic has also shifted our relationships with places in negative ways. Studies that examine COVID-19 and green/blue space use found concerns about a lack of social distancing and improper crowd management (Lopez et al., 2021). Additionally, because people around the world are staying at home or close to home (Rice et al., 2020), private gardens have become more important for fostering human nature connectedness and

associated mental health (Samus et al., 2022). Access to private green spaces is not equitable within communities. Not everyone in the community will have the same access or quality of private green spaces (Samus et al., 2022). A study of New York City urban green space found that access and the pandemic were associated with certain community groups, revealing potential ways green/blue space distribute benefits unequally, and the pandemic may amplify existing inequities (Lopez et al., 2021). The subjective experience of landscapes is contextually embedded by both the geographic and cultural history of a place and the perceptions held by one interacting with that place (Hegel, 1976; Gesler, 1992). When studying urban green spaces and emotions in the specific context of the COVID-19 pandemic, Samus et al. (2022) found the degree to which people felt connected to nature predicted their positive emotions during Covid-19 lockdown (Samus et al., 2022).

Some research views the COVID-19 pandemic as an opportunity for innovation in landscape design in a pandemic/post-pandemic world, including the need to study wellbeing through frames of relationships between places, people, and nature, and creating new landscape design that promotes social distancing but maintains community engagement and involvement (Dobson et al., 2020). Increased interest in green/blue space may provide new avenues for environmental education, diversity and inclusion in outdoor recreation and conservation, and innovation in landscape design that promotes distancing while fostering connection. Because of the limited research relating to natural spaces and the pandemic, this study hopes to establish the benefits of waterscapes specifically to reduce stress and act as a refuge from isolation experienced during the pandemic. Because the COVID-19 pandemic has hindered opportunities for in-person

environmental education, a socially distanced method of education, such as one using signs with QR codes to relevant information or assessments may be useful as the world adjusts to the new normal.

5. CONCEPTUAL FRAMEWORK

The conceptual framework of this project draws from disciplines of psychology, landscape architecture, and geography. This project was designed and developed during the unique and challenging coronavirus (COVID-19) global pandemic, allowing researchers to design projects that engage community members while maintaining social distancing. A growing body of literature is being published on the impact that COVID-19 has had on relationships between humans and nature. Because of the novelty of the pandemic and the variety of cultural and geographic contexts being investigated, research on COVID-19 and human-nature interactions is variable, and findings are contextual and dynamic.

This project draws on the concept of Gesler's (1992) theory of therapeutic landscapes, which was developed to explore the healing sense of place that some environments seem to provide. A major conceptual development that led to the inception of this project is the body of literature published in the last 10 years on the restorative potential of blue spaces in promoting environmental sustainability and wellbeing within communities (Helbich et al., 2019; Geneshka et al., 2021). Research on blue spaces has shown that the presence of water in a landscape can extend and complement existing therapeutic benefits of green spaces (Völker and Kistemann, 2011; Perrotti et al., 2020; Grellier et al., 2017) by promoting an active lifestyle (Pasanen et al., 2019) and providing opportunities for reflection and connection with nature (Völker and Kistemann, 2011). While several studies explicitly investigated how blue spaces can extend and complement the benefits provided by green spaces, more studies that investigate the role of blue spaces on mental wellbeing and relationships with nature are needed.

In order to investigate momentary emotional well-being, I developed a scale of emotional experience based on Plutchik's (1980) Wheel of Emotions. This conceptual presentation of how emotions relate to one another organizes emotions as existing on a circular spectrum (Figure 2). This structural representation of emotions shows how different emotions relate to one another, with positive emotions typically occurring opposite negative emotions. From the Wheel of Emotions, I used the emotions of Joy, Serenity, Sadness, Fear, Disgust, and Amazement to capture a representative subset of emotional experiences at each site. Participants had an opportunity to write in and rate any emotions they experienced that were not provided. Momentary subjective emotional experience (or mood) is less employed in empirical studies than biotic or psychological metrics of mental wellbeing. However, emotions are valid experiences and contribute to our behaviors, even if we do not realize we are acting emotionally (Kahneman, 2011).

Figure 2. Plutchik's Wheel of Emotions (Plutchik, 1980).

Quantifying relaxation and spatially displaying values and emotional reactions hopefully helps establish unaccounted-for benefits of waterscapes in San Marcos and inform future management and planning efforts. By measuring social demand for urban blue spaces can help promote sustainable management of SES. Social demand refers to the ways that stakeholders perceive "perceive, value, demand, or prioritize ecosystems (Castro et al., 2016; Martin-Lopez et al., 2014). Managing SES in a way that promotes autonomy, welfare, and justice requires an acknowledgement of various perceptions, patterns of behavior, and emotional experiences. This thesis uses the chosen framework

to specifically inform the city of San Marcos about the way various stakeholders perceive and have a relationship with the waterscapes in San Marcos.

I approach the concept of human-nature interrelations in SES through the framework of relational values. Relational values emerged out of the environmental value debate that for years relied on distinctions between intrinsic values (values for an ecosystem in itself, irrespective of their value to humans) and utilitarian values (values for the benefits to humans provided by ecosystems). Critics of this dichotomy argued that these two aspects of perception of a place's importance did not sufficiently describe the complex and dynamic relationships and responsibilities between humans and nature. Relational values focus on the importance of connection and interdependence (Arias-Arévalo et al., 2017). The relational values framework takes a systems approach that views human society as an inseparable part of the landscape and highlights the ways human behavior and environmental health are related. To avoid confusion, when discussing the types of values people assign to landscapes, I use the term ecosystem values (EV).

The goal of this project is to apply concepts established under the "Blue Mind" umbrella, including methods from psychology, neurobiology, and environmental studies (Nichols, 2014), to a landscape that is protected, but subject to the push and pull between economic development and environmental protection and restoration. The methodology of this project was derived from the Blue Index: Austin project, established in 2016. Blue Index: Austin used 32 photo stations to establish scores for waterscapes in Austin to inform resource managers on relevant issues at waterscapes and develop "Blue Index scores" for each based on perceptions, emotional experiences, impressions, and measures

of relaxation (Jeffery, 2020). This project is an extension of this approach and a collaboration with the Blue Index researchers. I expand on their survey by including measures of ecosystem values of waterscapes and examining how the COVID-19 pandemic has influenced relationships with these places.

This project uses mixed methods to analyze community survey data that is spatially and temporally distributed across waterscapes in San Marcos Texas. The project adopts an approach that quantifies aspects of the human-nature interactions that are rarely considered and almost never incorporated into quantitative cost-benefit analysis–moving beyond ecosystem services to a holistic view of models of interaction. The project adopts a post-structuralist position that emphasizes the subjectivity in assigning meaning to place and the ways that the effects of place are mediated and negotiated through symbolic meaning, social construction, and modes of interaction. Zhu et al. (2021) used photo databases from social media sites to quantify emotional differences in people's experiences of green spaces (Zhu et al., 2021), a framework that was evaluated and modified to create a photo database for this project. A temporal and spatial photo database may prove helpful in monitoring landscape changes over time.

By examining this sensitive site in a situation where its environmental integrity is threatened and population and urban development are increasing, I hope to demonstrate the profound and cost-effective benefits that protected waterscapes can have on mental and physical wellbeing. By providing perspectives on perceptions of ecosystem values from residents and tourists alike, this study may inform decisions that reflect community values and balance trade-offs between protection and development. At the same time, the methodology used in this study provides opportunities for community participation

through mobile landscape reporting at the 10 photo stations. Because of the subjective relationships with blue spaces and the degree of ambiguity involved in describing emotions and relationships with place, a mixed-method approach—one that allows open responses as well as quantitative data—may be beneficial to fully capture perspectives and relationships.

6. METHODS

6.1 Site and Situation

The San Marcos River is a valuable social-ecological system that provides multiple, overlapping benefits to the surrounding region and the broader global community. The headwaters of the San Marcos River are located in Spring Lake on the Texas State University campus. The lake was formed by the construction of Burleson Dam in 1849 (Kimmel, 2006). Fed by the Edwards Aquifer, the springs that form Spring Lake and the San Marcos River have not run dry in recorded human history (Kimmel, 2006). The Edwards Aquifer is formed from many groundwater and surface water inputs, including runoff from rivers along the Edwards Plateau. The San Marcos Springs flow at approximately 170 f^3/s, releasing water from the Edwards Aquifer (Kimmel, 2006). The system of springs, lake, and river provide habitat to six endangered species: San Marcos Salamander (*Eurycea nana)*, fountain darter (*Etheostoma fonticola*), Comal Springs Riffle Beetle (*Heterelmis comalensis*), Comal Springs Dryopid Beetle *(Stygoparnus comalensis*), Peck's Cave Amphipod (*Stygobromus pecki*), and Texas Wild Rice (*Zizania texana*).

The upper San Marcos River watershed (above Spring Lake) drains 130 km^2 in the Hill Country of Central Texas. The watershed is in the Edwards Plateau, which has a mixture of woodlands, grassland, and ustic soil. The average annual rainfall is 26-34 inches (Omernik, 1987). The San Marcos River is claimed to be the oldest inhabited river in North America, with documentation of human activity going back over 12,000 years (Kimmel, 2006). Like many places in North America, these lands were once home to indigenous tribes who were forcibly removed from their homelands. Many cultural and

social practices of the region were lost with this unjust removal, as is the case for many indigenous tribes. The presence of Texas State University, the growth of Austin and San Antonio, and the call of the river led San Marcos to become a prosperous tourist destination and college town with a population growth that reflects the booming area of Austin and San Antonio.

Hays County is the fastest growing county in the nation, with a 143% increase in population from 2000 to 2020 (U.S. Census Bureau, 2010, 2020). The population of the city of San Marcos has grown by more than 100% in that period. This growth requires local government to address trade-offs between the conservation of natural ecosystem functions and economic growth and development (Ellis et al., 2019; Kronenberg et al., 2021). A challenge facing the city of San Marcos is the ability to address threats to water sources and aquatic habitats from a growing population and increased development. Tens of thousands of tourists travel to Spring Lake and the San Marcos River each year, while residents visit local waterscapes as a daily source of exercise, relaxation, and recreation. Some of the San Marcos River waterscapes are located on Texas State University campus, providing students with educational and recreational opportunities to interact with clear, spring-fed water.

In reaction to this growth and the sensitivity of the aquifer, several initiatives arose to address future trade-offs between development and environmental preservation in recharge zones and riparian landscapes. The connection to the Edwards Aquifer and the leverage of the Endangered Species Act led to the protection of the San Marcos River through the Edwards Aquifer Protection Act of 1993 and the creation of the Edwards Aquifer Habitat Conservation Plan (Edwards Aquifer, 2021). In 1991, the Sierra Club

sued US Fish and Wildlife for failing to protect the endangered species in the San Marcos River. This led to the creation of the Edwards Aquifer Authority (Kimmel, 2006), the only of its kind in the state of Texas (George et al., 2011). In 2012, an excess of total dissolved solids (TDS) in the San Marcos River led to the development of the Upper San Marcos River Watershed Protection Plan (USMRWPP). In 2018, the EPA approved the plan as an official watershed management plan. Since its implementation, the plan has been successful at reducing TDS, *E. coli*, nutrients, and sediment (Navarro & Schlandt, 2020). The plan also includes language that dictates stakeholder involvement in identifying urgent problems. Because stakeholders are diverse in their values and priorities, this plan aims to address all relevant interests related to the protection of the San Marcos River. The San Marcos River Foundation (SMRF) is a non-profit organization dedicated to protecting the flow and water quality of the San Marcos River. SMRF serves on stakeholder committees to represent the interests of the river. They own property surrounding the river dedicated to environmental protection. They also collaborate on habitat conservation efforts, educate citizens in water quality monitoring, host annual river clean ups, and contribute to the creation and management of greenbelts and trails (SMRF, 2021).

The Meadows Center for Water and the Environment (hereafter Meadows Center) is located in the heart of San Marcos on Texas State University campus. Housed in the former Aquarena Springs amusement venue directly on Spring Lake, the Meadows Center is symbolic of the cultural history of the San Marcos River, transforming from prehistoric human dwelling to commodity for growth and tourism to an archetype of a protected and valued social-ecological system. Since 1994, the Meadows Center has been

synonymous with aquatic research, environmental education, and ecological tourism in San Marcos, Texas. The Center is dedicated to research, leadership, education, and stewardship. Their glass bottom boat tours, which feature views to the bottom of the lake, more than 8 meters in some places. In addition to hosting thousands of visitors every year, the Meadows Center is dedicated to publishing research on the ecology, hydrology, and water quality of Spring Lake and the San Marcos River (MCWE, 2021).

COVID-19 has inherently changed landscape dynamics in San Marcos. In 2020, nationwide lockdowns and pandemic protocols led to the closure of most of San Marcos parks, as well as the Meadows Center. By the time data collection began, in May 2021, all parks that I planned to gather data had reopened, but the effect of the pandemic was lasting and dynamic. While the river typically sees around 300,000 tourists per year, this number was likely much lower. The Meadows Center's annual report for fiscal year (September-August) 2020-2021 states that over 46,000 visitors came to the Meadows Center (MCWE, 2021). And 55, 211 attended in fiscal year 2019-2020 (MCWE, 2020). While these are impressive numbers, considering pandemic restrictions and safety measures, this is compared to 110,173 visitors in 2018-2019 (MCWE, 2019), which is more typical of the center's visitation numbers. Despite the dip in typical recreation numbers, the pandemic also changed the ways people experience nature, and where they seek it out. People around the world are developing a deeper appreciation for the restorative capacity of nature, and they tend to visit natural areas closer to home rather than traveling (ref). The same may be true in San Marcos, TX. Documenting the dynamics of human-nature relationships as a part of social-ecological system management is beneficial for planning and natural resource management. Considering all

of the following analyses through the contextual lens of COVID-19 is essential to documenting a true picture of community perceptions, behaviors, and values at the time.

As population and tourism grow in San Marcos, there will be a need for better monitoring and maintenance of ecosystems to ensure they provide necessary ecological functions while maintaining the range of benefits and cultural amenities they provide to local stakeholders (Sabatier et al., 2005). Thus, gathering stakeholder perspectives and data on modes of behavioral interaction may help give voice to under-represented stakeholders in the community and guide resource managers when balancing trade-offs between ecosystem services.

6.2 Research Design

6.2.1 Blue Index Photo Stations

I analyzed social demand of waterscapes in San Marcos by collecting questionnaire survey data and photos at various sites along the San Marcos River, including its headwaters, which form Spring Lake, and its adjacent wetland ecosystems (Figure 1). I selected ten sites to study interactions with waterscapes based on their various degrees of accessibility, popularity, riparian vegetation, natural vs. built environment, and optical water quality. Accessibility here is defined by the distance from parking and compliance with ADA recommendations. By conducting surveys at sites that are fairly close together, yet distinct in environmental setting, I hoped to conduct a *natural experiment* across different waterscapes.

Data were collected over a 10-month period using 10 *photo stations.* These stations consisted of an L-shaped frame attached to an existing bridge or post and a 6x6” acrylic sign with instructions for submitting photos and participating in the survey. This

structure forms a photo station where a participant can place their phone and submit a photo of the waterscape they are visiting (Figure 3). Participants accessed the survey through a QR code posted at each site. Participants were required to have a cell phone and access to cellular data to use the Internet on the phone, as almost all of the study sites were in public parks without free Wi-Fi.

Figure 3. Blue Index photo station attached to existing bridge at City Park.

6.2.2 IRB and Data Protection

This project (#7792) was approved as exempt by the Texas State University Internal Review Board (IRB) on 25 May 2021. Data collection began shortly after, on 29 May. Informed consent was obtained via an online form, which included a project description and information about confidentiality and anonymity of data. No identifying information was collected, and no incentive was offered for participation. Assessments consisted of 18 questions (Appendix A), most of which were based on a Likert scale or a list of multiple-choice options, although some questions allowed participants to type their responses. All questions, other than demographic questions, were based on the

participant's self-reported perceptions of waterscapes and their own motivations for visiting. Data were stored under a password-protected folder in the Texas State University data drive. Data were shared with the Blue Index repository to contribute to their nationwide database of Blue Index studies.

6.2.3 Survey Design

The assessments at the Blue Index stations consisted of measures of emotions experienced in the moment at the waterscape, measures of relative relaxation, an assessment of values based on why a waterscape is most important, questions regarding motivation and frequency of visitation, and demographic characteristics. Value measures were framed through self-reports of the important aspects of human-nature interactions, and I use the framework of relational values to tie these perceptions to potential outcomes (Arias-Arévalo et al., 2017; Muradian and Pascual, 2018). Measures of emotional experience were collected for six emotions (Joy, Serenity, Fear, Disgust, Sadness, and Amazement) on a 5-point Likert scale. Participants were asked to reflect on the landscape in front of them and indicate the extent to which they felt each of these emotions or other self-reported emotions.

Measures of relaxation were collected in a different manner than measures of momentary emotional experiences. Rather than ranking feelings of relaxation, the survey asked participants whether the waterscape they were visiting was *more relaxing or less relaxing* than their typical or other typical modes of relaxation. In this way, the data can provide insight into the comparative restorative potential of maintaining healthy blue spaces compared to other investments that promote community relaxation. Through this question, I was aiming to capture measures of *relative restorative potential*, to determine

whether urban blue spaces had higher potential for mental restoration and refuge than other avenues of relaxation. Participants were provided with a space to make comments on anything else they observed or would like to say about the waterscape. The survey measured environmental value orientations, in the framework of relational values, by asking participants to indicate the reason they perceive a place as *most important*. The response options and their associated value were: (1) Intrinsic Value: "It provides ecosystem functions such as wildlife habitat," (2) Relational Value: "It provides an opportunity for the community to connect with a natural environment," and (3) Utilitarian Value: "It provides useful benefits to society such as recreation and tourism." The survey then measured perceptions of waterscape characteristics, to both validate categorization of waterscapes in my framework and collect data on perceptions of social and physical waterscape characteristics. These questions were posed on an Agree-Disagree 5-point Likert scale. The waterscape social characteristic questions posed were "How much do you agree with the following statements": (1) This waterscape was easily **accessible**, and (2) This waterscape is a refuge from stress. The physical characteristic perceptions questions posed were "How much do you agree with the following statements": (1) This waterscape has **flowing** water, (2) This waterscape is **clean** enough to touch or swim in, and (3) This waterscape represents a **natural** environment.

Data on patterns of use and visitation were collected through questions about the reason (s) for visiting, in which participants selected as many applicable activities as applicable from a list of activities: **Community event/Music Event/Special Occasion, Commuting, Dog Walking, Exercising, Family Outing/Date/Socializing, Fishing, Art/Photography, Relaxing/Stress Relief/Meditating, Solitude, Water Sport/Tubing,**

Wildlife Viewing/Exploring Nature, or Work/School. They could also write in "Other" activities that drew them to the waterscape. Participants were then asked if it was their first time visiting that waterscape. If they indicated it was, they were asked whether they would return to the waterscape. If the participant indicated it was not their first time, they were asked how frequently they visit that place: Daily, Weekly, Monthly, or A few times a year or less. Demographic variables were used to organize participants into user groups. User groups were categorized as student (or non-student) and resident (or non-resident) to determine if these factors influence relationships with the waterscapes.

I collected demographic data on participants to investigate any potential associations between demographics and experiences with waterscapes. Participants answered questions about their age, gender, level of education, residency, and how frequently they visit that waterscape. I took two measures of residency to allow college students to define their residency themselves. I asked whether participants were a resident of San Marcos or resided there for the majority of the year. I also asked about **permanent** zip codes to see if permanent residents – those that indicated their permanent zip code as 78666 – had different associations than self-described residents. I displayed data across settings to determine whether demographic characteristics varied according to setting.

6.2.4 Analyses and Techniques

I collected data from May 2021 to March 2022 with Qualtrics software, an online survey distribution platform. Data analyses were conducted using R Studio and Excel. To describe and analyze results collected at each station, data were categorized and analyzed with descriptive statistics. Stations, located at various geographic locations, served as independent variables for analysis on how perceptions, emotions, and values vary among

participants across space. Descriptive statistics tell a spatially oriented story of perceived values and use of each site individually. I first analyzed the data across all study sites. I calculated descriptive statistics, analyzed frequency of use, and calculated proportions of ecosystem values. For the second portion of analysis, I selected four sites from different waterscape settings with similar sample sizes. I conducted descriptive statistics, ANOVA, Kruskal Wallis and Wilcox post-tests, and multivariate regression models to analyze relationships between sites. Stepwise linear regression considers the effects of predictor variables on a dependent variable by adding one variable to the model at a time. Stepwise regression starts with nothing in the model and asks which of the predictors is most significant and adds that predictor first, followed by the next most significant predictor. Using step wise regression can help determine which variables would be appropriate to include in a model that represents the predictors of a certain dependent variable. Stepwise regression can also reveal how covariates will muddle the model, so it selects variables with low covariance. Variables were included in the model only if they exhibited a p value of < 0.05.

The third portion of analysis compared sites along the SMR. I calculated descriptive statistics across the river sites. I then conducted ANOVA to determine whether any dependent variables were a function of site. I also utilized Spearman's rho, a nonparametric test, that takes ranked correlation into account to assess the strength of the associations between variables. No statistical significance tests were conducted to analyze the impact of the COVID-19 pandemic, but descriptive statistics derived from responses about changes in use of outdoor space and the use of these spaces to cope with stress or isolation may be helpful in demonstrating the increased value of these open

spaces during the pandemic. Open-ended comments left by participants were used primarily to communicate with the San Marcos Parks and Recreation Department any issues or perceptions of participants that were not covered in the assessment.

7. RESULTS

7.1 Data Distributions and Relationships

Data collection took place from 29 May 2021 to 4 March 2022. On that day, data was downloaded from Qualtrics and analyzed using Excel and R Studio. There was a total of 870 responses. The core questions of the survey included measures of emotional experiences, perceptions of waterscape characteristics, and ecosystem values. Many of the non-responses may have been due to a long consent form on the first page of the survey. After removing entries that did not answer the core questions of the survey, 566 responses remained viable for analysis.

Across the 10 sites, response counts ranged from 12 to 98 responses at each site. First, I analyzed results across all sites to summarize the overall social demand and ecosystem values for blue spaces in San Marcos, TX. Descriptive statistics across sites, as well as a breakdown of demographic characteristics for the entire sample area, show a large amount of variation among participants (Tables 1 and 2). A breakdown of responses by date and time of day revealed that the response counts were highest in Fall 2021 and lowest in the winter of 2022 (Figure 4). The most popular times for filling out the survey were 9:00-9:59 am, 2:00-2:59 pm, and 6:00-6:59 pm (Figure 5). The majority of participants were younger than 25 and over half of participants described themselves as a resident of San Marcos (Figures 4, 5, and 6).

Table 1. Demographics of participants across all study sites.	
Variable	Results across all 10 sites
Number of Responses	566
Age of Participants (all units % of total responses)	
18 to 24 years	51.3
25 to 34 years	20.5

35 to 44 years	13.4
45 to 54 years	10.1
55 to 64 years	3.2
65+ years	1.4
Education (all units % of total responses)	
Less than high school	0.2
High School Graduate	3.7
Some college – Texas State student	37.6
Some college – other institution	4.7
Some college –not currently enrolled	4.5
2-year degree	3.5
4-year degree	23.6
Master's/ Professional Degree	17.9
Doctorate	4.5
Gender of Participants (all units % of total responses)	
Female	64
Male	33.1
Non-Binary (%)	2.9
Residency Status (all units % of total responses)	
Self-Described Resident (%)	63.2
Self-Described Non-Resident (%)	36.8
78666 permanent zip code (%)	42.7
Other permanent zip code (%)	57.3
Frequency of Visit (all units % of total responses)	
Daily	6.4
Weekly	28.8
Monthly (%)	24.5
A few times a year or less (%)	40.4

Table 2. Mean and median responses for each emotion across all study sites.

	Joy	Serenity	Disgust	Fear	Sadness	Amazement	Relaxation	Access	Flow	Clean	Natural	Refuge
Mean	3.8	4.2	0.41	0.35	0.5	3.52	4.08	4.43	4.12	4.08	4.3	4.38
Median	4	5	0	0	0	4	4	5	5	5	4	5

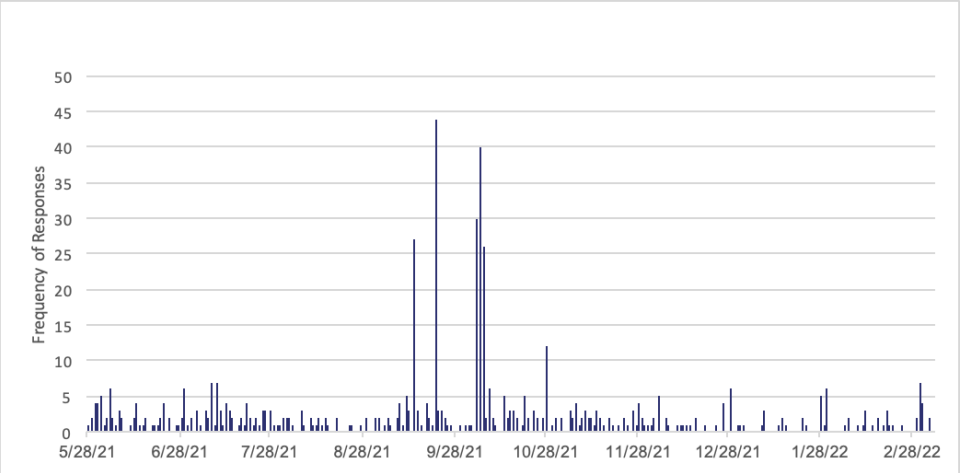

Figure 4. Frequency of responses across all sites by date the participant began the survey.

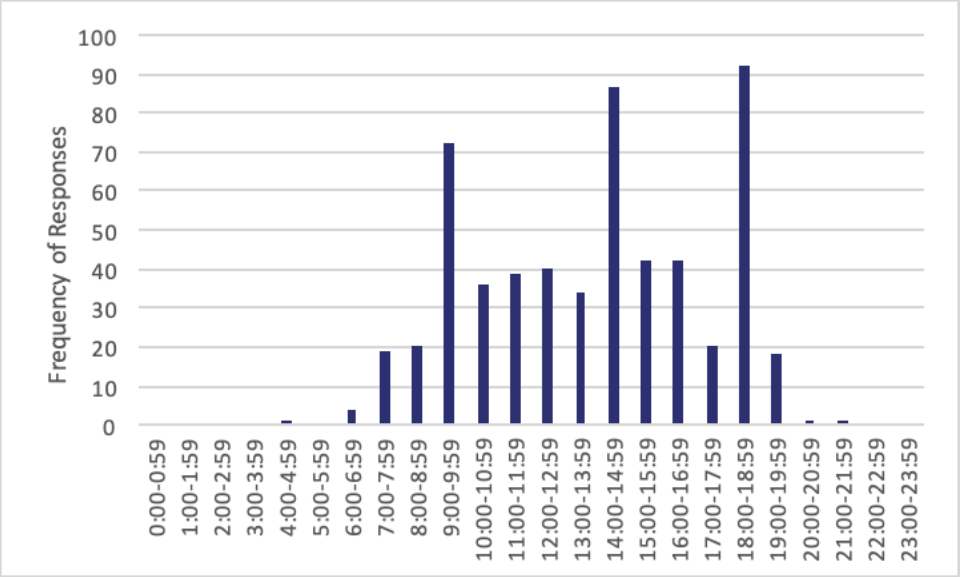

Figure 5. Frequency of responses across all sites by time of day the participant began the survey.

For my first analysis, I treated all variables as interdependent variables and used descriptive statistics to represent as many relationships between variables as possible. This portion of analysis paints with a broad brush the experiences, ecosystem values, and use patterns of San Marcos waterscapes. There was a statistically significant difference between the average intensity of positive emotions and negative emotions, with positive emotions expressed more often than negative emotions. Overall, participants indicated

that visiting the waterscape was more relaxing than their typical sources of relaxation (Figure 6). The average score for relaxation along the Likert scale was 4.08/5. Across sites, relational values (45.7%) were the most often cited, followed by intrinsic values (44.6%). Only 9.6% of participants indicated utilitarian values were the most important. Results about how COVID has impacted relationships with waterscapes revealed that the pandemic has shifted perceptions and patterns of use of blue spaces in San Marcos. Over half (56.8%) of respondents indicated they spend more time at the river at the time of the survey than they did before the onset of the pandemic. 93% of respondents agreed that the waterscape they were visiting represented a refuge from stress and isolation caused by COVID-19. An analysis of emotional experiences as a function of selected ecosystem value revealed that EV orientation was significantly associated with joy serenity and relaxation, with those expressing utilitarian values reporting significantly lower average intensity of joy, serenity, and relaxation (Table 3). Pairwise Wilcox tests revealed that perceptions of flow, cleanliness, naturalness, and feelings of refuge were also significantly associated with expressed ecosystem value (Table 4).

Table 3: Average scores for dependent variables across sites and organized by ecosystem value.

	Joy	Serenity	Disgust	Fear	Sadness	Amazement	Relax	Access	Flow	Clean	Natural	Refuge
Overall	3.80	4.23	0.40	0.35	0.49	3.52	4.08	4.44	4.12	4.08	4.29	4.38
Intrinsic (n = 227)	3.80	4.34	0.36	0.33	0.52	3.58	4.15	4.47	3.91	3.87	4.39	4.40
Relational (n = 233)	3.90	4.28	0.37	0.34	0.47	3.49	4.15	4.49	4.37	4.28	4.40	4.48

Utilitarian (n = 49)	3.38	3.61	0.53	0.28	0.36	3.25	3.73	4.14	4.31	4.37	3.41	3.98

Table 4. Results of Kruskal Wallis and Wilcox post-tests investigating emotional experiences and perceptions as a function of ecosystem value (EV) using results from all 10 sites.

Dependent Variable	P Value of Kruskal Test	P Values of Pairwise Wilcox Test by Ecosystem Value (EV)		
Joy	**0.009**		I	R
		R	0.35	
		U	**0.05**	**0.01**
Serenity	**0.009**		I	R
		R	0.59	
		U	**0.003**	**0.006**
Disgust	0.57		I	R
		R	0.35	
		U	**0.05**	**0.01**
Fear	0.81		I	R
		R	0.67	
		U	0.74	0.56
Sadness	0.98		I	R
		R	1	
		U	0.86	0.85
Amazement	0.45		I	R
		R	0.43	
		U	0.25	0.46
Relaxation	**0.04**		I	R
		R	0.41	
		U	**0.03**	**0.02**
Access	0.12		I	R
		R	1	
		U	0.06	**0.05**
Flow	**<0.001**		I	R
		R	**<0.001**	
		U	0.06	0.62
Clean	**0.002**		I	R
		R	**<0.001**	
		U	**0.03**	0.79
Natural	**<0.001**		I	R
		R	0.7	
		U	**<0.001**	**<0.001**
Refuge	**0.009**		I	R
		R	0.17	
		U	**0.03**	**0.002**

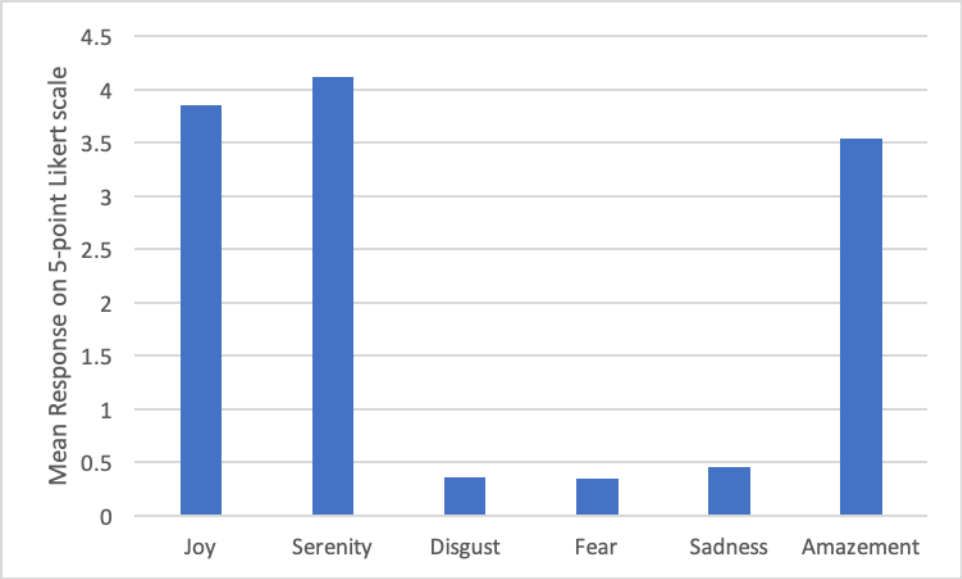

Figure 6. Average intensity of emotional experiences across all study sites.

I analyzed frequency of use by examining how often people indicated they were visiting for a certain reason. Participants were able to cite multiple uses, so I combined all reported uses into a list to determine the frequency of each use. Across sites, Wildlife Viewing/Exploring Nature was the most commonly cited use, followed by Relaxing/Stress Relief/Meditating, then Work/School, and then Family Outing/Date/Socializing (Table 5). Uses related to ecosystem functions or relationships with place were more frequently cited than uses related to recreation. The following two sections present an analysis of results across 4 sites that represent different waterscape settings and an analysis of results between 7 sites at various locations along the San Marcos River.

Table 5. Frequency of "reason for visiting" reported in the survey across all 10 sites (n = 566), organized by waterscape setting. Participants could indicate more than one use.

Use	Frequency Across all sites
Art/Photography	38
Community event/Music Event/Special Occasion	29
Commuting	10

Dog Walking	45
Exercising	132
Family outing/Date/Socializing	182
Fishing	8
Relaxing/ Stress Relief/ Meditating	199
Solitude	90
Water Sport/Tubing	54
Wildlife Viewing/Exploring Nature	207
Work/School	188

7.2 Waterscape Sites

7.2.1 City Park (#2)

City Park is one of the more popular river access points for community members and tourists. City Park is connected to two parking lots on either side of the river and has access points on both sides. Typical of San Marcos parks, river access points are lined with large concrete blocks on one side. The other side is paved and has steps and a ramp leading down from the parking lot to the river. This side of the park also features the Lions Club Tube Rental facility, where tens of thousands of people rent tubes each year to begin their float down the river. The station at City Park is located in between the tube rental facility and the stairs leading to the river (Figure 7). The station was attached to an existing post. While City Park is a popular tubing hub, the most common use cited by participants was Family event/Date/Socializing, which reflects the fact that City Park is a frequent destination of families or friends for picnics, birthday parties, or swimming at the river. The most common value cited at #2 were relational values. This reflects the fact that City Park is designed and maintained to facilitate access to and connection with the river. Picnic tables, ramps, stairs leading out of the river, and volunteer trash collectors are just a few examples of anthropogenic influences designed to foster connection with the river.

Figure 7. View from Blue Index station #2: City Park

7.2.2 City Park on Bridge (#3)

Station 3 was attached to an existing bridge that connects sidewalks on either side of City Park (Figure 8). While located just downstream of the river access points at City Park, the view and types of activities seen on or from the bridge are slightly different, as there are fewer river access points in view. The bridge connects the larger greenbelt system that connects city parks along the stretch of the San Marcos. The most common value expressed at City Park Bridge was relational values. The most cited use was Family outing/Date/Socializing.

Figure 8. View from Blue Index station #3: City Park on Bridge

7.2.3 Rio Vista Park (#4 and #5)

Rio Vista Park is one of the more iconic city parks along the San Marcos River. Located about half a mile downstream from City Park, it is the typical endpoint for most tubing activities, and it features the Rapids that draw thousands of tubers to the room each year. Two study sites were installed at Rio Vista Park at varying levels of accessibility and different stretches (Figures 9 and 10). Site number four was installed on an existing post on Rio Vista Island, an island that sits in the middle of the river as it meanders around toward the rapids. The most common value stated here was a relational value and the most common use was work/school as one small group of students attended the photo station as part of an assignment for class.

Station #5 was installed on a T-post near the rapids. The sign faced Ivar's River Pub, a restaurant directly on the bank of the SMR. This is one of the busiest areas for recreation activities along the river. The site is interesting because it is the only site direct

that features a view of a building directly adjacent to the riverbank. Historically development has not taken place along the banks of the San Marcos, but Ivar‘s River Pub, which has existed at the park since 1996, sets a precedent for riverbank development along the SMR. The most expressed value at site #5 was a Utilitarian value, the only site that had most participants select a utilitarian value. This value orientation reflects the typical activity of the river, as Rio Vista is a major destination for tourists and community members for outdoor recreation and water sports. The most cited use at site #5 was Work/School, as a group of students visited the site as part of a class assignment. The second most cited use was exercising.

Figure 9. View from Blue Index station #4: Rio Vista Island

Figure 10. View from Blue Index station #5: Rio Vista Park

7.2.4 Sewell Park (#6)

Sewell Park is located on Texas State University campus and is a source of relaxation, education, and leisure for Texas State University students and staff (Figure 11). While the park is specifically designated for students and staff of the University, hundreds of tourists and community members visit Sewell Park to swim or begin their water sports activities. Most participants at this site were students in the 18-24 age range. Students reported frequent use of the SMR at Sewell Park, with over half of the participants visiting the park weekly or monthly. A typical afternoon at Sewell sees hundreds of students sunbathing, swimming, tubing, and kayaking along the river. The banks of the SMR at Sewell Park are paved and the park represents, as one participant put it, “half of it is for nature and the other half is available for humans to use for recreational purposes”. This mixed-use space produced results that showed a preference for the

relational values experienced at the park. The most cited use was Relaxing/Stress Relief/Meditating.

Figure 11. View from Blue Index station #6: Sewell Park

7.2.5 Ramon Lucio Park (#7)

Ramon Lucio Park is located adjacent to I-35 and is the last park on the San Marcos River stretch on the West side of I-35. Ramon Lucio is located behind several baseball fields. The park features several river access points lined with concrete blocks. The photo station was installed on an existing bridge over the river at the park, facing I-35 (Figure 12). This park is frequented by groups of friends playing music, having picnics, or swimming. The river access points are not ADA accessible, but the sidewalk connecting the two parts of the park is compliant with ADA regulations. Ramon Lucio Park is located at a turn in the river and is up to 10 feet deep in some areas. The most expressed value at this site was relational values, reflecting the atmosphere of social

events that are typical of the park. The most cited use was Wildlife Viewing/Exploring Nature, but Relaxing/Stress Relief/Meditation was the second most cited use.

Figure 12. View from Blue Index station #7: Ramon Lucio Park

7.2.6 Wilderness Park (#8)

Wilderness Park, also known as Crook Park and sometimes referred to as Girl Scout Park, is located between Rio Vista Park and Ramon Lucio Park (Figure 13). Wilderness Park has several river access points, but no part of the park or riverbank is paved. The most commonly expressed value at Wilderness Park was relational, meaning the opportunity for connection was held in the highest regard. The most cited use from results at this site was Wildlife Viewing/Exploring Nature.

Figure 13. View from Blue Index station #8: Wilderness Park

7.2.7 Spring Lake near Meadows Center (#9)

Spring Lake is spring fed from the Edwards Aquifer and forms the headwaters of the San Marcos River. Station #9 is located at Spring Lake near the Meadows Center with a view of the glass-bottom boats (Figure 14). Spring Lake is not accessible to swimmers or water recreators but is explorable via a tour of the lake on a glass-bottom boat. The most expressed value at this site was intrinsic value, and the most common use was Work/School, followed closely by Wildlife Viewing/Exploring Nature.

Figure 14. View from Blue Index station #9: Spring Lake near Meadows Discovery Center

7.2.8 Meadows Center Wetland Boardwalk (#10)

Station #10 was installed on existing rails along the Meadows Center Wetlands Boardwalk (Figure 15). The boardwalk is maintained and managed by the Meadows Center, and there are several informational stations along the boardwalk that provide facts about the wetland ecosystem, endangered species, and nonnative species that live in the wetland. The wetlands at Spring Lake are adjacent to Aquarena Springs, a busy street that connects Texas State University campus to the larger San Marcos area. The most cited ecosystem value at this site was an intrinsic value, and the most frequent use was Wildlife Viewing/Exploring Nature.

Figure 15. View from Blue Index station #10: Meadows Center Wetland Boardwalk

7.2.9 Purgatory Creek at Bicentennial Park (#11)

Station #11 was attached to an existing bridge that crosses Purgatory Creek, a stagnant tributary of the San Marcos River. The bridge is located at Bicentennial Park, a frequent destination for walkers, bikers, swimmers, and tubers. The Blue Index station featured an upstream view of Purgatory Creek, which has unpaved banks and is lined by trees on either side (Figure 16). The most expressed ecosystem value at this site was an intrinsic value and the most common uses were exercising and relaxing/stress relief/meditation.

Figure 16. View from Blue Index station #11: Purgatory Creek at Bicentennial Park

7.3 Waterscape Setting

In order to compare experiences with blue spaces across different waterscape settings, I selected four different sites with similar sample sizes (Table 6). These settings were **Sewell Park** (River), **Spring Lake** (Lake), Spring Lake **Wetlands Boardwalk** (Wetland), and **Purgatory Creek** (Tributary), a stagnant tributary of the SMR. A second analysis follows that compares results along the San Marcos River, using the 7 *flowing* sites located on the main stem river.

Table 6. Demographics of participants at each setting.

	San Marcos River at Sewell Park (River)	Spring Lake near Meadows Discovery Center (Lake)	Meadows Center Wetlands Boardwalk (Wetland)	Purgatory Creek (Tributary)
Number of Responses	91	98	89	82
Age of Participants (all units % of total responses)				

18 to 24 years	62.4	44.6	39.0	38.2
25 to 34 years	21.2	24.3	20.7	19.1
35 to 44 years	7.1	17.6	24.4	16.2
45 to 54 years	9.4	8.1	14.6	10.3
55 to 64 years	0	2.7	1.2	10.3
65+ years	0	2.7	0	5.9
Education (all units % of total responses)				
Less than high school	0	0	0	0
High School Graduate	0	0	2.4	11.8
Some college – Texas State student	49.4	33.8	26.8	20.6
Some college – other institution	2.4	10.8	4.9	5.9
Some college – not currently enrolled	1.2	5.4	4.9	5.9
2-year degree	2.4	2.7	6.1	2.9
4-year degree	20.0	21.6	35.4	27.9
Master's/ Professional Degree	20.0	17.6	17.1	19.1
Doctorate	4.7	8.1	2.4	5.9
Gender of Participants (all units % of total responses)				
Female	60.2	59.4	71.2	59.7
Male	32.5	37.8	26.2	38.8
Non-Binary	7.2	2.7	2.5	1.5
Residency Status (all units % of total responses)				
Self-Described Resident	71.8	54.1	56.6	60.3
Self-Described Non-Resident	28.2	49.9	43.4	39.7
78666 permanent zip code	47.0	32.4	39.5	47.6
Other permanent zip code	53.0	67.6	60.5	52.4
Frequency of Visit (all units % of total responses)				
Daily	3.9	5.3	6.5	9.8
Weekly	38.2	10.5	15.2	41.5

Monthly	27.6	10.5	13.0	22.0
A few times a year or less	30.3	73.7	65.2	26.8

I compared results from the four settings to determine what, if any, differences existed in social demand between waterscape settings. I first characterized participants according to the demographic variables of each setting (Table 6). When comparing demographic variables between settings using ANOVA, I found a significant difference in the variance of age between settings, with the river setting having a higher proportion of younger participants (18-24 years) than the other three settings. This is likely because Sewell Park is located on Texas State University campus and is intended only for students and faculty of the University. No significant difference in age was found between the lake, wetland, and tributary setting. No significant differences were found between the gender, education, and residency of participants among the four sites. Across all four sites, positive emotions were experienced more often and to a greater extent than negative emotions (Figure 17). The stagnant tributary setting produced the highest degree of negative emotions. Average scores for all variables, including perceptions of physical and social characteristics of the four selected settings can be seen in Table 7.

Table 7. Mean scores for each dependent variable by waterscape setting, where 5 represents the highest rating.

	Joy	Serenity	Disgust	Fear	Sadness	Amazement	Relax	Access	Flow	Clean	Natural	Refuge
River	3.95	4.28	0.32	0.22	0.46	3.68	4.24	4.55	4.91	4.65	3.92	4.5
Lake	3.71	4.44	0.35	0.34	0.5	3.62	4.1	4.34	3.90	4.33	4.26	4.40

Wetland	4.10	4.47	0.25	0.26	0.45	3.83	4.26	4.5	3.59	3.93	4.62	4.44
Tributary	3.43	4.14	0.79	0.44	0.74	2.97	3.74	4.11	2.66	2.16	4.5	4.01

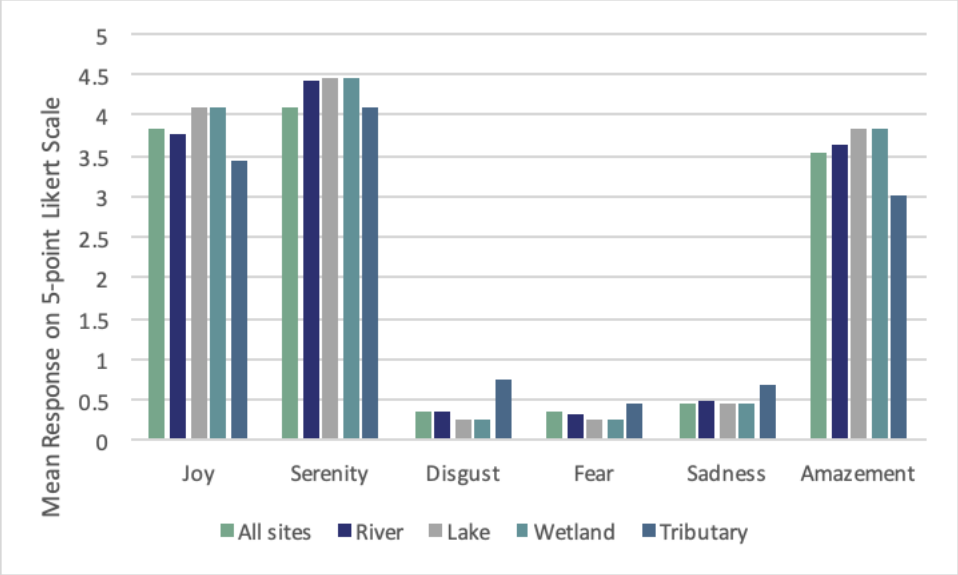

Figure 17. Average intensity of emotions experienced between four waterscape settings.

Experiences or connections to waterscapes may depend on biophysical, social, or aesthetic aspects of the setting. ANOVA, or analysis of variance, uses one or two categorical predictor variables to investigate a dependent variable as a function of ecosystem values or waterscape setting. I conducted ANOVA tests on results from the 4 selected settings to determine if social demand is a function of waterscape setting or ecosystem values (Table 8). Setting was a significant predictor of amazement, relaxation, and perceptions of access, flow, cleanliness, naturalness, and refuge. Ecosystem values were not significant predictors of experiences or perceptions.

While the overall mean relaxation score was high (4.08/5), relaxation did vary by waterscape setting, with the tributary setting exhibiting the lowest relaxation score. I

conducted ANOVA tests to determine that there was a significant difference in relaxation as a function of setting. A pairwise Wilcoxon post-test revealed that the difference between the tributary setting and the other three settings was statistically significant ($p<0.05$), but no statistically significant difference existed between the river, lake, and wetland settings.

The proportion of ecosystem values expressed varied across settings (Figures 18-21). An ANOVA test revealed that value was a function of waterscape setting, and relational values were significantly more common at Sewell Park (River). No statistically significant difference was found between the proportion of values at the lake, wetland, and tributary settings. Kruskal-Wallis tests were conducted to determine whether statistically significant differences exist between waterscape settings (Table 9). Kruskal-Wallis tests analyze variance between groups in non-parametric datasets. Because of the lack of random sampling in this experiment, I wanted to conduct both parametric and nonparametric statistical tests. Several variables were found to be a function of setting, with Purgatory Creek (Tributary) typically being the most distinct from other settings. Tests suggest that disgust was higher, but amazement and perceptions of refuge were lower for Purgatory Creek than other settings. Purgatory Creek also received a significantly lower score for perceptions of cleanliness. All 4 settings demonstrated significantly different perceptions of flow (Table 9). Frequency of use varied across settings, but frequent uses were Relaxing/Stress Relief/Meditation and Wildlife Viewing/Exploring Nature (Table 10, Figure 14).

Table 8. Two-way ANOVA tests investigating ecosystem values (EV) and waterscape settings on dependent variables. Bolded variables were significant at the 0.05 alpha level. Note that EV was not a significant predictor for any dependent variable.

Dependent Variables	**Predictor Variables**
Joy	EV, Waterscape Setting
Serenity	EV, Waterscape Setting
Disgust	EV, Waterscape Setting
Fear	EV Waterscape Setting
Sadness	EV, Waterscape Setting
Amazement	EV, **Waterscape Setting**
Relaxation	EV, **Waterscape Setting**
Access	EV, **Waterscape Setting**
Flow	EV, **Waterscape Setting**
Clean	EV, **Waterscape Setting**
Natural	EV, **Waterscape Setting**
Refuge	EV, **Waterscape Setting**
Covid Time	EV, Waterscape Setting
Covid Stress	EV, Waterscape Setting

Table 9. Relationships between emotions/perceptions and waterscape setting: San Marcos River (R), Spring Lake (L), Spring Lake Wetlands (W), and Purgatory Creek tributary (T). Bolded values were statistically significant at the 0.05 alpha level.

Dependent Variable	P Value of Kruskal Test	P values of pairwise Wilcox tests			
Disgust	**<0.001**		R	L	W
		L	0.35	-	-
		W	0.95	0.38	-
		T	**<0.001**	**0.001**	**<0.001**
Joy	**0.01**		R	L	W
		L	.16	-	-
		W	.78	.22	-
		T	.73	.27	.92
Serenity	**<0.001**		R	L	W
		L	.36	-	-
		W	.27	.82	-
		T	.46	.103	**.07**
Sadness	0.078		R	L	W
		L	0.70		
		W	0.84	0.85	
		T	0.06	**0.03**	**0.04**
Amazement	**0.009**		R	L	W
		L	0.91	-	-
		W	0.39	0.33	-

		T	**.01**	**0.01**	**0.001**
Fear	0.283		R	L	W
		L	0.25		
		W	0.71	0.44	
		T	**0.02**	0.23	0.06
Flow	**<0.001**		R	L	W
		L	**<0.001**		
		W	**<0.001**	**0.12**	
		T	**<0.001**	**<0.001**	**<0.001**
Clean	**<0.001**		R	L	W
		L	**0.001**		
		W	**<0.001**	**0.01**	
		T	**<0.001**	**<0.001**	**<0.001**
Natural	**<0.001**		R	L	W
		L	0.73		
		W	**<0.0010**	**0.003**	
		T	**0.002**	**0.01**	0.91
Refuge	**<0.001**		R	L	W
		L	0.80		
		W	0.92	0.78	
		T	**<0.001**	**<0.001**	**<0.001**
Access	0.09		R	L	W
		L	.18		
		W	.32	.65	
		T	**.02**	.25	.09
Relative Restoration (Relaxation)	**<0.001**		R	L	W
		L	.11		
		W	.76	.19	
		T	**< .001**	**.012**	**< .001**

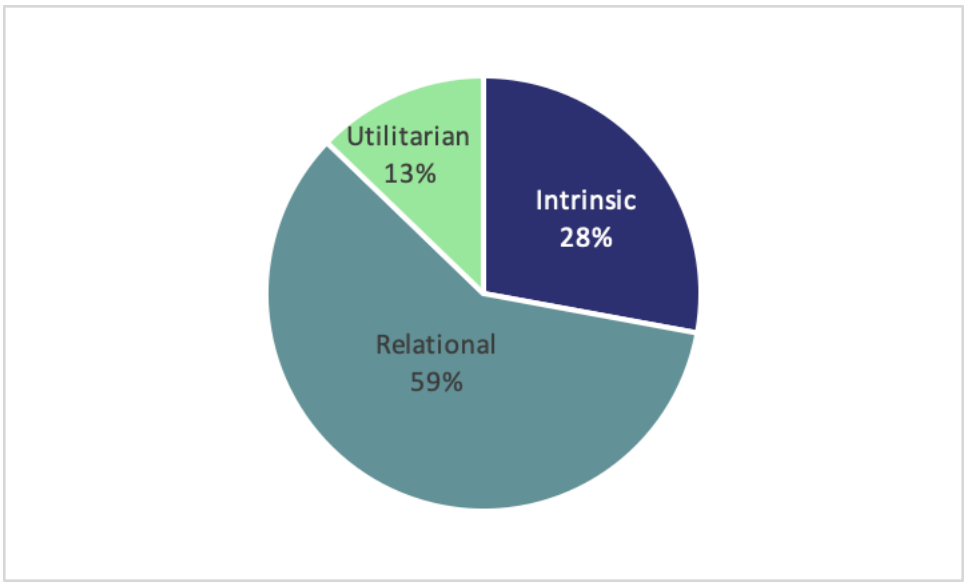

Figure 18. Proportion of ecosystem values assigned to San Marcos River at Sewell Park (#6).

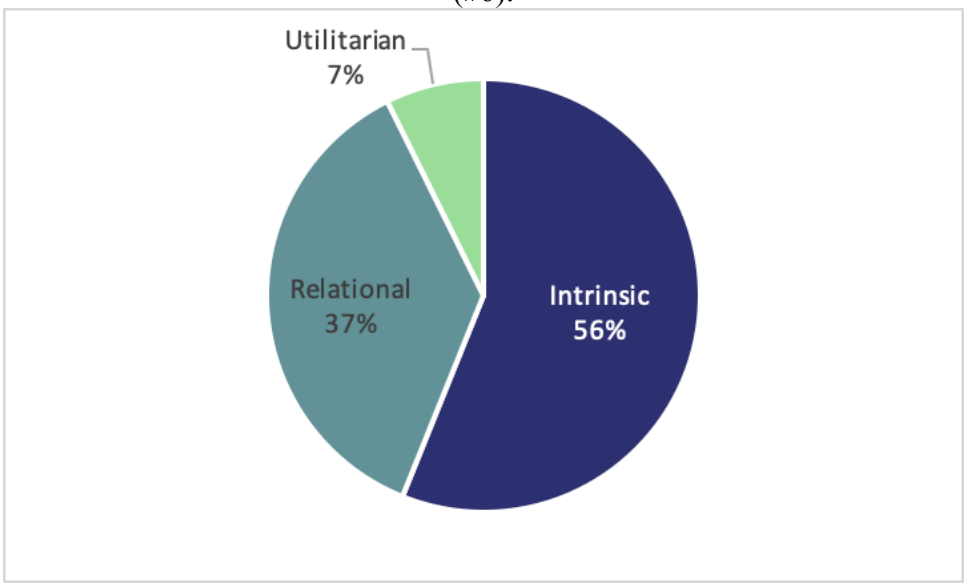

Figure 19. Proportion of ecosystem values assigned to Spring Lake (#9).

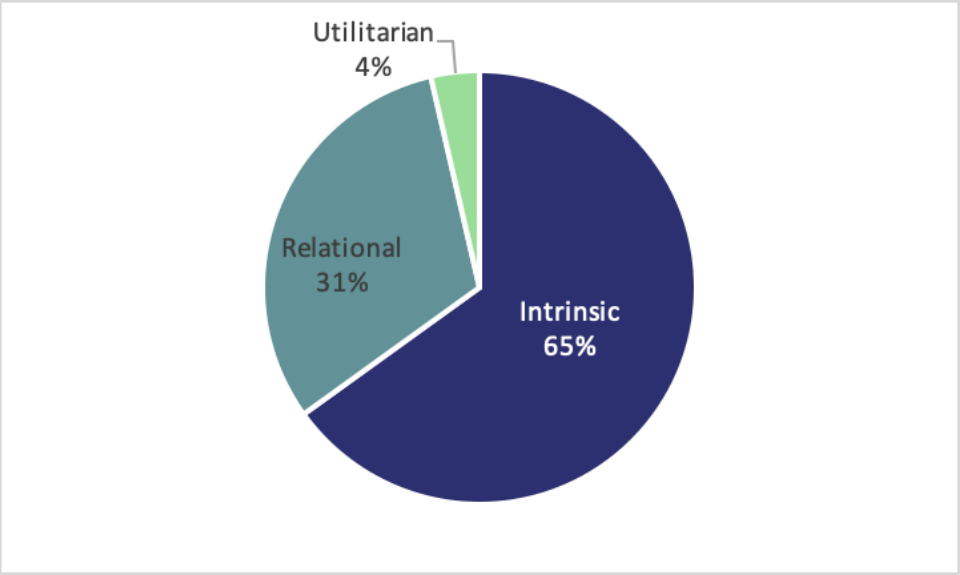

Figure 20. Proportion of ecosystem values assigned to Wetland setting (#10).

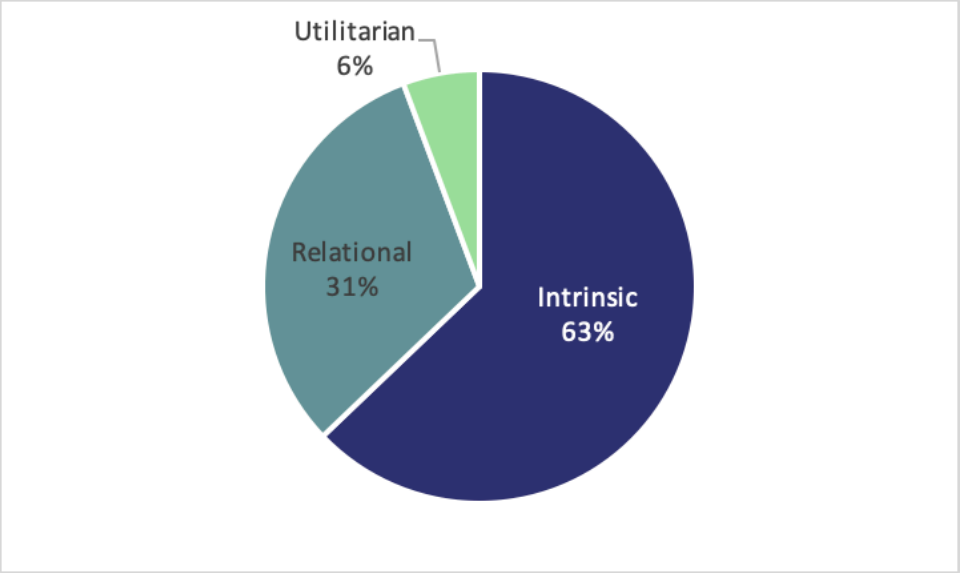

Figure 21. Proportion of ecosystem values assigned to Purgatory Creek (#11), a tributary of the San Marcos River.

Table 10. Frequency of uses across four waterscape settings.

Use	River	Lake	Wetland	Tributary
Art/Photography	23	6	9	0
Community event/Music Event/Special Occasion	21	6	1	1
Commuting	6	1	1	2
Dog Walking	28	3	5	9
Exercising	76	7	16	33

Family outing/Date/Socializing	92	30	37	23
Fishing	8	0	0	0
Relaxing/ Stress Relief/ Meditating	116	20	30	33
Solitude	56	5	15	14
Water Sport/Tubing	48	2	2	2
Wildlife Viewing/Exploring Nature	108	35	47	19
Work/School	118	37	24	10

7.4 Multivariate Regression Relationships

To characterize all potential relationships among variables, I created a correlation matrix for all sites in the dataset (Table 11). There were moderate positive relationships between flow and cleanliness (0.60). In general, positive/negative emotions were correlated with other positive/negative emotions. Fear and sadness were correlated (0.42), as were disgust and sadness (0.48), and disgust and fear (0.46). Amazement and joy were also correlated (0.65) as were joy and serenity (0.36), and serenity and amazement (0.35). Additionally, the correlation between flow and relaxation (0.31) and cleanliness and relaxation (0.33) indicate potential associations to be explored through linear regression.

I then conducted a stepwise linear multiple regression to determine which variables independently and in aggregation explained variance in relationships. Stepwise linear regressions for each of the dependent variables resulted in different predictor variables for each model (Table 12). The same candidate predictor variables were included in all stepwise functions: setting, joy, serenity, disgust, sadness, fear, amazement, relaxation, ecosystem value (EV), access, flow, cleanliness, naturalness, relaxation, amount of time spent at waterscapes since the onset of COVID-19 (“Covid

Time"), and the degree to which the waterscape brings refuge from the stress and isolation caused by COVID ("Covid Stress").

Table 11. Correlation Matrix for all emotional and waterscape perceptions.															
COVID stress	-0.03	0.08	0.15	-0.09	-0.08	-0.05	0.25	0.18	0.02	0.12	0.08	0.08	0.27	0.25	1
COVID time	-0.03	0.04	-0.02	0.02	0.08	0.05	0.07	0.02	0.50	-0.03	-0.06	0.02	0.001	1	0.25
Refuge	-0.13	0.27	0.29	-0.24	-0.16	-0.21	0.35	0.50	0.20	0.32	0.37	0.32	1	0.001	0.27
Natural	0.17	0.13	0.17	-0.07	-0.04	-0.14	0.13	0.20	0.30	0.07	0.08	1	0.32	0.02	0.08
Clean	-0.57	0.21	0.12	-0.24	-0.23	-0.14	0.22	0.33	0.31	0.60	1	0.08	0.37	-0.06	0.08
Flow	-0.61	0.20	0.08	-0.14	-0.12	-0.07	0.19	0.31	0.25	1	0.60	0.07	0.32	-0.03	0.12
Access	-0.10	0.07	0.08	-0.15	-0.09	-0.25	0.05	0.25	1	0.25	0.31	0.30	0.20	0.50	0.02
Relax	-0.10	0.33	0.34	-0.18	-0.13	-0.11	0.39	1	0.25	0.31	0.33	0.20	0.50	0.02	0.18
Amaze	-0.08	0.65	0.35	-0.04	-0.03	0.001	1	0.39	0.05	0.19	0.22	0.13	0.35	0.07	0.25
Sadness	0.07	-0.04	-0.06	0.48	0.42	1	0.001	-0.11	-0.25	-0.07	-0.14	-0.14	-0.21	0.05	-0.05
Fear	0.01	-0.05	-0.09	0.46	1	0.42	-0.03	-0.13	-0.09	-0.12	-0.23	-0.04	-0.16	0.08	-0.08
Disgust	0.09	-0.06	-0.01	1	0.46	0.48	-0.04	-0.18	-0.15	-0.14	-0.24	-0.07	-0.24	0.02	-0.09
Serenity	0.04	0.36	1	-0.01	-0.09	-0.06	0.35	0.34	0.08	0.08	0.12	0.17	0.29	-0.02	0.15
Joy	-0.07	1	0.36	-0.06	-0.05	-0.04	0.65	0.33	0.07	0.20	0.21	0.13	0.27	0.04	0.08
Setting	1	-0.07	0.04	0.09	0.01	0.07	-0.08	-0.10	-0.10	-0.61	-0.57	0.17	-0.13	-0.03	-0.03
	Setting	Joy	Serenity	Disgust	Fear	Sadness	Amaze	Relax	Access	Flow	Clean	Nat.	Refuge	Time	Stress

Table 12. Stepwise Forward Regression using the 0.05 alpha level as a threshold for variable selection.

Dependent Variable	Predictor Variables Selected	Cumulative R-Square	Adjusted R-Square	C(p)	AIC	RMSE
Natural	Access	0.09	0.08	41.11	886.75	0.91
	Setting	0.17	0.16	10.49	858.03	0.87
	Relax	0.20	0.20	-2.78	844.61	0.85
	Refuge	0.22	0.21	-7.51	839.58	0.84
	Clean	0.23	0.22	-9.61	837.23	0.84
Refuge	Relax	0.20	0.20	146.67	1261.73	0.80
	Access	0.28	0.27	87.36	1213.12	0.76
	Clean	0.32	0.31	55.26	1184.71	0.74
	Covid	0.35	0.34	16.58	1075.25	0.71
	Stress	0.38	0.37	-1.76	1054.56	0.70
	Natural	0.38	0.37	-0.99	1040.31	0.70
	Amazement	0.41	0.39	4.42	867.81	0.70
	Disgust					
Fear	Sadness	0.17	0.16	137.28	1086.53	0.82
	Disgust	0.19	0.18	108.54	1004.79	0.81
	Relax	0.19	0.19	108.51	987.53	0.81
Joy	Amazement	0.40	0.39	15.65	1639.91	1.05
	Serenity	0.42	0.42	-13.76	1610.26	1.03
Serenity	Joy	0.16	0.15	-25.26	1693.04	1.09
	Relax	0.22	0.22	-57.07	1627.51	1.06
	Refuge	0.22	0.21	-67.86	1528.83	1.04
	Setting	0.23	0.23	-74.54	1524.69	1.03
Disgust	Sadness	0.29	0.29	76.65	1029.77	0.76
	Clean	0.32	0.32	19.45	904.78	0.72
	Fear	0.36	0.35	4.73	830.22	0.71
Amazement	Joy	0.39	0.39	86.11	1748.84	1.16
	Relax	0.42	0.42	54.91	1691.12	1.13
	Covid	0.44	0.44	26.24	1478.38	1.11
	Stress					
Sadness	Disgust	0.29	0.29	31.53	1129.48	0.86
	Fear	0.33	0.32	23.75	1045.91	0.85
	Access	0.33	0.32	4.67	950.95	0.83
	Natural	0.33	0.33	2.72	948.95	0.83
Relaxation	Refuge	0.20	0.20	91.07	1384.15	0.89
	Amazement	0.26	0.25	52.00	1329.97	0.87
	Serenity	0.28	0.28	34.37	1313.62	0.85
	Clean	0.30	0.29	23.49	1303.21	0.84
	Natural	0.31	0.30	17.58	1297.44	0.84
Clean	Setting	0.36	0.36	179.08	1037.04	1.14

	Flow	0.44	0.44	115.79	993.20	1.06
	Disgust	0.48	0.48	80.72	823.68	1.04
	Refuge	0.51	0.50	65.46	811.62	1.01
	Covid Time	0.52	0.51	49.63	760.89	1.00
	Natural	0.54	0.53	43.92	756.05	0.99
	Relax	0.54	0.53	40.70	753.31	0.97
Covid Time	Covid	0.06	0.06	-14.17	1518.34	1.12
	Stress	0.06	0.06	-9.48	1265.87	1.12
	Fear					
Covid Stress	Refuge	0.08	0.08	-5.24	1190.76	0.80
	Covid Time	0.14	0.13	-33.06	1161.40	0.78
	Amazement	0.17	0.17	-46.44	1127.02	0.77
Access	Refuge	0.13	0.13	24.44	1369.64	0.88
	Natural	0.17	0.17	0.56	1346.12	0.86
	Covid Time	0.21	0.21	-30.42	1249.83	0.83
	Flow	0.22	0.21	-32.74	1247.12	0.83
	Sadness	0.24	0.23	-2.07	1101.47	0.85
	Serenity	0.25	0.23	-4.19	1099.17	0.85
Flow	Clean	0.33	0.33	90.45	1025.04	1.12
	Setting	0.41	0.41	43.56	985.75	1.05
	Relaxation	0.43	0.42	34.35	977.52	1.04
	Refuge	0.44	0.43	31.44	974.94	1.03

7.5 Comparative Analysis of Sites along the SMR

I conducted an analysis of results from stations along all the San Marcos River sites to hold waterscape setting (and flow by default) as a constant and test the effect of other variables on social demand (Sites #2-8). While my San Marcos River study area is a relatively short segment of the river, it is diverse in its degree of maintenance, development, geomorphology, and ecological features. Several city parks offer river access points, but these also vary in their degree of accessibility and use. I compared results between all river sites and conducted the same statistical tests as in section 8.3 to compare results between sites. Sites varied in aspects of emotional experience, ecosystem values, and perceptions (Table 13). The variability in frequency of uses reflected the diverse settings of the San Marcos River (Table 14). While relational values were the most frequently assigned ecosystem value across all river sites, the distribution of values

varied according to site. Again, positive emotions were experienced to a greater extent than negative emotions across sites (Figure 22), and negative emotions were often qualified with a concern for the river's ecological integrity.

Table 13. Comparative analysis of river sites along the upper San Marcos River.							
	City Park (#2)	City Park Bridge (#3)	Rio Vista Island (#4)	Rio Vista Park near Rapids (#5)	Sewell Park (#6)	Ramon Lucio Park (#7)	Wilderness Park (#8)
Number of Responses	32	48	12	26	91	59	27
Mean Emotional Scores where 5 represents the highest rating.							
Joy	4.03	3.65	3.00	3.62	3.96	4.05	3.81
Serenity	4.16	4.33	4.00	3.38	4.29	3.97	4.18
Disgust	0.33	0.58	0.09	0.24	0.32	0.36	0.32
Fear	0.20	0.64	0.30	0.27	0.22	0.46	0.29
Sadness	0.37	0.49	0.42	0.42	0.46	0.43	0.50
Amazement	3.5	3.53	3.17	3.35	3.68	3.36	3.85
Mean score of waterscape physical and social perceptions where 5 represents the highest rating.							
Relaxation	4.55	4	4.25	3.46	4.24	3.91	4.41
Access	4.71	4.46	4.27	4.39	4.55	4.54	4.67
Flow	4.81	4.54	4.64	4.78	4.91	4.57	4.96
Clean	4.94	4.15	4.82	4.83	4.65	4.31	4.89
Natural	4.16	4.52	4.18	3.35	3.94	4.26	4.59
Refuge	4.68	4.35	4.73	4.26	4.5	4.3	4.63
Ecosystem Value Frequency							
Intrinsic	9	19	2	3	24	19	7
Relational	19	24	8	5	51	31	17
Utilitarian	3	4	1	13	11	2	2

Table 14. Frequency of use across all sites along the San Marcos River (SMR).							
	City Park (#2)	City Park Bridge (#3)	Rio Vista Island (#4)	Rio Vista Park near Rapids (#5)	Sewell Park (#6)	Ramon Lucio Park (#7)	Wilderness Park (#8)
Art/Photography	4	5	0	1	10	4	4
Community event/Music	3	3	0	4	3	1	0

Event/Special Occasion							
Commuting	1	1	0	0	5	1	0
Dog Walking	2	5	0	2	19	9	5
Exercising	13	11	0	6	28	17	10
Family outing/Date/Socializing	14	17	1	3	4	21	8
Fishing	1	1	0	0	5	2	0
Relaxing/ Stress Relief/ Meditating	16	16	1	5	40	24	14
Solitude	8	8	1	3	21	8	7
Water Sport/Tubing	8	8		4	20	1	6
Wildlife Viewing/Exploring Nature	12	15	1	5	35	25	15
Work/School	13	12	8	17	43	12	12

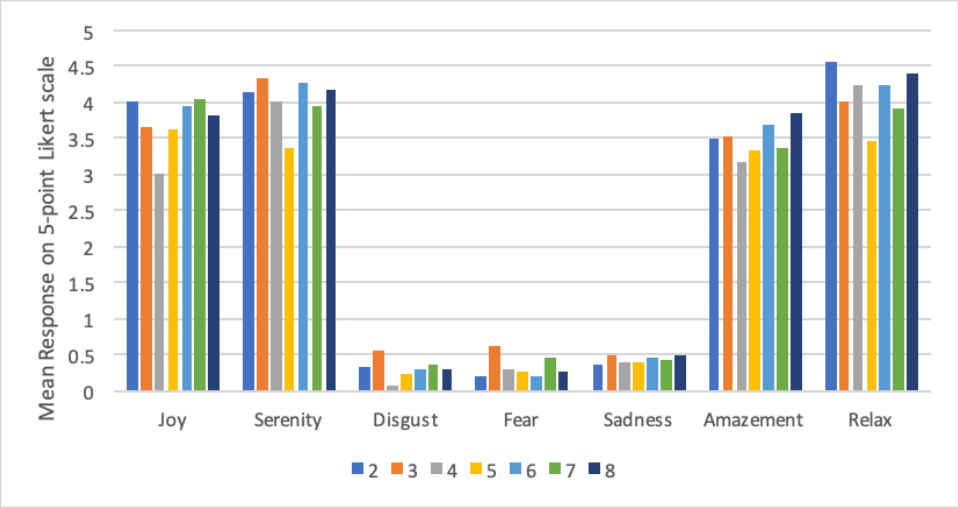

Figure 22. Average intensity of emotional experiences across sites along the San Marcos River. Chart legend: City Park (2), City Park on Bridge (3), Rio Vista Island (4), Rio Vista Park (5), Sewell Park (6), Ramon Lucio Park (7), and Wilderness Park (8)

Table 15. Demographics of participants across SMR sites.

	All San Marcos River Sites	**City Park (#2)**	**City Park Bridge (#3)**	**Rio Vista Island (#4)**	**Rio Vista Park (#5)**	**Sewell Park (#6)**	**Ramon Lucio Park (#7)**	**Wilderness Park (#8)**
Age (all units % of total responses at each site)								
18 to 24 years	60.2	70.0	55.6	72.7	81.0	62.4	41.2	65.4

25 to 34 years	19.7	6.7	24.4	18.2	9.5	21.2	27.5	15.4
35 to 44 years	8.2	13.3	2.2	9.1	9.5	7.1	11.8	7.7
45 to 54 years	9.3	6.7	15.6	0	0	9.4	9.8	11.5
55 to 64 years	2.2	3.3	2.2	0	0	0	7.8	0
65+ years	0.4	0	0	0	0	0	2.0	0
Education (all units % of total responses)								
Less than high school	0.4	0	0	0	0	0	2.0	0
High School Graduate	3.0	3.3	6.8	0	4.8	0	5.9	0
Some college – Texas State student	46.3	50.0	43.2	72.7	66.7	49.4	27.5	46.2
Some college – other institution	2.6	0	2.3	0	4.8	2.4	3.9	3.8
Some college – not currently enrolled	3.7	0	6.8	0	4.8	1.2	3.9	11.5
2-year degree	3	0	4.5	0	4.8	2.4	3.9	3.8
4-year degree	19.4	10.0	15.9	18.2	14.3	20	27.5	23.1
Master's/ Professiona l Degree	17.9	33.3	15.9	9.1	0	0	19.6	11.5
Doctorate	3.7	3.3	4.5	0	0	0	5.9	0
Gender of Participants (all units % of total responses)								
Female	64.2	66.7	68.9	63.6	71.4	60.2	60.8	61.5
Male	32.45	30	26.7	36.4	28.6	32.5	35.3	38.5
Non-Binary	3.4	3.3	2.2	0	0	7.23	7.2	0
Residency Status (all units % of total responses)								

Self-Described Resident	68.4	70	62.2	81.8	81	71.8	60.8	65.3
Self-Described Non-Resident	31.6	30	37.8	18.2	19	28.2	39.2	34.6
78666 permanent zip code	45.3	55.6	42.9	30	38.1	47	46.7	42.3
Other permanent zip code	54.7	44.4	57.1	70	61.9	53	53.3	57.7
Frequency of Visit (all units % of total responses)								
Daily	5.94	8.3	3.2	0	0	3.9	18.8	0
Weekly	32.67	37.5	29	0	17.6	38.2	25	53.3
Monthly	30.2	33.3	38.1	57.1	29.4	27.6	21.9	26.7
A few times a year or less	31.19	20.8	29	42.9	52.9	30.3	34.4	20

I conducted ANOVA tests on the results from the 7 sites along the San Marcos River to investigate whether any dependent variables varied as a function of site. ANOVA tests returned no significant results, meaning site did not significantly impact differences in emotional experiences, values, or perceptions of waterscape features. However, an analysis using ranked correlation and Spearman's Rho did reveal that waterscape characteristics were significantly associated with emotions. Flow, cleanliness, and naturalness predicted joy, serenity, amazement, and relaxation. some perceptions of waterscapes significantly predicted emotional reactions. Perceptions of cleanliness and whether the blue space is a refuge were significantly associated with all emotions (Table 16). Access only significantly predicted relaxation, meaning higher perceptions of access were not associated with higher intensity of emotional experiences.

Age, education, and gender makeup of participants did not vary significantly by site. The 7 sites along the SMR produced varying degrees of positive and negative emotions, and the most common value and use both varied by site. While site was not a significant predictor of emotional experiences, perceptions of waterscapes were, with perceptions of cleanliness and flow showing significant correlation with joy, serenity, sadness, fear, and amazement. Values often reflected the intended use of waterscapes, although use frequency was not always reflective of typical activities at each site. For example, Rio Vista sees thousands of tubers pass through the park every year, but only a handful of people indicated they were visiting for tubing. However, the prominence of utilitarian values at Rio Vista should be considered, especially since utilitarian values were so rarely cited across the entire study area. Rio Vista is catered toward recreation activities such as kayaking and tubing down the river rapids. This result may imply that value orientations are dependent on visual or social waterscape features, and values vary more according to setting than individual experience or perceptions. While aspects of social demand for blue spaces did not vary significantly between SMR sites, the diversity of responses reflects the myriad of activities that take place on the river every day.

Table 16. Results of Spearman's Rho (p) ranked correlation test. Bolded variables were significantly associated with the dependent variable at the 0.05 alpha level.

Dependent Variable	Predictor Variables	Spearman's Rank Rho	P Value
Joy	Access	0.10	0.11
	Flow	0.18	0.003
	Clean	0.28	<0.001
	Natural	0.24	<0.001
	Refuge	0.38	<0.001
Serenity	Access	0.05	0.43
	Flow	0.20	<0.001
	Clean	0.21	<0.001
	Natural	0.22	<0.001
	Refuge	0.42	<0.001

Disgust	Access	-0.10	0.14
	Flow	-0.10	0.15
	Clean	-0.22	<0.001
	Natural	-0.11	0.11
	Refuge	-0.15	0.02
Fear	Access	-0.02	0.78
	Flow	-0.18	0.008
	Clean	-0.17	0.009
	Natural	-0.11	0.10
	Refuge	-0.21	0.001
Sadness	Access	-0.03	0.60
	Flow	-0.06	0.39
	Clean	-0.17	0.008
	Natural	-0.16	0.01
	Refuge	-0.18	0.005
Amazement	Access	0.10	0.10
	Flow	0.16	0.010
	Clean	0.25	<0.001
	Natural	0.20	0.001
	Refuge	0.39	<0.001
Relaxation	**Access**	0.18	0.003
	Flow	0.23	<0.001
	Clean	0.31	<0.001
	Natural	0.22	<0.001
	Refuge	0.50	<0.001

7.6 Qualitative Analysis

The qualitative analysis for this project was based on optional comments left by participants and additional emotional experiences mentioned in the survey (See Appendix 2 for all comments). In addition to the 6 emotions surveyed, the participants could write in their own emotions and rank their intensity. Common additional emotions mentioned included “nostalgia”, “happiness” and “peace” (Table 17). The most common keywords in comments were related to water clarity, degree of naturalness, the interaction of people and landscapes, and noise (Table 18). I created word clouds using key words from comments at each setting (Figures 23-27). Most comments were positive, although some people expressed negative emotions that stemmed from disapproval of how others use the

waterscape. For example, many comments mentioned the effect of recreation on wild rice growth and the amount of trash in the river. Several sites such as Ramon Lucio Park and the Meadows Center Wetlands Boardwalk—both adjacent to busy streets—had several comments related to traffic noise. Several comments were place-specific and revealed a deep knowledge base. For example, one comment expressed sadness at the violent and racist history that shaped the current structure and function of the river. One participant expressed disdain for the use of slave labor in the construction of Burleson Dam. Another lamented that the "natural" area was built, although thoughtfully, by man to control the environment. Several people correctly identified species by sight. Others commented on seasonal or other temporal changes to optical water quality, vegetation density, and shoreline composition (e.g., "I feel the water color has been impacted by ongoing construction and winter time", "My favorite time to come here is in the fall or winter when there are less people in the water which causes the water and sediment to be less disturbed"). One comment mentioned the fact that the river has been inhabited by humans for over 12,000 years. This site-specific ecological knowledge indicates a community that is highly engaged in environmental issues and monitoring. Community engagement can increase the protection of water resources through mobilization for more sustainable behaviors (Sabatier et al., 2005; Kronenberg et al., 2021).

Many people in San Marcos have pursued or been exposed to environmental education about the river system. The Meadows Center is committed to educating people about the ecosystems and history of the Lake and river system. Anyone that visits the Meadows Center will undoubtedly come away with some new knowledge of the springs, lake, and river system. Qualitative analysis of comments left by participants reflected a

deep knowledge of environmental concerns as well as personal concerns for the integrity of the river and appreciation for the symbolic or environmental significance of the ecosystem. As one participant phrased it “We find the waters of the SM river to have a certain magic to them- the history, the color, the constant temp- it's spiritual.”

A mixed-methods approach allowed for perspectives like these to be incorporated with quantitative data analysis to provide holistic representations of relationships with place. By adopting SES and relational values frameworks, research on interaction with blue spaces can become more representative of actual relationships. Without this qualitative approach, these perspectives and frames of viewing waterscapes would not have been considered. While primarily descriptive, this qualitative data provides insight to the most common key words or themes of participants’ impressions.

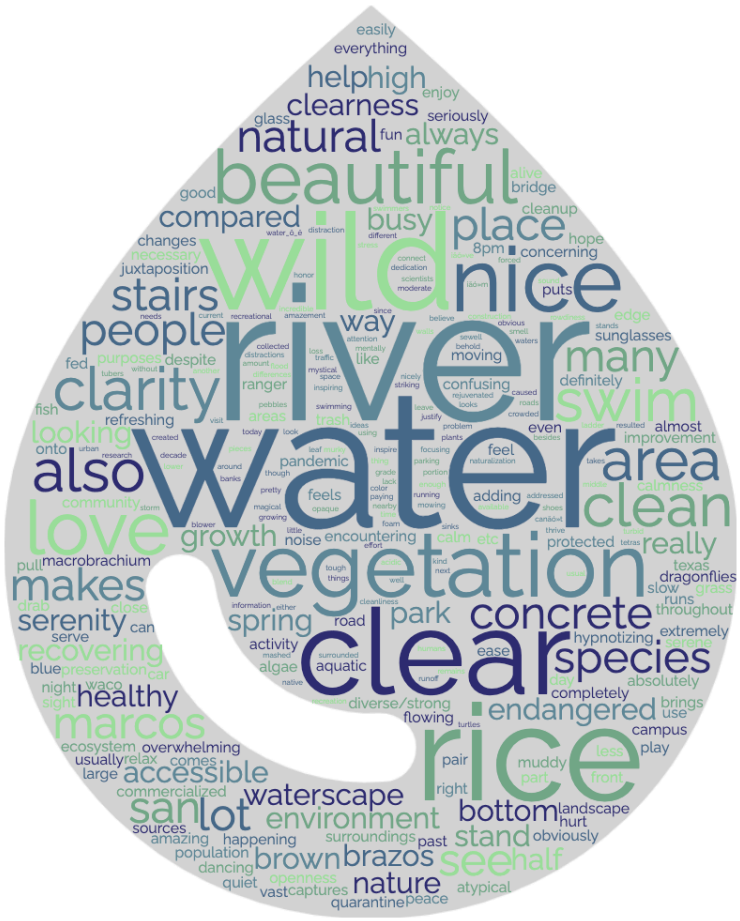

Figure 23. Word cloud showing the frequency of key words from additional comments left by participants at the river setting.

Figure 24. Word cloud showing the frequency of key words from additional comments left by participants at the lake setting.

Figure 25. Word cloud showing the frequency of key words from additional comments left by participants at the wetland setting.

Figure 26. Word cloud showing the frequency of key words from additional comments left by participants at the tributary setting.

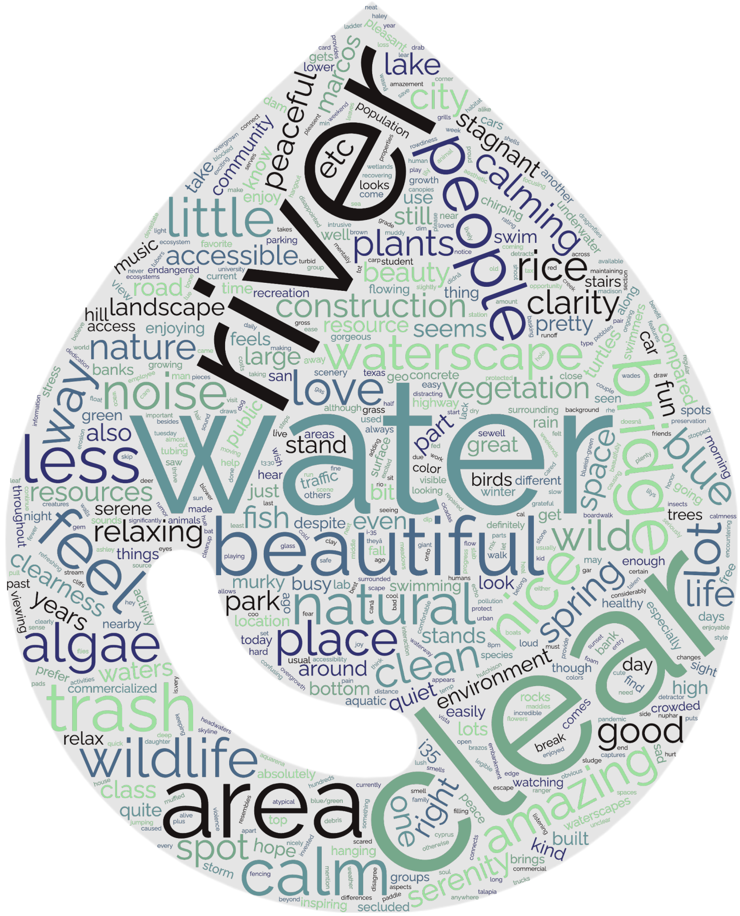

Figure 27. Word cloud showing the frequency of key words from additional comments left by participants across all settings.

Table 17. Most mentioned additional emotions listed in the survey	
Emotion	**Number of times mentioned**
Peace/Peaceful	9
Happy/Happiness	6
Nostalgic/Nostalgia	6
Love	3
Wonder	3
Relaxation/Relaxing	3
Appreciation	2
Excitement	2
Hope	2
Pride	2

Table 18. Key words with the highest frequency from additional comments left by participants at each site.	
River Setting (Sewell Park)	1. Water 2. River 3. Rice 4. Wild 5. Clear
Lake Setting	1. Water 2. Clear 3. Beautiful 4. Lake 5. Blue
Wetland Setting	1. Clear 2. Noise 3. Water 4. Natural 5. Wildlife
Tributary Setting	1. Water 2. Beautiful 3. Stagnant 4. Algae 5. Area
Across all Settings	1. Water 2. River 3. Clear 4. Beautiful 5. People

8. DISCUSSION

8.1 Human-Nature Relationships in Blue Spaces

Results from this study revealed human-nature relationships with blue spaces on a spatial and temporal scale. Results reflect the fact that, on average, blue spaces are valued more for their habitat provision or opportunities for connection with nature than for recreation or development opportunities. The community and visitors alike express a reverence for the wildlife, optical water quality, and educational opportunities that the river system possesses. Results from statistical tests demonstrated that perceptions of physical and social characteristics of waterscapes are significantly associated with emotional experiences. For example, the degree of perceived cleanliness and naturalness had a positive association with higher positive emotions. This supports the finding that the benefits of blue spaces are in part determined by visual landscape features (Twedt et al., 2019).

Additionally, Wilcox tests revealed that both emotional experiences and waterscape perceptions varied as a function of ecosystem value. Those expressing a utilitarian value experienced significantly lower levels of joy, serenity, and relaxation; and they reported significantly higher levels of disgust. Ecosystem values were also significant in predicting perceptions of flow, naturalness, accessibility, cleanliness, and whether the blue space represented a refuge from stress. Those that expressed utilitarian values often saw places as less natural and less of a refuge. These findings support the idea that emotional experiences are mediated through the symbolic meaning of place (Völker and Kistemann, 2015; Foley and Kistemann, 2015). The reasons we perceive a place as important or valuable may influence the ways those places affect us emotionally.

Those that demonstrate an intrinsic or relational value may feel a deeper sense of connection to blue spaces, which can increase the benefits to mental and physical health associated with exposure to blue spaces (Samus et al., 2022).

Comparative analysis of sites along the SMR revealed some differences in patterns of use and ecosystem values. The SMR sites exhibited varying degrees of development, recreational opportunities, and traffic noise. These factors were often reflected in comments, ecosystem values, and reported uses. For example, Sewell Park is located on Texas State University campus and caters to social and recreation activities. Relational values were most common here, and the most common use was Relaxing/Stress Relief/Meditation. This reflects the atmosphere of Sewell Park, which is seen by many as an on-campus refuge from the stresses of living, working, or attending school (Julian et al., 2018). Sewell Park represents a blue space that is directly on campus and available for use by students, staff, and faculty. The presence of healthy blue spaces on university campuses and visiting them for just 10 minutes a day can significantly improve the mental health outcomes of college students (Meredith et al., 2020; Jackson et al., 2021). On the other hand, Wilderness Park (#8) is a more isolated and less developed location. Because of its position off the main trail among a grove of trees, Wilderness Park is not visible from the road or any parking lots and requires walking a fair distance from parking. The noise from traffic and crowds is negligible, making it an ideal location for those seeking solitude, relaxation, or wildlife viewing. Results at Wilderness Park reflected this, with relational values ranking highest and the most common use being Wildlife Viewing/Exploring Nature. These findings support my hypothesis that the most common uses would reflect the type of ecosystem value expressed at that waterscape.

My study used community survey data to quantify social demand for urban blue spaces. The mixed-methods approach quantifies emotions and ecosystem values, as well as allowing for open communication about relationships with these spaces. Through qualitative data collection, I incorporated perspectives that may often go unnoticed in empirical studies of human-nature interactions. The photos and data collected through this 10-month study can be used to inform recommendations for the sustainable management of urban blue spaces based on community values and experiences.

8.2 Quantifying Emotional Experiences as a Measure of Restorative Potential of Waterscapes

Blue spaces can impact our mood, and longitudinal exposure to blue spaces can result in positive outcomes for community health (Smith et al., 2021). The Blue Index survey collects measures of subjective momentary emotional experiences in reaction to blue spaces, a metric rarely quantified in empirical studies of blue spaces. Within this study, positive emotions were experienced at waterscapes significantly more often and to a higher degree than negative emotions, reflecting the potential for waterscapes to provide community health benefits and restoration from stress. This project aimed to create documentation of emotional experiences, perspectives, and impressions of waterscapes in San Marcos, TX. Quantifying emotions can bring light to what seems obvious: The San Marcos River system is a source of pleasure, education, and enlightenment for community members and visitors alike. Rather than a purely empirical approach, the framework of this study is targeted toward community engagement, communication of stakeholder perspectives, and thus a mixed-methods analysis is

needed. A purely quantitative analysis may fail to capture the full extent of relationships with blue spaces.

While several studies have empirically studied the effects of blue spaces on community health and wellbeing, along with what factors influence these effects, few engage directly with participants to understand relationships between personal experiences and benefits of blue spaces. Many studies concerning community physical and mental health use psychological measures such as the SF-12 v2 (Völker et al., 2018), WHO-5 Wellbeing Index (Garrett et al., 2019), General Health Questionnaires (GHQ-12) (Triguero-Mas et al., 2015), Cantril ladder (Huynh et al., 2013), Personal Wellbeing Index (Mavoa et al., 2019), and SWEMWBS (Gilchrist et al., 2015). While standardized measures such as these are crucial to documenting reliable public health data, they may overgeneralize or fail to capture nuances of human-nature relationships that could help identify variables that may mediate the benefits blue spaces provide (Foley and Kistemann, 2015). Community survey data allows stakeholders to decide which information they want to provide, give feedback to resource managers, and communicate their experiences with waterscapes.

Quantifying emotional experiences and encouraging elaboration or feedback about these experiences can be beneficial in moving toward holistic representations of human-nature relationships (Stålhammer and Thorén, 2019; Chan et al., 2016). Momentary affect may help reveal implications for community wellbeing (Nichols, 2014). In other words, quantifying emotions helps bring data to common-sense ideas that waterscapes make people happy and are good for the community. Identifying specific areas that elicit positive or negative emotions, as well as feelings of relaxation, may help

resource managers advocate for the continued protection of river ecosystems. Gathering feedback from users of urban blue spaces can help resource managers identify areas of need, where maintenance, environmental monitoring, or increased enforcement of regulations would be beneficial.

This measure is not meant to serve as a substitute for measures of public health, but as supplementary perspectives not often quantified in analyses of restorative potential of blue spaces. Because of the remote framework and lack of extensive expertise on clinical or public psychology, I chose to investigate mood, or *momentary subjective emotional experience*, rather than *subjective well-being*, which is a longitudinal measure of positive and negative emotional experiences over time (Smith et al., 2021). Positive emotional associations can influence potential outcomes related to public mental health.

Results from this study show that perceptions of waterscape characteristics may influence emotional and restorative experiences. Ecosystem values were significantly associated with all waterscape perceptions, and these perceptions were significantly correlated with emotional experiences. Ranked correlations revealed that lower perceptions of flow, cleanliness, and naturalness, resulted in a lower intensity of positive emotions (joy, serenity, and amazement). These results provide evidence that experiences of urban waterscapes may depend on the physical or social aspects of those waterscapes. While the statistical analysis did not support my hypothesis that waterscape perceptions would significantly predict negative emotions, it did reveal that waterscape perceptions, especially perceptions of physical or hydrologic characteristics, can influence positive emotional experiences.

It is important to note that the concept of *natural* or *nature* is heavily contested, as nearly every inch of the planet is impacted by human activity in some way. The San Marcos River is a highly maintained and frequently altered river ecosystem that is not exempt from human influence. Given that these are urban waterscapes, it is difficult to claim they are natural. Rather than assigning a label of *natural* to any of the waterscapes, I based my analysis on perceptions of naturalness—using ranked values to look for associations between perceptions and behaviors. This allowed participants to define *natural* for themselves and reflect on how they assign that attribute to an urban landscape. Different people will have different ideas of what naturalness is, and some participants commented on this saying, with one stating: *Natural* seems like a problematic adjective. I feel like it's a beautiful place either way but there's clearly *anthropogenic* influences, like there are in any landscape in one way or another." This perspective provides insight into the ways that perceptions influence emotions. The benefits of blue spaces are influenced by visual aspects of blue spaces (Twedt et al., 2019) and influenced by personal experiences or knowledge (Foley and Kistemann, 2015). Someone that has studied historical geography or environmental science will likely be hesitant to assign the word *natural* to any urban landscape.

Time spent in nature that produces sensations of happiness, reflection, and restoration contributes to physical and mental well-being in the long term (Meredith et al., 2020; Samus et al., 2022; Smith et al., 2021). Connection with green and blue spaces can also promote public health through access to outdoor recreation (Grellier et al., 2017; Pasanen et al., 2019). Blue spaces can provide opportunities for social interaction, education, and restoration (Smith et al., 2021; Hermanski et al., 2021; Völker and

Kistemann, 2015), which can promote positive health outcomes. While benefits vary according to characteristics of waterscapes and personal experience, blue spaces can have measurable benefits to reduce collective stress and provide opportunities for refuge and restoration. San Marcos, Texas is a community that protects and cherishes its river, and the positive emotions experienced across sites reflect this culture of reverence and protection.

8.3 Using Relational Values to examine interactions and perceptions of waterscapes

Relational values move beyond traditional ecosystem services assessments to represent relationships with and responsibility to place (Himes and Muraca, 2018). Measuring relational values of waterscapes in San Marcos allows resource managers to view human-nature relationships through expressions of place values. As part of social-ecological systems (SES), humans can both change and be changed by aspects of the landscape. Relational values were collected through a question of why a place is "most important." Some relational value measures have collected a plurality of values, but I wanted to force a choice to reveal people's primary value orientation. Overall, intrinsic and relational values were balanced, but much more common than utilitarian values. Relational values were significantly more frequently assigned to SMR sites. This may be because the SMR offers more opportunities for physical interaction with the water, and therefore may be seen to offer more opportunities for the community to develop a relationship with waterscapes.

In San Marcos, there is a cultural and social norm of reverence and protection for Spring Lake and the San Marcos River. During my time installing or replacing stations at various sites, I had conversations with community members that possessed extensive

knowledge of the ecological conditions and wildlife of the San Marcos River, including endangered species and the history of protection that partly stems from their presence. The third most mentioned word at the River was “rice” in reference to Texas Wild Rice (*Zizania texana*) (Figure 28). San Marcos, Texas is a college town and a hub for commuters from Austin and San Antonio. But more so than that, it is a community that reveres and respects the San Marcos River, not only for the ecosystem services it provides (Julian et al., 2018) but for the cultural-historical and symbolic meaning that it holds for many people (Kimmel, 2006). This reverence is clear from the fact that over 300 people left additional comments expanding on their answers or providing more information. Many of these comments showed a deep knowledge of the ecosystem makeup, history, and functions of the San Marcos River.

Figure 28. Texas Wild Rice (Zizania texana).

Relational values aim to represent the complex and dynamic ways that people can relate to and feel about nature (Muradian and Pascual, 2018; Klain et al., 2017). The mental health benefits provided by blue spaces are mediated and negotiated through our experiences, perceptions, and beliefs (Foley, 2011; Samus et al., 2022). Therefore, relationships may represent symbolic meaning of place, and that meaning can change or be reinforced through new experiences (Nichols, 2014). Qualitative analysis of comments left by participants revealed the dynamic ways that characteristics of blue spaces can negotiate emotional reactions, perceptions of waterscapes, and relationships with place. This mixed-method approach may be more effective at representing relational values of

waterscapes than a purely quantitative analysis. For example, one participant commented that they felt some sadness at the site because they used to visit at a rough time in their life. Relational values, as a framework of understanding, aims to capture these nuanced relationships with place through measures of motivations for interaction with landscape and personal emotional experience.

Many participants wrote in "nostalgia" as an additional emotional experience. The different meanings of place and the complexity of factors that influence that meaning are partly captured through a survey of relational values, but to understand what relational values represent to different people, qualitative analysis is crucial. A cost-benefit analysis of ecosystem services in the traditional empirical sense would fail to account for these types of relationships and experiences. For many people, it is more important to be a part of something than to focus on the benefits a place provides. Resource managers face trade-offs when planning urban blue and green spaces and may benefit from a relational values approach. This way, policy can reflect human experiences with blue spaces rather than just a quantification of the monetary or anthropocentric benefits they provide.

8.4 Emerging Effects of COVID-19 on dynamics and practices of human-nature interactions

The coronavirus pandemic has been a time of collective stress, grief, uncertainty, and loss across the globe. Collective stressful events provide a setting to evaluate the role of landscapes in mitigating stress, isolation, negative emotions, and symptoms of mental health disorders. Several studies have shown that mental health problems have worsened over the course of the pandemic, even for those that were not infected by the virus (Cullen et al., 2020; Galea et al., 2020; Holmes et al., 2020; Jackson et al., 2021). Urban

blue spaces represent opportunities for restoration and refuge from the negative impacts of the pandemic, and these opportunities have shifted perceptions of the significance of urban green and blue spaces. Many people around the world have expressed an increased appreciation for nature since the beginning of the pandemic (Ugolini et al., 2020). In line with previous literature, I found that people perceive blue spaces as a refuge from the stress and isolation caused by the COVID-19 pandemic. Over 90% of participants agreed that they seek out waterscapes as a refuge from these negative emotions. Research on time spent in nature since the beginning of the pandemic has produced mixed results, as lockdowns and required isolation periods inherently lead to more time spent inside and alone. However, some research has shown that people are using blue/green spaces more often than before the pandemic, and these excursions into nature are taking place closer to home (Venter et al., 2020). Results from this study show that about half of participants spend more time at urban blue spaces than they did before the pandemic, while the other half indicated spending less time or the same amount of time. These results reflect the complex conditions of the pandemic that has simultaneously made people more isolated and more curious about exploring nature. My results show that about half of participants were non-residents, which may indicate that as COVID restrictions relaxed, people resumed traveling outside of their residential zip code to explore blue spaces.

While primarily descriptive, these results contribute to the growing body of literature on the influence of COVID-19 on relationships with nature and patterns of interaction with blue spaces. By implementing simple metrics, I gathered descriptive data on the amount of time spent at blue spaces since the onset of the COVID-19 pandemic. Over half of the participants indicated they spend more time around blue spaces now, and

nearly all respondents agreed that blue spaces provide refuge from stress and isolation caused by COVID-19. Collective stressful events can provide opportunities for landscapes to act in a transformative way. Connectedness to nature can lead to mobilization that promotes collective action (Kronenberg et al., 2021) and may lead communities to hold refuge opportunities in higher regard (Samus et al., 2022). Fostering connectedness and relational values in collective stressful events is crucial to not only preserving the ecosystem services they provide but managing their potential benefits on community mental and physical health. The framework presented in this study is also a starting point for designing new landscape monitoring or environmental education programs that aim to foster connection with nature while maintaining social distancing and other COVID-related safety measures.

8.5 Qualitative Analysis of Photos and Comments

In addition to documenting human-nature relationships as functions of the health of SES, this project resulted in a temporal and spatial database of participant-submitted photos. Photos taken from the same angle of the same place over a 10-month period provide visual data of landscape variability and change over time. Time-stamped photo databases may provide insight into the ways that extreme weather events, intense recreation activity, or other land use practices may influence the flow, water quality, and habitat of the San Marcos River. On one occasion in October 2021, an extreme flood event took place in San Marcos. The San Marcos River was flooded and heavily turbid. Blue Index participants submitted photos in the aftermath of the storm that may help reveal the timing and duration of hydrologic responses to extreme flood events (Figure 29).

Figure 29. Receding floodwaters on October 18, 2021 at Sewell Park (Site #6).

An analysis of comments left by participants revealed that many additional comments contained both positive and negative themes. Positive comments were often related to amazement in reaction to wildlife, interactions between the river and groups of people, and the water color or clarity. Some comments contained observations of changes over time; ("I feel the water color has been impacted by ongoing construction and winter time.")

When negative emotions were experienced and expressed in responses, they were often accompanied by a qualifier explaining that negative emotions stemmed from perceived misuse or degradation of the river ecosystem. Ten comments mentioned trash or pollution of the river. One participant remarked, "Green algae from fertilizer must be

stopped. City ordinance to prohibit its use is the only way. Trash in the bends of river is gross. Must fine offenders thru camera evidence." This concern for the river may not have been captured in a purely quantitative analysis of social demand. Over 10 comments mentioned noise pollution in some way, with some marveling that the waterscape has been protected from the rapid urban development in San Marcos. Others mentioned noise as a distraction or as something impeding their ability to relax or experience serenity. Noise has been found to be a significant predictor of the restorative potential of blue spaces; spaces that offer natural soundscapes in urban settings are particularly effective (Liu et al., 2022). One participant noted the impact of this soundscape at Ramon Lucio Park (#7), commenting that the park was "A little oasis despite being so close to a busy highway." While traffic noise is hard to avoid near roads, the common concern about noise interference in urban blue spaces may be of interest to resource managers as they plan for future development in San Marcos.

Several comments reflected the extensive environmental knowledge of the community. Several times, species were identified correctly by name. People commented on the coverage and health of the Texas Wild Rice over time. One participant pointed out the ways the pandemic and lack of visitors to the river had been helpful in restoring Wild Rice populations. There is a culture of reverence and concern for the San Marcos River that translates to people's perceptions and behaviors. Knowledge about specific ecosystem functions or species may create a heightened sense of responsibility to monitor and protect those things (Julian et al., 2018). One participant even stated this directly pointing out that "Having waterscapes like this in my community makes me more invested in maintaining their health and conserving their ecosystems" (See Appendix 2

for all comments). Relational values of blue spaces in San Marcos are evident through ecosystem-specific knowledge, emotional reactions, and concern for the wellbeing of these systems.

8.6 Limitations to Study

This study analyzed how people perceive, value, and use blue spaces in San Marcos; yet, there is an inherently spatial limitation to this concept that creates a selection bias. Only those that are physically visiting the river and willing to engage with a cell phone application were participants in the study. Therefore, this analysis missed an opportunity to assess these perceptions in populations that have limited access to blue spaces or technology. There is also a limitation of assigning responses to a subjective category such as the category of ecosystem services provided or relational values. If a goal of this project is to evaluate the accessibility of these landscapes, it misses any feedback from those with limited accessibility, as only those with social and physical access responded to the assessment. Some sites, such as Rio Vista Island, had a very small sample size. Rio Vista Island is not compliant with ADA regulations as it requires visitors to cross the river along a stretch of concrete blocks that is often slippery and potentially dangerous. Perhaps because of the low accessibility, Rio Vista Island received the lowest number of responses to the survey (n=12). As with all survey data, this data is subject to errors from humans either rushing through the survey or giving intentional false information. Another limitation of the survey was the question regarding time spent in nature since COVID. The question asks if people spent more or less time at waterscapes than they did before the beginning of the pandemic. This wording may have been confusing as many participants likely moved to the area during the pandemic. When

aiming to differentiate between emotional experiences and waterscape characteristics by setting, I realized that these variables experienced ceiling effects, as averages were all similar and high on the scale. A more effective method may be to ask about specific emotional reactions to place and rank these emotions, rather than placing them on an intensity Likert scale.

City parks were closed due to COVID-19 for over 6 months prior to the beginning of the survey period, which could lead to confusion about what the question means by "since before the pandemic". While this question aimed to understand time spent in nature anywhere, not just in San Marcos, this was not clear from the wording of the question. Although sites grouped to compose the River Setting condition were similar in terms of waterscape structure, there were some differences between sites within this category. Notably, value attributions across all sites were largely intrinsic or relational, however the most expressed value at Rio Vista Park (Site #5) was a Utilitarian value. This may indicate that values are related to the type of activity, as Rio Vista is a popular site for tubing, swimming, and kayaking and many tourists are drawn to this site. Differences such as these may go unnoticed when grouping together sites that represent different purposes and degrees of development along the same watershed feature.

9. CONCLUSIONS

Blue spaces can have profound and measurable benefits to overall wellbeing, especially in urban settings where stressors may be more intense and constant. Maintaining healthy blue spaces is a cost-effective way to prevent negative mental health effects from these stressors. In San Marcos, Texas, blue spaces are held in high regard and are seen as a symbol of the cultural, social, and environmental history of the Texas Hill Country. Blue spaces in San Marcos have been shifted and negotiated by human alterations, including the construction of Burleson Dam, the development of impervious surfaces, roads, and buildings along the San Marcos River, intense development in the Edwards Aquifer recharge zone, and the destruction of vegetation and shore banks from recreation activities, just to name a few. In this way, the history of human values and interactions is embedded in the landscape. The community of San Marcos, including resources managers, are faced with determining the future of waterscapes in San Marcos through their accessibility, perceptions, relationships, and interactions. Community surveys can ensure that these perspectives are considered in assessments of potential trade-offs in water resource management.

Understanding stakeholder perspectives and considering perspectives equitably is essential to the sustainable management of blue spaces. While ecosystem services are useful, the full dynamics of a social-ecological system (including how humans interact with, value, and perceive natural systems) are more complex. Social demand, relationships with nature, goal orientations, and modes of interaction with space are all examples of quantifiable, or at least describable variables that often go unaccounted for when trying to represent human-nature relationships using ecosystem services.

Waterscape assessments that utilize the ecosystem services framework should try to work toward a sustainable balance between biophysical, socio-cultural, or monetary values. Environmental valuation assessments should also consider whether they approach values in terms of biophysical, socio-cultural, or monetary valuations, in order to not exclude any potential ways of thinking.

Relational values are an emerging framework to view interactions and relationships of people and ecosystems as part of a social ecological system. Encouraging reflection on meaning of place and emotional experiences can uncover collective values that can help guide decision making related to trade-offs in land use planning. Documenting perceptions of social and physical characteristics of waterscapes can provide evidence for areas where community education may be beneficial. Optical water quality, often more than actual water quality, can form perceptions that can determine restorative potential of waterscapes (Julian et al., 2013; Liu et al., 2022).

The COVID-19 pandemic has illuminated the ways access to healthy blue spaces can mitigate and decrease the negative impacts caused by extremely stressful collective events. Collective action in times of challenge or stress can mobilize communities to hold landscapes in higher regard and interact with them in a way that promotes their protection and sustainability. Collective interaction with natural systems reflects a "therapeutic community" that can help people cope with stressful times (Sempik, 2008). Documenting photos and relationships with waterscapes in San Marcos, TX on a spatio-temporal scale provides insight into relevant landscape changes, values, and perceptions of waterscapes in San Marcos. Future research could explore methods of photo data analysis that derives from photos relationships between conditions of the landscape and emotional reactions.

That is, I could identify landscape characteristics (e.g., weather, sunlight, temperature, number of people present) from photos and local monitoring tools to investigate photo databases as a tool for gathering stakeholder perceptions of waterscapes.

Planning green and blue spaces in urban settings often comes with difficult trade-offs and can be influenced by push-pull factors from competing or contrasting interests within the community (Misiune et al., 2021). Planning for sustainable urban growth requires a consideration of multiple aspects of ecosystem value attribution, including what people value about these systems, how these values are spatially distributed, and what factors influence the way people perceive and express their values (Sander and Zhao, 2015). By collecting perspectives from stakeholders that may often go unheard, this project promotes the equitable consideration of stakeholder interests when considering trade-offs between community interests in blue space management.

APPENDIX SECTION

Appendix 1. Blue Index Survey

1. By selecting "I Acknowledge" below, you acknowledge that "I grant permission to the researchers for the use of my uploaded waterscape photograph in any presentation or product of this research. I understand that I am entering a Creative Commons Attributions Noncommercial No Derivatives license. My photo will not be changed or sold. It will be used to share knowledge of San Marcos waterscapes with the public and park managers."

2. Take a photo of the waterscape in front of you if you have not already. Upload your photo of the waterscape from your photo storage folder.

3. Take 10-20 seconds to observe the waterscape in front of you. Which feeling(s) best describe your experience? Drag your finger on the sliders to rate the intensity of what you are feeling. A higher rating means more intense emotion. You must touch each slider even if your response is 0 (no emotion). Joy; Serenity; Disgust; Fear; Sadness; Amazement; Other (blank text box)

4. Compared to my usual sources of relaxation, this waterscape is: (Likert Scale) Considerably less relaxing; Somewhat less relaxing; Neither less or more relaxing; Somewhat more relaxing; Considerably more relaxing

5. How much do you agree or disagree with the following statements: Likert Scale: Completely Disagree; Somewhat Disagree; Neutral; Somewhat Agree; Completely Agree. This waterscape has flowing water; This waterscape was easily accessible; This waterscape is clean enough to touch or swim in; This waterscape represents a natural environment; This waterscape is a refuge from stress.

6. Optional: Please use this space to describe what stands out most to you about this waterscape or elaborate on any of your above responses. Open text response box; 500 characters max

7. I came to this waterscape for: (mark all that apply). Options: Community event/Music Event/Special Occasion, Commuting, Dog Walking, Exercising, Family outing/Date/Socializing, Fishing, Art/Photography, Relaxing/Stress Relief/Meditating, Solitude, Water Sport/Tubing, Wildlife viewing/Exploring Nature, Work/School, Prefer not to answer

8. This waterscape is most important because: (choose one) Options: It provides ecosystem functions such as wildlife habitat (Intrinsic value), It provides useful benefits to society such as recreation and tourism (Utilitarian value), It provides an opportunity for the community to connect with a natural environment (Relational value).

9. Thinking back to before the beginning of the pandemic in March 2020, do you spend more or less time around waterscapes like this one now? Likert scale: Considerably less time, Somewhat less time, Neither less or more time, Somewhat more time, Considerably more time

10. To what extent would you agree with the following statement: "Spending time around waterscapes like this one helps me cope with the isolation or stress of the pandemic"? (Likert scale) Options: Completely Disagree; Somewhat Disagree; Neutral; Somewhat Agree; Completely Agree

11. My permanent zip code is: Open text response box

12. Are you currently a resident of San Marcos or do you reside in San Marcos for the majority of the year? Options: Yes, No

13. What is your age range? Options: Less than 18 years (these responses were deleted), 18 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years, 65+ years.

14. How do you describe yourself? (check one) Options: Female, Male, Non-Binary, Prefer not to answer

15. Please indicate your level of education. (check one) Options: Less than high school, High school graduate, Some college (currently in college at Texas State University), Some college (currently in college at another institution), Some college (not currently enrolled), 2-year degree, 4-year degree, Master's/Professional degree, Doctorate.

16. I traveled to this waterscape by (mark all that apply): Options: Foot, Bike, Car, Bus, Train, Boat, Plane, Other, Prefer not to answer

17. Is this your first time visiting this waterscape? Options: Yes or No

18a. (If yes on 17) How often do you come to this waterscape? Options: Daily, Weekly, Monthly, A few times a year or less

18b. (If no on 17) Would you return to this waterscape? Options: Yes or No

Appendix 2. All Comments left by participants

Comment	Site
After coming back from Houston for winter break, this is the perfect spot to relax and unwind.	City Park (#2)
All the different plants and trees along the water	City Park (#2)
Calm	City Park (#2)
Clear, some wild rice. Considerably less due to recreation.	City Park (#2)
Fun, exciting, a place to hang out with friends.	City Park (#2)
Great station location! Nice water entry points here.	City Park (#2)
I came to the river to de-stress after my run. The river calms me down and allows me to take a deep breath and obtain the much	City Park (#2)

needed break from school, work, and negative things going on in my life. I love how nature can have an extreme impact on our mood.	
I love how accessible it is. Itäó»s a nice place to be connected to nature and other people.	City Park (#2)
I love how blocked off this area is from the road. You can still hear road noise but I feel like Iäó»m tucked away in a little escape. And even the built environment around this section of the river looks really nice.	City Park (#2)
I swim here at down at least 3 days a week. I am disabled and use the metal stairs. During sights and sounds, the city removes my access and forces me to use the more dangerous and difficult stone stairs on the other bank. In the water, I am part nature.	
It represents gratitude for the gem that it is for its beauty, community connector, and healing source for humans for over 14,000 years, not to mention all its wildlife with the same properties. Thank you for all is done for conservation & preservation of this amazing natural resource! Grateful SMTX Resident	City Park (#2)
people kayaking	City Park (#2)
The lush green scenery really stands out to me, plus the calm look of the river	City Park (#2)
The river is beautiful and a space I come to relax at. The swimmers are a bit loud, making it slightly unpleasant. The water is very clean.	City Park (#2)
the traffic here in all aspects is significantly less than the last location	City Park (#2)
The water in this area is more calm and very clear.	City Park (#2)
The wild rice stand population and trees on the bank stand out the most to me about this waterscape.	City Park (#2)
This part of the river has plenty of space and is much quiter and relaxing	City Park (#2)
This waterscape is more quiet in comparison to Sewell Park. There is much less noise here.	City Park (#2)
Water clarity	City Park (#2)
What stands out to me most about this waterscape is the broadness of it. Just upstream at the previous waterscape, the river seems more narrow and windy. This waterscape resembles a pool to me.	City Park (#2)
Beautiful to see families and groups of friends from many backgrounds enjoying the river. Accessibility is important for all. Keeping Texas rivers clean is so important.	City Park on Bridge (#3)
Calm, Quiet, a bit of trash	City Park on Bridge (#3)
Clear water, safe space for people & animals	City Park on Bridge (#3)

Endangered wild rice growing	City Park on Bridge (#3)
I like that the riparian environment is being repaired and replanted, its nice to see new plants and wildflowers growing in the area	City Park on Bridge (#3)
I loved watching the sea grass wave like hair in the water.	City Park on Bridge (#3)
I've never seen it this murky I'm scared to float it, I assume it's because of the recent rain	City Park on Bridge (#3)
Its a beautiful place to see the beauty of nature and human architecture together with the bridge you can see. It may not be as swimmable with the reeds in the water, but it's a beautiful place to see the natural habitats of the river and animal life like the turtles.	City Park on Bridge (#3)
Large source of water is easily visible.	City Park on Bridge (#3)
My family and I enjoyed the visit tot he beautiful landscape.	City Park on Bridge (#3)
No where to get in.	City Park on Bridge (#3)
Peaceful reprieve in the city	City Park on Bridge (#3)
seems to be more natural than other spots on this river	City Park on Bridge (#3)
Someone built this place. Thoughtfully so that others may heal, too bad the shadows of hatred, violence, loneliness, and pain echo throughout the surrounding region	City Park on Bridge (#3)
The clarity of the water is peaceful to look at. I think there would be more fear if the water was murky. I did not feel fear.	City Park on Bridge (#3)
The clarity of water and lack of pollution from an intrusive gas pipeline or other intrusive things	City Park on Bridge (#3)
The clear waters are very pretty, I can even see fish in the water. And I kind of really like the style of bridge that you can see in the distance. It's kind of industrial which is really pretty paired with the natural environment.	City Park on Bridge (#3)
The Texas Wild Rice is always captivating, relaxing, and mesmerizing to me. My favorite time to come here is in the fall or winter when there are less people in the water which causes the water and sediment to be less disturbed.	City Park on Bridge (#3)
The vegetation is very visible and appears to be healthy	City Park on Bridge (#3)
This is my favorite view of the river, the long strands of wild rice flowing with the river is so calming to watch.	City Park on Bridge (#3)
Trees	City Park on Bridge (#3)
We find the waters of the SM river to have a certain magic to them- the history, the color, the constant temp- it's spiritual	City Park on Bridge (#3)

What stand out most to me about this watershed is the plants in the water.	City Park on Bridge (#3)
You can't access the water from this specific part of the bridge	City Park Bridge (#3)
I feel the water color has been impacted by ongoing construction and winter time.	Upper Rio Vista Island (#4)
A lot of human activity right by the river, dam presence, man made and natural canal Construction	Rio Vista Park (#5)
Good	Rio Vista Park (#5)
I felt a bit of sadness because I used to come to this park during a rough time in my life, but it is still beautiful	Rio Vista Park (#5)
I saw a large duck swimming in the water	Rio Vista Park (#5)
The Cyprus tread and the blue/green flowing water create a unique and beautiful landscape that elicits feelings of both fun and peace.	Rio Vista Park (#5)
the little ecosystems around the area stand out the most. although hundreds of people swim in this river they're still thriving	Rio Vista Park (#5)
The river shoot that is towards the end of the stream.	Rio Vista Park (#5)
This part of the river is definitely more populated and noisy.	Rio Vista Park (#5)
This point of the river is currently being used for various recreation activities- tubing, paddle boarding, swimming and hanging out. It is surprisingly quiet, despite about 20 people at the park. There is quite a bit of construction going on, along with fencing around the river, which concerns me. I know this park gets incredibly busy on weekends with good weather and there is a restaurant across the river that draws in even more. It is also the final stretch of a commercial tubing operation.	Rio Vista Park (#5)
As a San Marcos River Ranger it's an honor to serve	Sewell Park (#6)
At beautiful as the water is, the construction, leaf blower/ grade mowing, and car traffic sound caused the loss of the serenity completely.	Sewell Park (#6)
Beautiful wild rice and clear blue water	Sewell Park (#6)
Besides the water, there are a lot of distractions, but focusing on the water is almost hypnotizing.	Sewell Park (#6)
Brown water from flood!	Sewell Park (#6)
Calm, less crowded than usual	Sewell Park (#6)
Clarity, cleanliness, mystical	Sewell Park (#6)
Clean, Quiet, a way to connect with nature in the middle of a busy community.	Sewell Park (#6)
Clear beautiful water.	Sewell Park (#6)
Clear spring fed water	Sewell Park (#6)
I absolutely love this space but I do believe there is a problem of trash that needs to be addressed. Tubers swimmers etc visit and	Sewell Park (#6)

leave their trash and it sinks to the bottom. I've collected many pieces of glass that for those without shoes could seriously hurt them. There should also be more easily accessible stairs, either by adding a lower edge or ladder below the stairs. Even if the water is high, it takes a lot of effort to pull yourself up and out onto the stairs.	
I always feel rejuvenated after a swim in the San Marcos river	Sewell Park (#6)
I like how half of it is for nature and the other half is available for humans to use for recreational purposes. It's a nice blend compared to other natural areas	Sewell Park (#6)
I love how the forced quarantine resulted in the river recovering so nicely. It's fun that people play in it but I also like the changes.	Sewell Park (#6)
It remains a very natural environment despite many people using it. It is a very alive river compared to many other commercialized areas. It's nice that there is part of the river for people to swim and also an area where water plants can thrive.	Sewell Park (#6)
Its openness	Sewell Park (#6)
Lack of calmness or serenity comes from being on campus (rowdiness, stress, etc)	Sewell Park (#6)
Love the water	Sewell Park (#6)
Moderate activity and swimming happening at around 8pm. Clean surroundings.	Sewell Park (#6)
River rice	Sewell Park (#6)
recreation, wild rice, clear water	Sewell Park (#6)
Road noise is overwhelming and mashed it tough to enjoy. Beautiful water though, even at night	Sewell Park (#6)
Storm runoff. Atypical	Sewell Park (#6)
The amazement of the waters' clarity stands out. It is mentally refreshing to see the pebbles at the bottom of the river and see the wild rice dancing in the water.	Sewell Park (#6)
The clarity of the water. I'm from the Waco area and the Brazos is very pretty but always muddy. There are obvious differences between this portion of the San Marcos River and the Brazos, but it's really nice to see water that's so clean and clear. The other thing that I can't help but notice is all the concrete. It makes everything accessible which is really nice but it's a little drab looking.	Sewell Park (#6)
The clear spring water makes Sewell park a magical place to relax. The wild rice flowing in the current brings me peace and is a beautiful sight to behold.	Sewell Park (#6)
The clear water and recovering population of wild rice since before the pandemic	Sewell Park (#6)
The clearness and the wild rice	Sewell Park (#6)
The concrete banks stand out to me the most.	Sewell Park (#6)
The dedication to the naturalization of the area and preservation of endangered species is amazing and inspiring	Sewell Park (#6)

The growth of vegetation in the river is definitely striking.	Sewell Park (#6)
The large amount of vegetation in the water. The clarity of the water is also extremely nice. It's a place where it feels clean to swim.	Sewell Park (#6)
The moving water	Sewell Park (#6)
The park is busy but paying attention to the river puts me at ease.	Sewell Park (#6)
The road nearby created a lot of noise and distraction.	Sewell Park (#6)
The things that stand out most to me in this waterscape in front of me is the clearness of the water. Most water sources that I have surrounded myself with (usually throughout Texas) are murky and not as opaque as this river. It makes me feel very serene and calm as I look at the slow running that runs through it.	Sewell Park (#6)
The vast improvement in the native vegetation over the past decade.	Sewell Park (#6)
The waterscape captures the aquatic vegetation and urban landscape at the same time.	Sewell Park (#6)
The wild grass growth!	Sewell Park (#6)
There is vegetation growing in the river that looks healthy. The water is very clear and is obviously in a protected area.	Sewell Park (#6)
Today is concerning, it's very high, turbid, brown color, has a foam, and has a smell that's acidic	Sewell Park (#6)
Water necessary for diverse/strong ecosystem with wild rice, different fish species, turtles, dragonflies.	Sewell Park (#6)
We love being so close to endangered species - I would love more information about them and what the scientists are doing to help! Parking was confusing- but the river environment is so incredible.	Sewell Park (#6)
Wild rice is looking healthy. Another algae cleanup would do it well. Tetras above bridge inspire research ideas and the hope of encountering a nice pair of sunglasses or a macrobrachium is enough to justify a swim on any day.	Sewell Park (#6)
Despite a highway being right across the view, you don't really hear or notice. It's so calm and you feel a certain sense of clarity.	Ramon Lucio Park (#7)
A little oasis despite being so close to a busy highway	Ramon Lucio Park (#7)
Beauty clear water	Ramon Lucio Park (#7)
Clarity of the water	Ramon Lucio Park (#7)
Great use of our tax dollars! Ty! But could you turn off the noise from I35? :-)	Ramon Lucio Park (#7)
Green algae from fertilizer must be stopped. City ordinance to prohibit its use is the only way. Trash in the bends of river is gross. Must fine offenders thru camera evidence.	Ramon Lucio Park (#7)
Having waterscapes like this in my community makes me more invested in maintaining their health and conserving their ecosystems.	Ramon Lucio Park (#7)

How clear the water is and how it flows.	Ramon Lucio Park (#7)
How relaxing the place is compared to other parts of the water	Ramon Lucio Park (#7)
I love how natural with the overgrowth of the banks this part of the river is but the sounds of 1-35 make it less enjoyable	Ramon Lucio Park (#7)
I saw a deer and a few ducks. It was cute.	Ramon Lucio Park (#7)
It was amazing and calming	Ramon Lucio Park (#7)
It's a beautiful place. Although there's other people here, it's not too crowded, and they're playing good tunes, so that helps.	Ramon Lucio Park (#7)
Its fall & at 11am rhe water is very clear you can see dwon to the bottom	Ramon Lucio Park (#7)
Live here just walking my dog after a few days of rain nice area to walk considering all other trails are muddy. No swimming today but it's usually clean.	Ramon Lucio Park (#7)
Lots of people uprooting the aquatic plants while swimming	Ramon Lucio Park (#7)
Right off the bat there were peers of my age soaking up the sun and basking in the water. It stood out how clean the water was enough to enjoy.	Ramon Lucio Park (#7)
So blue	Ramon Lucio Park (#7)
The blueish-green hue draws the eyes and envelopes me in a sense of serenity and closeness to nature as the soft-touch breeze invites me to observe the ripples on the surface and beckons me to sit on the bridge and stare undisturbed by the more material world around me. I feel not in a bustling city but in the vastness of the natural world.	Ramon Lucio Park (#7)
The bridge and the steps. Very calming	Ramon Lucio Park (#7)
The bridge overlooking the water!	Ramon Lucio Park (#7)
The clarity of the water, and the number of people enjoying themselves with upbeat but not harsh music playing.	Ramon Lucio Park (#7)
The clear water	Ramon Lucio Park (#7)
The cold river	Ramon Lucio Park (#7)
The serenity and nature of this scene is very calming and a pleasant sight. It's easy to forget I-35 is so close and how busy the city is.	Ramon Lucio Park (#7)
The smell here is a little pungent. This is a busier area of the river and with more people comes more smells	Ramon Lucio Park (#7)

the water after the rain	Ramon Lucio Park (#7)
the water and scenery is amazing, but the amount of trash I consistently see is disheartening. so sad to see such a natural beauty disrespected	Ramon Lucio Park (#7)
The water appears to be murky and unclear today and I'm wondering if it is from the construction at Rio Vista. :-(	Ramon Lucio Park (#7)
The water clarity is amazing	Ramon Lucio Park (#7)
There is a highway in the background	Ramon Lucio Park (#7)
"There was a group of about 15 people hanging out & enjoying the river. Given that its a Tuesday afternoon, I imagine that its a regular thing. I prefer to hear the water, birds, etc, so no music, but at least their music wasn't terrible. There's a large concrete slab beneath the bridge and I don't really know what it's purpose is, but it serves as an area for this group to hangout, although it detracts from the natural beauty of the river. There is also nearby construction noise.	Ramon Lucio Park (#7)
Water is more turbid than usual, but I am filling this out on a Sunday evening.	Ramon Lucio Park (#7)
Water is murky from rain but the scene is peaceful and serene with birds chirping in the background. The only detractor is the noise from I35 (nothing we can do about that)	Ramon Lucio Park (#7)
Water is very blue and clear. Bridge was very nuce and vegetation as well. Really just a great little spot to chill at; nice and shady and relaxing	Ramon Lucio Park (#7)
Besides the road noise, the calmness and silence in this area is very relaxing.	Wilderness Park (#8)
Clean and green	Wilderness Park (#8)
Enjoying a beautiful morning at the clear, wonderful river	Wilderness Park (#8)
Its so clean and has beautiful colors and is so relaxing I love it	Wilderness Park (#8)
San Marcos river is paradise.	Wilderness Park (#8)
Secluded and nice	Wilderness Park (#8)
The clear water that seems to be clear of debris and waste.	Wilderness Park (#8)
The clearness of the water in the winter and the ease of access are a few of the things that draw me to this location	Wilderness Park (#8)
The erosion on the embankment causing 5-7 trees to fall into the water over the last 4 years right here.	Wilderness Park (#8)

The water color is gorgeous. The light catches the water really beautifully. It feels like a little unknown pocket even though itäó»s a public park. The shade is really nice and itäó»s cool to see the underwater plants and rocks. Makes me want to jump in.	Wilderness Park (#8)
the water is clean & moving & easily accessible for a quick dip.	Wilderness Park (#8)
There are lots of small pieces of trash which makes me sad. I wish people cared more to take care of this beautiful waterway which brings so much joy and recreation opportunity to students and those alike.	Wilderness Park (#8)
This part of the river feels more quiet and secluded, which is nice. Sometimes it's hard to find a good spot on the river that's not too busy.	Wilderness Park (#8)
"This waterscape is much more serene than the one before (#7). While there's still a bit of noise from construction and traffic, it's muffled off in the distance. You can hear the wind rustling the leaves and birds chirping. It was slightly less accessible than #7, but still very accessible in my book with less than 5 min walk from the car. There are people enjoying this waterscape as well, but in smaller, quieter groups of 1-2.	Wilderness Park (#8)
"Traffic noise is only thing bringing lower rating"	Wilderness Park (#8)
Water current	Wilderness Park (#8)
Water was very blue, much more than I expected. Also, park was a bit hard to get to because of construction near Sewell* *this participant was likely referring to construction at Rio Vista park	Wilderness Park (#8)
Lear water and reflection of the sun. A lot of vegetation and creatures	Spring Lake near Meadows Discovery Center (#9)
Amazement at the spring fed Lake and its incredible beauty and all the fascinating creatures that live in the lake.	Spring Lake near Meadows Discovery Center (#9)
Beautiful origin of the start of the river.	Spring Lake near Meadows Discovery Center (#9)
Calming way to start the day. Meditative.	Spring Lake near Meadows

	Discovery Center (#9)
Clear water	Spring Lake near Meadows Discovery Center (#9)
Horizon scenery	Spring Lake near Meadows Discovery Center (#9)
How clean the water is you can see fish at the bottom on the banks.	Spring Lake near Meadows Discovery Center (#9)
How clear the water is,very nice to see all thatäó»s is in the water	Spring Lake near Meadows Discovery Center (#9)
I love how you can see the algae / vegetation . Itäó»s clear enough to also see the fish and turtles in the water. I love the type of sand they use for this waterscape ! I wish it didnäó»t have a fence around it but I understand its for the environment ! I was curious though because I saw an employee throw something inside the water.	Spring Lake near Meadows Discovery Center (#9)
It feels very relaxing and idyllic. “Natural” seems like a problematic adjective, I feel like it’s a beautiful place either way but there’s clearly anthropogenic influences, like there are in any landscape in one way or another, I especially liked seeing the Nuphar plants.	Spring Lake near Meadows Discovery Center (#9)
It's an amazing natural water space with lots of opportunity to see wildlife, but it is not easily accessible because of university parking	Spring Lake near Meadows Discovery Center (#9)
Listening to all the birds and insects around the Headwaters and the occasional jumping fish. This place is good for my soul.	Spring Lake near Meadows Discovery Center (#9)
Quite different from the surrounding water areas. Itäó»s standing and gross	Spring Lake near Meadows Discovery Center (#9)
Serenity	Spring Lake near Meadows Discovery Center (#9)

Spring Lake is absolutely gorgeous. I am so grateful this resource is available to the public.	Spring Lake near Meadows Discovery Center (#9)
The beautiful skyline and serene calm water	Spring Lake near Meadows Discovery Center (#9)
The calm water stands out the most to me. And the boats!	Spring Lake near Meadows Discovery Center (#9)
The clear spring waters, the protected wetlands, the plants and animals	Spring Lake near Meadows Discovery Center (#9)
The clear water	Spring Lake near Meadows Discovery Center (#9)
The clear water and greenery below	Spring Lake near Meadows Discovery Center (#9)
The clearness of the river and the high possibility of seeing wildlife	Spring Lake near Meadows Discovery Center (#9)
The glass bottom boats stand out most to me	Spring Lake near Meadows Discovery Center (#9)
The lake	Spring Lake near Meadows Discovery Center (#9)
the super clear blue water	Spring Lake near Meadows Discovery Center (#9)
The water is blue and calm.	Spring Lake near Meadows Discovery Center (#9)
The water is very clear.	Spring Lake near Meadows

	Discovery Center (#9)
This seems to be a very clean and well balanced ecosystem.	Spring Lake near Meadows Discovery Center (#9)
Water is still, feel closer to nature, beautiful nature scape, welcoming easy to access	Spring Lake near Meadows Discovery Center (#9)
What stands out is how blue the water is in the parts that aren't covered in seaweed sludge on the surface.	Spring Lake near Meadows Discovery Center (#9)
Amazing, verdant, I eaceful, free	Meadows Center Wetland Boardwalk (#10)
Beautiful natural area with great wildlife viewing, but not easily accessible because of university parking	Meadows Center Wetland Boardwalk (#10)
Beauty of nature. I hope we can save it for future generations	Meadows Center Wetland Boardwalk (#10)
Birds and fish And flowers	Meadows Center Wetland Boardwalk (#10)
Cal, relaxing, educational, inspiring, stress reducing. Distracting due to road noise	Meadows Center Wetland Boardwalk (#10)
Great habitat for birds. Road noise. Loved the walkways.	Meadows Center Wetland Boardwalk (#10)
Healthy fish, turtles, fauna, and clear water. So thankful for it all!	Meadows Center Wetland Boardwalk (#10)
How can I get involved?	Meadows Center Wetland Boardwalk (#10)
How naturally and peaceful this place is even though we are surrounded by man made things, like cars, street etc	Meadows Center Wetland Boardwalk (#10)
I have not seen a waterscape before, very cool :)	Meadows Center Wetland Boardwalk (#10)

I live in urban San Antonio, and most of our waterways have been converted to commercialized or aesthetic spaces, taking away from the natural beauty of these areas. The Meadows Center Boardwalk was a great example of how to make a waterscape accessible to tourists while maintaining the natural landscape of it.	Meadows Center Wetland Boardwalk (#10)
I love how comfortable the wildlife is in this environment	Meadows Center Wetland Boardwalk (#10)
I love the river and I hope we can continue to protect it. It would devastate me if all this current construction and influx of people destroyed our river. Itäó»s a sacred land and we need to protect and provide for it at all costs!!	Meadows Center Wetland Boardwalk (#10)
I love the spices in reserve and the way it's taking cake of the turtles and plants.	Meadows Center Wetland Boardwalk (#10)
Itäó»s so beautiful	Meadows Center Wetland Boardwalk (#10)
Just beautiful	Meadows Center Wetland Boardwalk (#10)
Lily pads and algae	Meadows Center Wetland Boardwalk (#10)
Loud with cars and trucks. Cicadas are loud too but they belong here	Meadows Center Wetland Boardwalk (#10)
Natural, ecologically mindful	Meadows Center Wetland Boardwalk (#10)
Noise is a downfall of location, but the wetlands are calming and relaxing.	Meadows Center Wetland Boardwalk (#10)
Not polluted	Meadows Center Wetland Boardwalk (#10)
The accessibility of the boardwalk stands out most to me	Meadows Center Wetland Boardwalk (#10)
The beauty of it and easy viewing of wildlife.	Meadows Center Wetland Boardwalk (#10)
The clear water and absence of trash is remarkable. We could see the different fish nesting and a multitude of turtles. The children	Meadows Center Wetland Boardwalk (#10)

were excited to spot so many large gar and the cichlids had amazing colors that I have not seen anywhere else.	
The clear water definitely has a lot of life from underwater life to plants	Meadows Center Wetland Boardwalk (#10)
The only thing that detracts is the noise from i35	Meadows Center Wetland Boardwalk (#10)
The water lilys have taken over aquarena springs!	Meadows Center Wetland Boardwalk (#10)
The wetland like landscape	Meadows Center Wetland Boardwalk (#10)
This is one of my favorite spots. There are not a lot of people which I really enjoy. The only thing that takes away from it is the highway. (I wish it wasn't built)	Meadows Center Wetland Boardwalk (#10)
Unfortunately there is a lot of noise pollution in this area	Meadows Center Wetland Boardwalk (#10)
Very relaxing but the car sounds from nearby roads/highway diminish effect on this side of the spring lake	Meadows Center Wetland Boardwalk (#10)
Water is so clear!! Some plants and algae obscure water but thatäó»s natural for the animals. Itäó»s really clear and pretty and calm.	Meadows Center Wetland Boardwalk (#10)
What stands out most is how clear the waterscape is. Despite the depth the algae and grass allows for a very serene waterscape.	Meadows Center Wetland Boardwalk (#10)
White people used slaves to build a dam here and impede the free flow state of the river, fuck you.	Meadows Center Wetland Boardwalk (#10)
Wildlife	Meadows Center Wetland Boardwalk (#10)
Wildlife is evident but traffic noise is distracting	Meadows Center Wetland Boardwalk (#10)
Algae	Purgatory Creek at Bicentennial Park (#11)
Aquatic Plant life	Purgatory Creek at Bicentennial Park (#11)

I like the hill scape beyond the river. The area between the road and the river is a bit overgrown and could benefit from some tending to allow for better interaction with the landscape.	Purgatory Creek at Bicentennial Park (#11)
I love jogging through here with my boyfriends s well as tubing up stream	Purgatory Creek at Bicentennial Park (#11)
I really like watching the water runoff from the rain mix in with the clear(er) water.	Purgatory Creek at Bicentennial Park (#11)
It coo	Purgatory Creek at Bicentennial Park (#11)
It is just a beautiful place	Purgatory Creek at Bicentennial Park (#11)
It is still because it seems to be an offshoot and not have much flow	Purgatory Creek at Bicentennial Park (#11)
Itäó»s a little stagnant and murky.	Purgatory Creek at Bicentennial Park (#11)
Its beautiful in that a public access bridge is above it and it connects to the river which is visible from here- and is flowing & beautiful.	Purgatory Creek at Bicentennial Park (#11)
Looking great but a bunch of green algae is forming at the banks on the surface	Purgatory Creek at Bicentennial Park (#11)
Lots of large carp and Talapia today	Purgatory Creek at Bicentennial Park (#11)
Nice day	Purgatory Creek at Bicentennial Park (#11)
Other than non-native plants, this is a very lively and natural spot. Others may disagree, as it has more aquatic growth than many people prefer.	Purgatory Creek at Bicentennial Park (#11)
Sessom Creek* looks cleaner than usual. Less algae, making it more appealing	Purgatory Creek at Bicentennial Park (#11)
Some trash	Purgatory Creek at Bicentennial Park (#11)
The fish eating off the top of the water was the best.	Purgatory Creek at Bicentennial Park (#11)

The red flowers near it	Purgatory Creek at Bicentennial Park (#11)
There are many beautiful shades of green and signs if wildlife. The water is clear enough to see the bottom, rocks, fish, flora, and other detritus. There are dragon flies and other insects that are very pleasant . I do see some trash and that is why I am a little disgusted.	Purgatory Creek at Bicentennial Park (#11)
This area doesnäó»t feel very safe and the water is stagnant. The bridge is pretty but the surrounding features have large piping and it looks somewhat like a work in progress with the pipes and large cut stones. Itäó»s quite dim at night.	Purgatory Creek at Bicentennial Park (#11)
this area seems more stagnant than others. but it is gorgeous and feels very set apart from the city	Purgatory Creek at Bicentennial Park (#11)
Trash in the water and it seemed still. Otherwise very nice part of our park walk	Purgatory Creek at Bicentennial Park (#11)
Very quiet and nice. Iäó»ve seen deer at this location before and stand and look out once and a while.	Purgatory Creek at Bicentennial Park (#11)
Very quiet and peaceful, but the water seems stagnant and there is a scum on the surface.	Purgatory Creek at Bicentennial Park (#11)

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