A PATH TO NATURE CONSERVATION: THE ROLE OF MEGA TRAILS IN CONNECTING HIKERS, COMMUNITIES, AND LANDSCAPES

By

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To all who work for nature conservation in Brazil,
who have faced even greater challenges in recent years

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AT	Appalachian Trail
ATC	Appalachian Trail Conservancy
CDT	Continental Divide Trail
CDTC	Continental Divide Trail Coalition
CN	Connection to Nature
GIS	Geographic Information System
GR	Grande Randonée or Gran Recorrido
IUCN	International Union for Conservation of Nature
NP	National Park
NPS	National Park Service
NST	US National Scenic Trails
PCT	Pacific Crest Trail
PCTA	Pacific Crest Trail Association
PEB	Pro-Environmental Behavior
SoP	Sense of Place
SSP	Sense of Place Spatial Scale index
TT	Trail Town
US	United States of America
USFS	Unites States Forest Service
WTN	World Trails Network

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A PATH TO NATURE CONSERVATION: THE ROLE OF MEGA TRAILS IN CONNECTING HIKERS, COMMUNITIES, AND LANDSCAPES

By

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Trail advocates argue that trails promote contact with nature, generate economic benefits for communities, and raise awareness about the importance of nature conservation. Mega trails, thousands of kilometers long crossing different regions, could spread these benefits for extensive landscapes, protecting important ecological and climate corridors. However, these benefits are poorly supported, and few studies evaluated whether these trails show effective conservation outcomes. This study uses a multidisciplinary approach to explore these outcomes and assess if mega trails are effective conservation tools. Based on extensive surveys and interviews along the three most renowned US national scenic trails – NST (Appalachian, Pacific Crest, and Continental Divide Trail) the influence of these trails on hikers, local communities, and landscapes is investigated. Regarding hikers, the results suggest that the longer the hiking experience, the stronger and broader the sense of place. Hikers motivated by NSTs present a stronger and broader sense of place, and this difference occurs even among day hikers, suggesting a brand effect. Mega trails help create meaning for extensive landscapes, facilitating the understanding of large-scale ecological processes. However, the path leading from sense of place to support for conservation and pro-environmental behavior is complex and seems to be mediated by a connection to nature as a whole. Mega trails also influence residents' perceptions

of trail benefits. Initiatives such as trail town programs and personal experiences influence the gateway communities' residents' perceptions more than economic benefits. The engagement of hikers, communities, and other actors to protect trail corridors, scenic views, and landscapes results in legal protection, land acquisition, and other land use actions. Trails with a high level of mobilization result in greater landscape connectivity and can be large corridors to allow species range shifts in response to climate change and habitat destruction. These findings suggest some guidelines for mega trail implementation worldwide, such as investing in the association of trail brands with geographical features or ecoregions and alternate routes to reach a diverse audience. Overall, when properly managed, mega trails seem to contribute to people's awareness, community engagement, and habitat connectivity, corroborating the discourse in favor of mega trails as conservation tools.

CHAPTER 1
INTRODUCTION

Since its origin, humankind has used trails to move between different environments for basic activities such as gathering food and interacting with other groups. Initially done on foot, new means were developed for overland travel, from horses and carts to trains and cars. Trail networks were gradually replaced by railroads and highways as the main transport routes (Kaszynski, 2000). The process of industrialization and urbanization over the last 200 years heavily impacted the relationship between people and natural environments and resulted in a progressive alienation from nature (Bogert et al., 2022; Zylstra et al., 2014). In recent decades, the rise in the use of electronic devices (Pergams & Zaradic, 2006) and poorly designed dense urban settings (Hartig et al., 2014) further compound the problem by making it more difficult to experience nature. The problems arising from this alienation have been emphasized in terms such as extinction of experience (Pyle, 2003) and nature-deficit disorder (Louv, 2005). Reconnecting humans to nature is seen as strategic for mitigating the environmental crisis (Tam, 2013).

If in the past trails were present in everyone's routine, being essential for accomplishing essential tasks, today they stand out more as an opportunity for recreation and outdoor experiences. They are the most basic element to provide opportunities of contact with natural environments. Hiking is the simplest of natural outdoor activities, being accessible in terms of the skills and equipment needed (Mitten et al., 2016). It is practiced by millions of people worldwide, and because of its low speed allows closer contact with the environment. The recent restrictions and confinement measures necessitated by the COVID-19 pandemic encouraged people to seek nearby natural environments and further reinforced the growth trend of these activities (Hansen et al., 2022; Morse et al., 2020). Furthermore, there is ample evidence that nature-based experiences positively affect human health and well-being (Brymer et al., 2010;

Naidoo et al., 2019), even having a major economic impact on health spending and work productivity (Buckley et al., 2019).

Trails can be seen as facilities to access an attraction or as attractions themselves (Moore & Shafer, 2001). They can be defined by their scope (historical, cultural, nature), settings (natural, rural, urban), scale (different lengths), and surface (paved, natural, water), but they are "essentially a visible linear pathway of many varieties, which is evident on the ground and which may have at its roots an original and historical linear transport or travel function" (Timothy & Boyd, 2015, p. 4). In a more management-oriented definition, a trail is "a linear corridor, on land or water, with protected status and public access for recreation or transportation" (American Trails, 1990, p.2).

Regarding the scale, trails can vary from a few meters to thousands of kilometers (Timothy & Boyd, 2015). The widely used term long-distance trail (Amerson et al., 2020; Moore & Barthlow, 1998; Stender et al., 2018) sounds intuitive. However, it is subjective and encompasses everything from trails of only tens of kilometers (Cook, 2008; Sarmiento et al., 2002) to thousands of kilometers long that require months to be completed (Fondren & Brinkman, 2022). Long trails often receive designations such as regional, national, or transnational (Timothy & Boyd, 2015). However, these classifications are unrelated to length and may also vary with the size of each country. Timothy & Boyd (2015) used the term mega trail to describe paths thousands of kilometers long crossing more than one region or country. Seeking a more objective definition, here I adopt the term mega trail for trails longer than a thousand kilometers, requiring at least 30 days to be thru-hiked, and crossing different ecoregions, biomes, or political borders, such as regions or countries.

1.1 US National Scenic Trails

Mega trails aimed at outdoor experiences have the Appalachian Trail as a global landmark. The proposal presented by forester Benton MacKaye (1921) started from the idea of connecting existing trails in the White Mountains (New Hampshire) and the Green Mountains (Vermont). The trail that would eventually cross the entire Appalachian Mountains, some 3,500 km, was part of a regional planning vision. Socialist-inspired (L. Anderson, 2002), the paper questioned the little paid rest time of workers, highlighted the importance of contact with nature for health, and proposed autonomous communities along the trail to create rural jobs, in an attempt to reverse the intense urbanization and promote local development in settlements with limited numbers of people (MacKaye, 1921).

These early trails were managed voluntarily by mountaineering clubs such as the Appalachian Mountain Club and the Green Mountain Club. Led by MacKaye, these and other groups founded the Appalachian Trail Conference in 1925 (King et al., 2000). Propelled by Civilian Conservation Corps, work fronts created to generate jobs during the Great Recession, the trail was completed in 1937 (Mittlefehldt, 2013). In 1948, Earl Shaffer was the first to hike the entire AT in a single journey (King et al., 2000). Since then, the number of people attempting to thru-hike the AT exceeds 4,000 per season, and an estimated three million people visit at least one AT section annualy (ATC, 2023b).

Also in the 1930s, the Pacific Crest Trail, proposed by Clinton Clarke, began to be implemented (Elkinton et al., 2008). Traveling 4,265 km near the US Western Coast, between the borders with Mexico and Canada, the PCT crosses seven national parks, including the renowned Yosemite, Crater Lake, and Mount Rainier (Goldenberg & Soule, 2014). The trail was thru-hiked for the first time in 1970 by Eric Ryback (Livermore, 2014) and considered fully

implemented in 1993 (Wilson & Belote, 2022). About 800 people thru-hike the PCT annually (PCTA, 2023).

In 1968, AT and PCT were recognized as National Scenic Trails (NSTs) by the National Trail System Act, which also created other categories, such as historical and recreation trails, with the objective of providing "simple, inexpensive recreation opportunities for all people by having an abundance of trails for walking, cycling, and horseback riding near home, as well as providing some major historic and scenic interstate trails of national significance" (Elkinton et al., 2008, p. 1). Another 14 trails were indicated for studies and future inclusion in the system. Among them is the Continental Divide Trail, designated in 1978 (Wilson & Belote, 2022). Still considered unfinished due to tracts along highways, the CDT is 4,873 km-long (Elkinton et al., 2008). Just over 150 people successfully thru-hike the CDT annually, and this number is increasing (CDTC, 2023b). These three mega trails cross the United States from north to south, following great mountain ranges. They are considered "The Triple Crown of Hiking" in the US (Wilson & Belote, 2022) and are on the wish list of many hikers worldwide.

In 2023, the US National Trail System has 11 national scenic trails, nine longer than 1,000 km, which would fit this definition of mega trails. In addition to the "Triple Crown" already mentioned, they are North Country (6,760 km, designated in 1980), Ice Age (1,600 km, 1980), Potomac Heritage (1,770 km, 1983), Florida (2,250 km, 1983), Arizona (1,300 km, 2009), and Pacific Northwest (1,930 km, 2009). Some of these trails have yet to be fully implemented, such as the North Country trail, which has about 50% of its route open for public use (NPS, 2023b).

1.2 Mega Trails Worldwide

Inspired by the AT example, indigenous paths, Roman roads, historical routes, and nature trails have been connected and structured as mega trails worldwide for the past 100 years (Stender et al., 2018). In Europe, Hungary began implementing the Országos Kéktúra, meaning Blue Trail due to to the color used in signs, in 1938 (Molnár, 2022). It crosses 1,128 km between the borders of Austria and Slovakia, passing through Budapest. Networks of ancient Roman and medieval roads and park trails in France and Spain are recognized by the mountain sports national federations and named *Grande Randonée* or *Gran Recorrido* — GR, meaning long trail. It is possible to follow the entire Pyrenees mountain range from the Mediterranean to the Atlantic coast on GR–10, on the French side, or the GR–11 on the Spanish side (Mauri, 1994; Siroux, 1968). In 1969, many of these trails were connected in an international network with 12 mega trails called the *E-paths*, totaling 55,000 kilometers in 22 countries (ERA, 2022). The famous Camino de Santiago de Compostela, a pilgrimage route for centuries connecting different paths between France and Spain that today is one of the most popular mega trails worldwide, is the GR–65 and part of the E-3 (Gallegos et al., 2005). The Bechyne Declaration, from the European Ramblers Association, establishes criteria for integrating E-paths and other trails but values historic trails and previous initiatives and recognizes different signaling systems as cultural heritage (ERA, 2004).

In New Zealand, many overnight trails known as the Great Walks, such as the Milford Track and the Tongariro Alpine Crossing, are connected by the Te Araroa Trail. The 3,000 km-long trail traverses the North and South Islands. Proposed in 1967 (Chapple, 2001), the trail was officially opened in 2011 and is thru-hiked by more than 1,000 people annually (TAT, 2019). In Australia, there are mega trails for hikers, bikers, and horse riders. The longest is the National

Trail, proposed in 1972, is 5,330 km long following the Eastern Coast but only a few hikers hiked the entire trail (BNT, 2023). The Bibbulmun Track, in the Southwest, is a 1,000 km-long trail proposed in 1972 and thru-hiked by more than 100 people per year (BTF, 2023). In Japan, the Tokai Nature Trail was proposed in 1969 (Oi, 1969) and is 1,697 km long. Soon after, in 1970, the 2,932 km Kyushu Nature Trail was created. Today, Japan has a network of mega trails totaling almost 28,000 km (TNT, 2023).

In South America, mega trails are still in their infancy. The Sendero de Chile, with 6500 km following the Andes from north to south of the country, began to be implemented in 2000 but stopped at about 1,500 km broken up into many sections. Due to difficulties with land tenure and other issues, the project today focuses on promoting contact with nature, but without the intention of building a continuous foot-track (FSC, 2023). In Brazil, The Atlantic Forest Trail was proposed in 2012, following the Southern Atlantic Coast and the Serra do Mar Mountain Range. The 4,270 km-long trail was conceived as an ecological corridor to reconnect forest fragments in one of the most threatened biodiversity hotspots (Grelle et al., 2021; Viveiros de Castro et al., 2021). In 2018, the Brazilian Trail Network was created to connect several existing long-distance trails (Gonçalves, 2021). All these initiatives motivated the creation of the World Trails Network in 2012. This organization brings trail associations, advocates, hikers, and researchers to promote creating, enhancing, and protecting outstanding trail experiences (WTN, 2023).

1.3 Mega Trails as Conservation Tools

Advocates argue that trails are conservation tools by promoting closer contact with nature, raising awareness about the importance of nature conservation, protecting important ecological corridors, and generating economic benefits for small communities, (ATC, 2023a;

Cerveny et al., 2020). If the pioneer Benton Mackaye already mentioned the importance of contact with nature and the AT as a regional development strategy (MacKaye, 1921), the perception of the role of trail corridors in connecting natural areas emerged much later (ATC, 2023a, 1964a, 1975). The Island Biogeography theory (MacArthur & Wilson, 1967) proposes that the size of islands and their isolation determines the species richness in a given area. Its application to forest patches in landscapes fragmented by human activities drew attention to the importance of habitat connectivity and ecological corridors to conserve forest-dwelling species (Saunders & Hobbs, 1991; Taylor et al., 1993).

The growing awareness and concern about climate change have drawn the attention of wildlife biologists to the potential of mega trails as climate corridors (Hunter Jr. et al., 1988). Trails with a predominant poleward orientation, such as the US Triple Crown and the Atlantic Forest Trail, can allow species range shifts in response to climate change (Carroll et al., 2018; Grelle et al., 2021). This view of mega trails as conservation tools has gained momentum in recent years. In 2000, the ATC proposed the AT Mega Transect, an initiative involving researchers and citizen scientists to monitor the AT corridor (Dufour & Crisfield, 2008), which evolved into the AT Landscape Partnership (Igelman, 2017b). In 2019, the IUCN created the Trails and Conservation Working Group to discuss long-distance trails as conservation tools (WCPA-IUCN, 2023), and in 2022, the World Trails Network created the Trails & Conservation Task Team (WTN, 2023).

Despite the growing attention, few studies have evaluated whether mega trails show effective conservation outcomes, considering the effects on users, local communities, and landscape connectivity. Much of the accumulated knowledge is empirical, based only on claims by trail advocates (Decker, 2020; Godtman Kling et al., 2017; Moore & Barthlow, 1998). Most

studies that address the effects of trails on the environment focus on negative impacts at a local scale, such as trail soil erosion or compaction, trail widening, or avoidance by animals (Godtman Kling et al., 2017; Kays et al., 2017; Marion et al., 2016). Some studies assess environmental integrity (McKinley et al., 2019) or connectivity (Wilson & Belote, 2022) along mega trails but only report the current situation without evaluating the influence of the trails themselves on the degree of conservation of these landscapes. Filling this knowledge gap about the benefits and role of mega trails as large-scale conservation tools is important to assess the extent to which they are helpful conservation strategies and to guide investments.

1.4 Conceptual Framework and General Research Questions

The present investigation explores the contributions of mega trails to nature conservation, seeking to answer if they are a valid strategy to promote the conservation of extensive landscapes. Three elements stand out in the relationship between mega trail and nature conservation: trail users, local communities, and the natural environments (Figure 1-1). These elements of highly interdependent and generate a variety of feedback that impact society and ecosystems at a variety of scales, and that will be analyzed and discussed in the following chapters.

Natural environments are the setting where the trails are implemented and provide several direct and indirect benefits for users and residents, the so-called ecosystem services (Huynh et al., 2022). This study focuses on cultural ecosystem services, represented by opportunities for recreation and leisure, personal development, social relations, and aesthetic experiences (Huynh et al., 2022). Users and, mainly, residents are also favored by provisioning services (water, wood, etc.), regulating services (climate regulation, water purification), and supporting services (soil formation, nutrient cycling, etc.) (Millennium Ecosystem Assessment, 2005).

Through recreational opportunities in natural environments, users can develop a sense of place and support landscape conservation (Cerveny et al., 2020). Hikers also spend money on products and services near the trail, generating income and economic opportunities in so-called gateway communities, small towns near major tourist attractions (Stoker et al., 2021). These communities, in turn, are at the same time beneficiaries of these economic activities and often the creators of these routes since most of them originates from historical use by local people (Moore & Shafer, 2001). The social exchange theory (Emerson, 1976) proposes that tourism's positive and negative impacts influence residents' perception of this activity. According to the stakeholder theory (Honey, 1999), economic incentives from tourism induce local people to adopt pro-environmental behavior, conserving lands and supporting their conservation (Figure 1-1).

Some of these subjects have already been evaluated for trails, but not in an integrated way and never focusing on mega trails. Due to their scale, these trails have a particular dynamic, promoting experiences ranging from a few hours to several months and reaching different audiences (Fondren & Brinkman, 2022). The economic and social effects are also dispersed across dozens of gateway communities, which on the one hand, mitigates known social problems in these towns (McMahon, 1999; Stoker et al., 2021) and, on the other hand, limits their economic benefits. It needs to be clarified to what extent experiences on the mega trails affect the perception of the landscape by hikers and local communities and whether specific actions to protect the trail corridor and the visitor experience throughout history have had significant effects on landscape connectivity.

From this conceptual framework, in this study, I explore three general research questions combining different approaches:

1. Do experiences on mega trails influence hikers' relationship with these environments and landscapes (e.g., sense of place) and generate pro-environmental behaviors?
2. Do mega trails influence local communities' economies, identities, and relationships with natural environments?
3. Do mega trails, engagement, and processes around them affect the conservation of their corridors and influence landscape connectivity?

1.5 Dissertation Structure

Given its multidimensional matter, nature conservation is influenced by physical, ecological, and socioeconomical aspects (Cumming et al., 2015; Ditmer et al., 2022). This study uses a mix of socioeconomic and ecological approaches, combining qualitative and quantitative data from hikers and residents with GIS and historical data, to answer the general research questions. This investigation addresses the three most renowned US National Scenic Trails (AT, PCT, and CDT), known as "the Triple Crown of Hiking." I drove through the three trails, covering about 30,000 km and visiting dozens of trailheads and trail towns, and hiked about 300 km to get a general perception and evaluation of the trails, the landscapes, and the people related to them. In six sections of each trail, I interviewed hikers (602 total), and in 10 towns I interviewed local key actors, as well as trail managers from the US Forest Service and the National Park Service and the non-profits that co-manage each of the trails (total 52). I also visited the headquarters of the Appalachian Trail Conservancy (Harpers Ferry, WV) and the AT Museum (Gardners, PA) to consult documents and staff and identify places where mobilization and direct intervention to conserve the trail corridor occurred, which were visited as much as possible.

Chapter 2 discusses how experiences on mega trails are related to the sense of place (Williams & Stewart, 1998) and its spatial scale. Based on 602 on-site interviews with hikers, I used structured questionnaires with open questions, five point scales heat maps to investigate

whether direct experiences in mega trails create a sense of place and place meaning (Manzo, 2005) for large landscapes, bringing landscapes into people's perceptible realms (Gobster et al., 2007). If so, mega trails could play a role in large landscape conservation. Going further, I discuss whether this meaning can be transferred to similar areas and reach day visitors through a brand effect (Swait & Erdem, 2007), extending the effects to a much wider audience than long-distance hikers.

In Chapter 3, I continue to follow the path between experience and civic actions in favor of nature conservation, exploring how the sense of place is related to several pro-environmental behaviors (Steg & Vlek, 2009). Using the same survey, structural equation modeling (Nunnaly & Bernstein, 1994) was used to test whether there is a direct relationship between these two constructs or whether a connection to nature (Tam, 2013) is a partial or full mediator between them and some of their subdimensions. Since pro-environmental behaviors include a wide range of actions (Larson et al., 2015), the model assesses the relationships between sense of place and connection to nature and different behavior sets, such as place-related behavior intentions and actual daily behaviors. Together, chapters 2 and 3 seek to cover the path from mega trail experience to pro-environmental behaviors and conservation support.

Chapter 4 focuses on the relationship between local communities and trails. Based on the social exchange theory, I use semi-structured interviews with 47 local key actors (*sensu* Ap, 1992) to assess their perceptions of the importance of trails to the local economy and identity, and eventual negative impacts. Using qualitative comparative analysis (Rihoux & Ragin, 2009), I identify patterns and the factors that best explain the prevailing perception in each community. The influence of participation in Trail Town programs (Camp, 2020), the measured economic importance of tourism, and personal experiences with the trail on the actors' perceptions are

analyzed to see to what extent perceptions are influenced by objective or subjective factors. In the discussion, I also explore some emerging themes related to the perception about hikers, conflicts, and residents' self-esteem and compare the contexts of different trails and trail town programs seeking to guide actions of management and engagement.

Chapter 5 discusses the role of mega trails as ecological corridors, based on a case study on the Appalachian Trail. It evaluates to what extent civic actions of users and public managers to conserve the trail corridor and conservationist concerns incorporated into trail management positively affects connectivity. The chapter includes a review of the collection of magazines published since 1939 by the Appalachian Trail Conservancy (ATC) to identify actions in favor of trail and landscape conservation, relevant time frames, and incorporation of the conservationist discourse by the ATC. Based on relevant time frames, such as the National Trail System Act (1968), GIS analysis is used to compare the landscape resistance (R. Fletcher & Fortin, 2018) along the corridor in the past with current times. Based on before-after-control-intervention analysis, I assess whether the AT significantly influenced the scenario. Corridors with different widths around the AT are compared to determine the extent of possible trail effects on the landscape.

Finally, I conclude the dissertation by combining the key findings from the different chapters. This chapter focuses on answering the general question about the contribution of mega trails to nature conservation, discusses their potential and limitations, and identifies guidelines for making mega trails worldwide more effective as conservation tools.

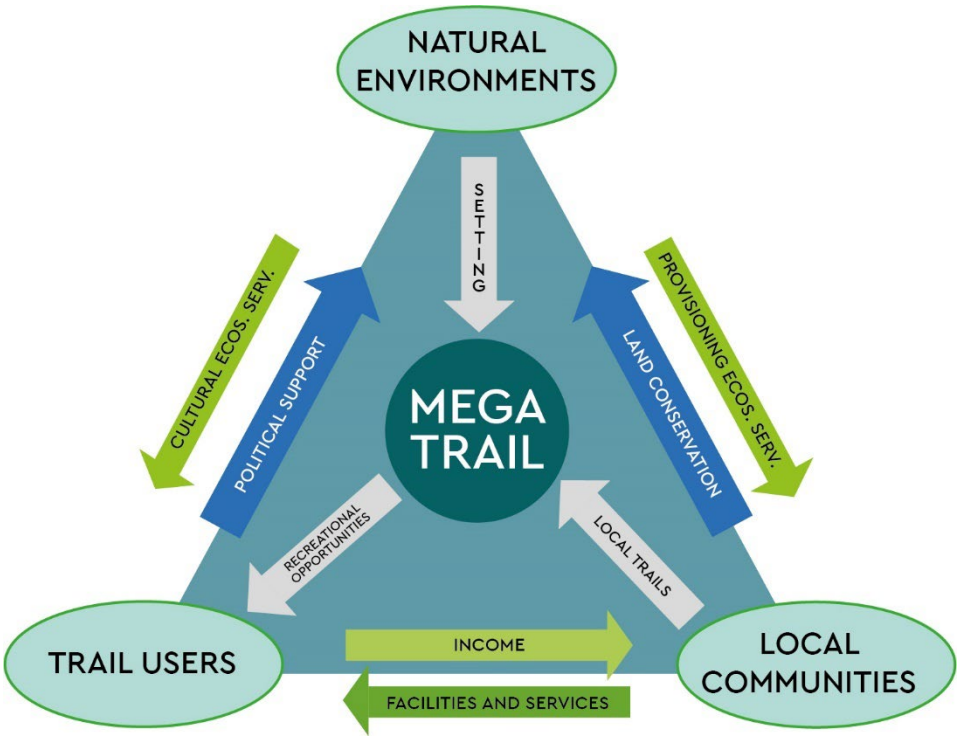


Figure 1-1. Conceptual framework showing the relationships between natural environments, trail users, and local communities around mega trails.

CHAPTER 2
THE ROLE OF MEGA TRAILS IN CREATING MEANING AND SENSE OF PLACE TO CONSERVE LARGE LANDSCAPES

Industrialization and urbanization over the last 200 years resulted in progressive alienation from nature, and many authors associate this “human/nature hyperseparation” with the environmental crisis we face (Bogert et al., 2022; Zylstra et al., 2014). Even with the projected scenario of climate change (Shukla et al., 2019) and severe loss of biodiversity (Maxwell et al., 2016), the efforts and resources globally committed to nature conservation are limited (Butchart et al., 2010; McCarthy et al., 2012). Generating awareness and obtaining social support for nature conservation is a valuable strategy to face this crisis (Marvier & Wong, 2012; J. R. Miller, 2005).

Although the process that leads a person to adopt pro-environmental behaviors is complex, several authors highlight the development of a meaningful connection to natural areas - a sense of place - as one of its critical elements (*e.g.*, Vorkinn & Riese, 2001; Walker & Ryan, 2008). Williams & Stewart (1998) define sense of place as "a collection of meanings, beliefs, symbols, values, and feelings that individuals or groups associate with a particular locality" (p.19). Creating meaning for a locality can be an individual or collective process and be influenced by childhood and youth experiences, residence, or use time, among other factors (Altman & Low, 1992; Lewicka, 2011). Although the creation of meaning for a place is more frequently based on direct experiences (Moore & Graefe, 1994; Proshansky & Fabian, 1987), this process can also occur in the symbolic field, through storytelling, history, religion, and other cultural linkages (Low, 1992).

Regarding nature conservation, it seems possible to use the symbolic dimension to reinforce the sense of place and create meaning for lands (Manzo, 2005) intended to be

protected. Furthermore, this meaning can be transferred to similar areas, including sites one has never visited (Williams et al., 1992). National Park, for instance, is a brand that conveys the idea of a natural area with unspoiled landscapes and representative ecosystems, which provides opportunities for public nature appreciation (NSW-NPWS, 2023). The designation of an area as a national park instead of other protected area categories seems to result in higher visitation (Reinius & Fredman, 2007; Weiler & Seidl, 2004), suggesting a symbolic meaning for this nomenclature and an interest in visiting or protecting these areas regardless of a previous direct experience.

If sense of place is an understandable concept at a site level, it is more difficult to be perceived at a larger or landscape scale (Roe, 2012), which makes developing strategies to promote conservation at this scale challenging (Cantrill & Senecah, 2001; Scarlett & McKinney, 2016). Gobster *et al.* (2007) use the term *perceptible realm* to highlight the people's difficulty in perceiving phenomena that occur at scales beyond their direct experience. However, people who travel farther tend to develop a sense of belonging to larger territorial units (Gustafson, 2009). Ardoin (2014) investigated the scale of place and found that around 20% of respondents indicated that their place connections occurred at an ecoregional scale. Creating meaning for large landscapes to be perceived as places to which one can be connected may be a way to extend the perceptible realm.

Hiking is the simplest of natural outdoor activities, being relatively accessible in terms of the skills and equipment needed (Mitten et al., 2016). It is practiced by millions of people worldwide, and because of its low speed allows closer contact with the environment. Hikers may spend an afternoon in the woods or many weeks on a long journey. Mega trails can provide both experiences and have been developed worldwide for the past 100 years (Stender et al., 2018).

They are seen as a strategy to promote outdoor recreation opportunities, but also local development and nature conservation (Cerveny et al., 2020; MacKaye, 1921). In the US, the national scenic trails (NST) were recognized by Congress in 1968 (Elkinton et al., 2008).

By associating the ideas of developing sense of place for large landscapes, creating brands that give meaning to them, and the role played by experiences in nature, we can hypothesize that NSTs have the potential to generate meaning and sense of place for large landscapes. To what extent are these mega trails able to generate place meaning and sense of place? And at what scale? Which audiences are these trails able to influence? What are the implications for nature conservation? This study investigates the sense of place and its spatial scale among hikers on the three NSTs forming the *triple crown of hiking* in the US (Wilson & Belote, 2022) and discusses their potential to promote conservation at large landscape scales.

2.1 Background and Hypotheses

The discussion about sense of place necessarily involves the concept of place itself. (Cresswell, 2009) defines *place* as "a meaningful site that combines location, locale, and sense of place" (p.1) or simply, place is any meaningful location (Cresswell, 2004). Tuan (1975) defines *place* as "a center of meaning constructed by experience" (p.152). Ardoin (2006) points out that sense of place is a construct whose definition can vary enormously among different fields. For her, sense of place refers to the relationship people develop with places in their multiple spatial and meaning dimensions, such as psychological, biophysical, sociocultural, political, and economic. For Jorgensen & Stedman (2001), it is a construct formed by three dimensions: place identity (cognition, beliefs, and perceptions), place attachment (affective and emotional connection), and place dependence (behavioral advantage). They consider sense of place the

broadest term among the many concepts describing the relationship between people and spatial settings.

In keeping with Tuan's (1975) definition of place, many authors highlight the experience as the principal mean of creating sense of place. Childhood experiences (Wilson, 1997) and permanence in ancestral lands (Hay, 1998) are two ways of forging sense of place. Among several other strategies, recreational experiences generate sense of place for natural environments. Many authors reported positive relationships between recreational use time and sense of place (e.g., Kil et al., 2010; Williams & Vaske, 2003). Furthermore, many studies suggest this may be more likely with opportunities for solitude or recreating in less developed areas (Kyle *et al.* 2004; Warzecha and Lime 2001; Wynveen *et al.* 2020). On the other hand, its relationships with activity involvement, duration, and specialization can show contradictory results and remain unclear (Budruk & Wilhelm Stanis, 2013; Farnum et al., 2005; Kyle et al., 2003).

Millar & Millar (1996) argue that direct experiences generate more affective reactions, while indirect experiences produce more cognitive reactions. Supporting this idea, when exposed to pictures of personally meaningful places, volunteers showed neurological responses in the amygdala, associated with emotion processing (Gatersleben et al., 2020). On the other hand, Proshansky et al. (1983) argue that this multidimensional construct includes "a complex cognitive structure which is characterized by a host of attitudes, values, thoughts, beliefs, meanings and behavior tendencies that go well beyond just emotional attachments and belonging to particular places" (p.62). Low (1992) suggests that sense of place can be created in the symbolic field, such as the concept of a country. Most people do not physically experience a

whole country, moving only through restricted regions, but even so, most of them have a well-developed concept of a nation (Low, 1992).

Success in creating meaning for extensive areas also begs the question of the requirements of spatial scale for what can be called a place. Shamai (1991) argues that "the word place is dimensionless; it can apply to any scale, from an individual home to any part of the globe" (p.347). Place, therefore, can range from a small scale, like a room, to gigantic, like a continent (Low & Altman, 1992). A single person can even have sense of place on different spatial scales in a concentric structure that expands from local to global (Shamai, 1991).

Despite the potential conflation between place and space, methods to spatialize sense of place have received limited attention. Tools to address its geographic dimensions (Dixon & Durrheim, 2000) and integrate data into land use and conservation planning are needed (Brown & Raymond, 2007). Williams & Roggenbuck (1989) developed a framework to explore the landscape meaning but highlighted the difficulty of defining the appropriate spatial scale. Brown & Raymond (2007) used a map-based place attachment approach to identify special places and investigate landscape values. Black & Liljeblad (2006) mapped place attachment by asking residents to locate special areas in maps and relating them to values mentioned in structured interviews. Ardoin (2014) used maps at different scales and asked residents to show "their place" to identify the extent of sense of place in three ecoregions. Despite efforts and advances, representing spatially social constructs that relate people to nature is a relevant research issue (Restall & Conrad, 2015).

Still in the symbolic field, Proshansky (1978) hypothesized that people can develop bonds that go beyond a specific location to include a certain type of place, such as urban areas in general. Williams et al. (1992) found that outdoor recreationists can develop sense of place for a

type of natural area, in their case wilderness areas, what they called wilderness attachment. Some authors refer to this "generic sense of place" as sense of belonging, arguing that it is a better term since it is not place-specific (Jones et al., 2000), also close to the concept of connection to nature (Tam, 2013). Despite some controversy about terms, several studies reporting effects of designation as national parks or world heritage sites on visitor numbers reinforce this idea (Buckley, 2004; Weiler & Seidl, 2004). The influence of a name or brand in choosing a product or destination can be called a *brand effect* (Swait & Erdem, 2007). Natural site brands have an emotional component consisting of all the thoughts, feelings, associations, and experiences a person had in places with a given brand, reinforcing the association between place brand and sense of place (King et al., 2012). Indeed, Kyle *et al.* (2004) reported that highly place-attached hikers indicated the Appalachian Trail as the "motivation to be there" more frequently than those with a low attachment level. According to them, some hikers seemed to regard that trail as "somewhat akin to a recognizable brand" (p. 74).

Based on the importance of experiences in nature and in the possibility of expanding the sense of place to different scales or even transferring that meaning to other places through the brand effect, we developed questions and tested hypotheses that explore the relationships between experiences on NSTs, sense of place, and the spatial scale of sense of place:

- Considering the importance of direct experience, are the duration and length of a person's hike associated with that person's sense of place and the spatial scale of that person's sense of place?

  H1: As hike duration increases, the individuals' sense of place and its spatial scale also increase.

- Considering the hypothesized potential of mega trails to create meaning for extensive landscapes and the trail brand effect, is the motivation for hiking on a trail "because of the NST" associated with sense of place and its spatial scale?

  H2: Hikers motivated by the NSTs present a stronger sense of place and on a broader spatial scale than those in search of local attractions.

- Considering the reported relationship between opportunities for solitude and sense of place, is the intensity of trail use associated with sense of place and its spatial scale?

  H3: Hikers in moderately used trail sections present a stronger sense of place and on a broader spatial scale than those in popular trail sections.

2.2 Methods

2.2.1 Study Areas

This study comprises a survey with hikers along the three most renowned NSTs in the US, the *triple crown of hiking* (Wilson & Belote, 2022): the Appalachian Trail, the Pacific Crest Trail, and the Continental Divide Trail (Figure 2-1).

The Appalachian Trail (AT) is a 3,524-km long trail that follows the Appalachian Mountains in eastern US. Proposed in 1921 (MacKaye, 1921), wholly implemented in 1937, and first thru-hiked in 1948 (NPS, 2015), the AT was the pioneer mega trail in the US, and was recognized as an NST in 1968 (Elkinton et al., 2008). The trail crosses 14 densely populated US States, which are home to more than 100 million people (WPR, 2023). The AT is legally protected by a roughly 300 m-wide corridor and runs through a region subjected to intense exploitation for centuries (McKinley et al., 2019) and continues to suffer from forest clearing in recent decades (Potere et al., 2007). The trail crosses two national parks, eight national forests, and other protected areas (NPS, 2015). The trail has more than 99% of its corridor in public lands and is managed by the US National Park Service (NPS) in partnership with the Appalachian Trail Conservancy and the US Forest Service (USFS). Annually, more than 1,000 people thru-hike the AT, and an estimated three million people visit some section of the trail (ATC, 2023b).

The Pacific Crest Trail (PCT) is a 4,265-km long trail that extends across the Sierra Nevada and Cascade mountain ranges, from the Mexican to Canadian international borders,

including three US states that are home to 50 million people (WPR, 2023). The PCT was first proposed in the 1930s by Clinton Clarke (Elkinton et al., 2008) and, along with the AT, was recognized in the National Trail System Act in 1968. It was fully implemented in 1993 (Wilson & Belote, 2022). The trail runs through desert areas and mountains, including seven national parks, three national monuments, 24 national forests, and 33 federal wilderness areas (Goldenberg & Soule, 2014). It mostly crosses public lands with a relatively well-protected corridor (Wilson & Belote, 2022). The USFS manages the trail with the PCT Association, the NPS, and the Bureau of Land Management (BLM). About 800 people thru-hike the PCT annually, with a record of 1,190 in 2018 (PCTA, 2023).

The Continental Divide Trail (CDT) is a 4,873-km long trail that runs through the Rocky Mountain Range in the USA, between the international borders with Mexico and Canada, crossing five sparsely populated US states that are home to 12 million people (WPR, 2023). The CDT was designated as an NST in 1978 but is not yet fully implemented due to stretches along highways (Wilson & Belote, 2022). As its name suggests, the CDT follows the geographic continental divide, separating the Atlantic and Pacific Ocean watersheds. From the deserts of New Mexico to the glaciers in Montana, the CDT crosses 27 wilderness areas and three national parks in a well-conserved corridor (Wilson & Belote, 2022), which predominantly crosses public lands. The USFS manages the trail in partnership with the CDT Coalition, the NPS, and BLM. Just over 100 people successfully thru-hike the CDT annually, but this number is increasing (CDTC, 2023b).

2.2.2 Participants and Data Collection

The sampling consisted of an on-trail intercept survey in 18 sections, six along each trail (AT from July to August 2021; CDT and PCT from May to August 2022). Paired popular and

moderately used sections were spread across each trail's southern, central, and northern portions, with a sample of between 30 and 40 people in each section (Figure 2-1). Expert opinions were used to select sections, and their popularity was gauged using the *AllTrails* app categories based on data generated by its users. The first adult hiker from each group passing through the interview point was approached for the survey, and only one person each group was interviewed.

The survey was conducted in-person by the first author only to ensure consistency in survey administration. A tablet with Qualtrics offline survey tool was used to record the answers. The questionnaire included open and close ended questions related to the hike duration, previous experience in long-distance trails, motivation in choosing the trail, as well as heatmaps and Likert scales used to assess the sense of place. The questionnaires were anonymous, but demographic data were collected to support analysis and discussion.

2.2.3 Procedures and Measurements

2.2.3.1 Sense of place

The sense of place was measured using a 5-point Likert scale with items based on Williams & Roggenbuck (1989) and Ardoin et al. (2012), with word adaptations for the trail context. After a literature review to ensure content validity, 11 initial items were used in the 2021 survey (AT). The 2022 data (PCT and CDT) were used as a holdout sample to validate the item selection. The internal consistency was tested using Cronbach's Alpha and corrected item-total correlation. If the exclusion of items improved the Cronbach's Alpha or the item-total correlation was < 0.40, the worst item was excluded until all met the criteria (Vaske, 2019). The AT data with all items showed acceptable internal consistency (Cronbach's Alpha = 0.83), but items 7 and 9 were excluded because of low correlations (Table 2-1). The final Cronbach's Alpha for the AT sample was 0.89, and all the corrected item-total correlations fell within the acceptable standard,

ranging from r = 0.505 to 0.783. The PCT and CDT data confirmed the exclusion of items 7 and 9, and item 11 had an item-total correlation < 0.40 (r = 0.363), but its exclusion would not result in a higher Cronbach's Alpha, having been maintained in the scale. The Cronbach's Alpha for the entire dataset was 0.88, and all held items had corrected item-total correlation > 0.40 (Table 2-1). The final Sense of Place score (SoP) used in analyses was the mean value of the nine items, which could range from 1 to 5.

2.2.3.2 Sense of place spatial scale

The Qualtrics heatmaps tool was used to assess the spatial scale of sense of place. This tool has been successfully used and has shown good engagement in communication (Chen-Sankey et al., 2022; Gorham et al., 2016), psychology (Cain et al., 2019), and education (Rysavy et al., 2018) studies, but as far as we know, its use to study sense of place is unprecedented. Hikers were asked to choose up to 10 sites that were especially important by tapping the tablet with a map showing a vast region around each NST (the Eastern or Western USA). The spatial scale of sense of place was characterized by the Euclidean distance between the extreme points chosen by each hiker equalized by the maximum possible distance on each trail, composing a Sense of Place Spatial Scale index (SSP) from 0 to 1 (1 representing the entire trail length). A previous question with a local-scale map was used to train respondents in using the map tool. Only points inside a 50-km buffer around the trail were considered, discarding outliers.

Since it is a new approach, a second method was tested in the AT to either confirm the findings or be an alternative. It was based on Cuba & Hummon (1993) approach to identify the *locus* of place identity: dwelling, community, or region. Each interviewee was asked: “thinking in your connection with these places, please tell me which of these places is more important for you, ranking in order of importance: the local attraction, the local protected area, the outstanding

geographic feature of the region (*e.g.*, a local mountain range), the state, and the NST. The inverted position of the NST was used as an index of the spatial scale amplitude. Spearman's correlation showed a significant relationship between the methods (rho = 0.389; $p < 0.01$). The heatmap method was chosen because it is more visual, effectively spatializes the data, and engaged respondents.

2.2.4 Data Analysis

We evaluated the relationship between both the Sense of Place Score and the Spatial Scale of Sense of Place Index and each of three variables: the hike duration, hiker motivation, and section popularity. Comparisons were performed with the entire sample, representing the NST hikers' population, and by trail, aiming to identify and discuss similarities and differences. Subsample analyses were performed when relevant to explore specific points in depth.

The hike duration was divided into three categories: day, multi-day, and long-distance. Day hikers were those who started and ended their hike on the same day. Multi-day hikers include people hiking for several days without plans to complete the trail. Long-distance hikers include those who plan to complete one or more NSTs – i.e., those who are thru-hiking an NST or have thru-hiked another Triple Crown trail before and section-hikers, following the classification of Fondren & Brinkman (2022). A set of questions was used to define whether the respondent chose that trail section motivated by the NST. First, it was asked, "how do you refer to this trail?" and spontaneous mentions of the NST name were recorded. Later, it was asked if they had already referred to that section as part of the NST and how important the NST was in the trail choice compared to the main local attraction, the local protected area, or the convenience of location. As for the section popularity, the previous classification of use intensity defined in the sampling design was used, separating popular and moderately used sections.

Analyses of variance (One-way ANOVA and t-tests) using SPSS 26.0 were performed to test for differences between groups. Welch's ANOVA test was used when equal variances could not be assumed. Homogeneity of variances were verified using Levene's test. Since differences between means can be statistically significant but not necessarily relevant, especially for large samples, the effect size was estimated using the Eta index for multiple comparisons and Cohen's d index for pairwise comparisons, also adjusted for unequal variances when necessary (Vaske, 2019). The effect sizes were classified following Cohen's guidelines adapted by Vaske et al. (2002), with minimal, typical, and substantial effect sizes (Table 2-3). Because the data had unequal sample sizes, a bootstrapping method with 1,000 repetitions and bias-corrected and accelerated (BCa) correction was used to estimate the standard errors and confidence intervals (95%). Bonferroni test was used for pairwise comparisons, being replaced by Games-Howell test when equal variances could not be assumed (Shingala & Rajyaguru, 2015).

2.3 Results

2.3.1 Profile of Respondents

On the AT, 226 hikers were interviewed: 141 day hikers, 49 multi-day hikers, and 36 long-distance hikers (Table 2-2). The response rate was not systematically recorded but was around 80% in popular areas and greater than 90% in moderately used areas. The profile of respondents was more male (58.0%) and white (85.8%) participants, with ages ranging from 19 to 91 years, with a predominance in the ranges of 18-30 years (30.9) and 31-45 years (29.3%). Most (71.7%) had completed college and were employed full-time or had a guaranteed job after the hiking (60.2%). Only three came from other countries; 99% (223) were US residents.

In the PCT, the sample includes 104 day hikers, 16 multi-day hikers 16, and 65 long-distance hikers (Table 2-2). The response rate was 89% and respondents were predominantly

male (63.8%), white (80%), with ages ranging from 18 to 77 years old, with a predominance in the range of 31-45 years old (32.4%). Most had completed college (80.2%) and were employed full-time (57.8%). Most were US residents (163 or 88%) and 22 (12%) lived abroad.

In the CDT, 121 day hikers, 16 multi-day hikers, and 54 long-distance hikers were interviewed (Table 2-2). The response rate was 91% and respondents were predominantly male (60.7%), and white (87.4%), with ages ranging from 19 to 91 years, with a predominance in the ranges of 18-30 years (30.9%) and 31-45 years (29.3%). The majority have completed college (80.6%) and were employed full-time (55.5%). They were predominantly US residents (92%) and 16 came from other countries (8%).

The overall mean of SoP was 4.17 out of 5. Regarding each trail, the highest average SoP was at AT (4.28), followed by PCT (4.16) and CDT (4.05). The overall mean for SSP was 0.39 out of 1. The highest mean SSP was at PCT (0.47), followed by AT (0.37) and CDT (0.35).

2.3.2 Research Question 1: Hike Duration's Relationship with Sense Of Place and its Spatial Scale

The results showed a trend that the longer the hike, the stronger the sense of place, confirming the first hypothesis (Figure 2-2). Considering all the hikers, Welch's ANOVA showed a significant difference in SoP between the categories of hike duration (Table 2-3). However, the Eta index suggests a minimal effect size (Vaske et al. 2002), and the pairwise comparisons using Games-Howell post-hoc test showed that only the difference between long-distance and day hikers is significant. Multi-day hikers presented intermediate values of SoP that was not significantly different from the shorter and longer hikers. When considering one trail at a time, long-distance hikers for each trail presented higher SoP than shorter distance hikers. However, AT hikers were the only sample where this difference was significant, with effect size

higher but still considered minimal. For AT hikers, the pairwise comparisons showed a significant difference in SoP between long-distance and day hikers, with Cohen's d suggesting a typical effect size (Table 2-3). The difference was also significant between long-distance and multi-day hikers (Cohen's d suggesting minimal effect size) but not between day and multi-day hikers. Despite showing the same trend of higher SoP for long-distance hikers, in the PCT and CDT there were no significant differences between the hike duration categories (Table 2-3).

The ANOVA for SSP showed a significant difference according to the hike duration (Table 2-3). The results also confirmed the hypothesis that the longer the hike, the broader the sense of place spatial scale (Figure 2-2). The Eta suggests a typical effect size. Differences were significant across all categories, but the effect size was substantial only for long-distance and day hikers. In contrast, the effect size was typical for long-distance and multi-day hikers, and multi-day and day hikers pairwise comparisons. Differences in sense of place spatial scale, and adherence to the trail between the hike duration categories can be perceived in the heatmaps (see example in Figure 2-3).

Regarding each trail, the AT shows the same pattern, with significant difference in SSP for hike duration and effect size considered typical. The pairwise comparisons showed significant differences between all categories of hikers with Cohen's d suggesting a substantial effect size for long-distance and day hikers, and typical for the other relationships. The PCT showed the higher overall SSP mean with the highest mean for day hikers among all trails (Figure 2-2) but without any significant difference between the hike duration categories. For the CDT, the ANOVA showed significant difference in SSP and typical effect size, but the pairwise comparison with Bonferroni post hoc test showed that only the difference between long-distance and day hikers is significant and has substantial effect size (Table 2-3).

2.3.3 Research Question 2: Motivation Relationship with Sense of Place and its Spatial Scale

When comparing the SoPs, the results confirmed the hypothesis that hikers motivated by the NSTs present a stronger sense of place than those in search of local attractions (Figure 2-4). The Welch's t-test showed that NST-motivated hikers have significantly higher SoP than those motivated by local attractions or other reasons (hereinafter referred as non-NST-motivated), but the Cohen's d suggests a minimal effect size (Table 2-4). Regarding each trail, the difference was also significant in the AT and in the PCT, but the effect size was typical for AT and minimal for PCT. In the CDT, there was no significant difference.

As for SSP, Welch's t-test showed NST-motivated hikers' sense of place on a broader spatial scale than those non-NST-motivated, also confirming the hypothesis. Cohen's d suggests a typical effect size (Table 2-4). The result was similar for the AT, with typical effect size, and for the CDT, in this case with a substantial effect size. There was no significant difference in the PCT, but this result is likely due to the high SSP value for the non-NST-motivated participants, the highest among all trails.

Considering only day hikers, the same result was found, with those NST-motivated hikers presenting a higher SoP than those non-NST-motivated. Welch's t-test showed significant difference and the effect size was considered slightly below typical (Table 2-4). Among AT day hikers, the same pattern was found, while in the PCT the same trend was found but the t-test showed no significant difference between day hikers regarding motivation. In the CDT, the motivated day hikers showed the highest SoP among all sub-groups (Figure 2-4). However, the extremely small sample (n = 3) resulted in a non-significant difference.

With respect to the SSP, Welch's t-test showed no significant difference between day hikers motivated and non-motivated by NST. The same pattern was found for AT and PCT. The exception was CDT, where the difference was strongly significant with substantial effect size (Table 2-4).

2.3.4 Research Question 3: Section Popularity Relationship with Sense of Place and its Spatial Scale

When SoP was compared between hikers interviewed in popular and moderately used sections, the ANOVA showed no significant difference (Figure 2-5). Regarding each trail, hikers in AT and PCT moderately used sections presented a slightly higher SoP than those in popular sections, but none of the differences were significant. The result was reversed in the CDT, but also not significant (Table 2-5). Regarding the spatial scale, hikers interviewed in moderately used sections showed a broader sense of place, but Cohen's d suggests a minimal effect size. The same result was found for AT hikers, but not for PCT and CDT hikers, where the difference was not significant (Table 2-5). In the PCT both categories presented a higher SSP than in the other trails, but those interviewed in popular sections presented a SSP even higher than those in moderately used sections.

2.4 Discussion

To our knowledge, this study represents the largest on-site sampling of hikers on mega trails. The findings improve our understanding of the relationships between hiking experiences and both sense of place and its spatial scale, which could have implications for nature conservation. The sample size covered only a small portion of trail users. However, these demographic data do not differ much from the profile of long-distance hikers reported for these trails by previous studies for race, gender, age, and education, except for the employment

situation, where only thru-hikers presented a profile similar to that of other surveys with a more significant number of unemployed not looking for work (Fondren & Brinkman, 2022; Halfway Anywhere, 2023).

The overall mean of SoP among NST hikers can be considered high (4.17 on a scale of 1 to 5), which was expected since only people who sought activities in a natural environment were sampled and the interviews were conducted on trails. Halpenny (2010) used a similar scale with a national park visitors and found an average value of 3.6. Nevertheless, it is not possible to compare these results directly since the scales used slightly different items and these values should be used only as a reference. Furthermore, the sampling design and the format of questions did not allow the use of a control group with non-hikers.

2.4.1 Hike Duration and Sense of Place

The analyses suggest that sense of place and its spatial scale are related to the hike duration, confirming the first hypothesis that the longer the hike, the stronger the sense of place and the broader its spatial scale. Although some differences were not statistically significant, all trails showed the same trend, with long-distance hikers presenting a stronger sense of place. This relationship seems intuitive, but studies on the level of involvement with an activity and sense of place do not always show clear results (Farnum et al. 2005).

Kyle et al. (2003) found no relationship between place attachment and the hiking duration in the AT using four categories (day, multi-day, section, and thru-hikers). However, their data suggest that, if grouped, long-distance hikers (thru + section hikers) differ from short-distance hikers (day + multi-day hikers), a result close to what we found. Fondren and Brinkman (2022) suggest that section and thru-hikers on the AT and PCT form a single subculture, which they

group as long-distance hikers. This categorization, therefore, seems to make more sense to assess the relationship between hike duration and their perceptions of environments.

The positive relationship found between hike duration (and, therefore, the length) and spatial scale, corroborates studies associating mobility and distance traveled with the spatial scale of place (Sager 2006; Gustafson 2009). Although some effect sizes were limited, taken together, the results of sense of place and spatial scale analyses suggest that the experience of a long-distance hike has the potential to create meaning for NSTs as places and aid in turning extensive landscapes into meaningful places, a necessary step to develop sense of place (Hashemnezhad et al., 2013). By acknowledging that one area in Maine is somehow part of the same trail as an area in Georgia thousands of kilometers away, trail users can grasp the concepts of magnitude and connectivity among areas might have been viewed as entirely separate entities. The fact that these respondents are walking across this landscape, which takes months even if completed continuously, speaks to the ability to capture a large scale in space, time, and experience into meaning. As Gobster et al. (2007) argue, bringing these landscapes to people's *perceptible realm* can help them understand ecological processes at large spatial scales. By experiencing different portions of a trail, hikers can be conscious of how human activities alter land use and create gaps between preserved areas. They can also perceive *in loco* how large continuous natural areas present better environmental conditions (*e.g.*, water and air) or harbor animals not found in smaller and less connected areas. The perception of the importance of connectivity in extensive landscapes is essential, for example, for conserving species that make large terrestrial migrations (L. C. Gigliotti et al., 2022).

Several studies associated sense of place and support for conservation (e.g., Halpenny, 2010; Stedman, 2002; Walker & Ryan, 2008). Moreover, Ardoin (2014) found that people with

larger-scale place connections were more likely to take environmental action. She argues that this difference is also related to the type of actions that are taken: "perceiving one's place at a larger-than-local scale may facilitate understanding of how an individual action may combine with others to create broader change" (p.435). Based on these findings, our results suggest that providing this opportunity for recreation and extensive contact with nature could contribute to garnering support for large-scale conservation. By being protected as spaces for recreation and contact with nature, mega trails can constitute corridors along extensive landscapes. Those trails with a predominantly poleward orientation, as is the case of the Triple Crown, may constitute corridors for species range shifts along the latitudinal gradient in response to climate change (Carroll et al., 2018; Grelle et al., 2021; Hunter Jr. et al., 1988). Thus, this place connection and eventual willingness to take action at a larger spatial scale developed by long-distance hikers may be especially relevant in a climate change scenario, garnering support to protect the so-called climate corridors (Nuñez et al., 2013).

2.4.2 Motivation and Brand Effect

The analyses confirmed the hypothesis that NST-motivated hikers show a stronger sense of place and on a broader spatial scale than those motivated by local attractions or other reasons. Considering the relationship between contact with the environment and sense of place, this result was expected for long-distance hikers. However, this difference is also observed among day hikers, which suggests that these mega trails could influence the sense of place even among those who hike short sections and do not experience the trail as a whole.

Comparing the three trails, the AT seems to have a more substantial effect on motivation than the others. The level of sense of place among hikers who are not motivated by NSTs is similar for the three trails (Figure 2-3). However, among hikers motivated by NSTs, those

motivated by AT show higher SoP than those motivated by PCT and CDT. The AT is the oldest and most consolidated trail of the Triple Crown, predating the PCT by 56 years, which leads to greater publicity and notoriety. It is also closer to urban areas that are home to two-thirds of the US population (Fondren & Brinkman, 2022). A larger regional population means more roads cross the AT and more communities are nearby, leading to greater accessibility of people to the trail and hikers to towns. Hikers and managers frequently mention that there is a "natural order" to hike the Triple Crown (AT, PCT, then CDT) associated mainly with challenge, access, and support (Fondren & Brinkman, 2022) but probably also with popularity. Indeed, 20% of those interviewed in the CDT and PCT mentioned having already hiked in the AT. Among CDT thru-hikers, 67% had already thru-hiked the AT, PCT, or both. Managers of the three trails interviewed for a related study reinforced this image that the AT is "a more social trail," while PCT and CDT management are more focused on long-distance hikers. Moreover, the AT invests in more intense signage and offers facilities, such as shelters, which provide access and reinforce social bonding and popularity (Fondren & Brinkman, 2022).

Another element that reinforces this perception is the higher proportion of day hikers motivated by the AT than by the other trails. In the AT, 48 (34%) day hikers were classified as motivated by the trail, while in PCT, they were 14 (13%), and in CDT, only three (2.4%). The greater accessibility and popularity, plus the managers' attention to a wider audience seems to strengthen AT's image among the general public. The stronger sense of place among AT hikers and the higher proportion of hikers motivated by it compared with the other trails corroborate previous findings that highly attached hikers see the AT as a *recognizable brand* (Kyle et al., 2004).

This trail brand is related to the place meaning discussed above but also encompasses the symbolic field (Low, 1992). A trail with a strong and popular brand can be a gateway to long-distance trails in general, and from this experience, the sense of place and interest in other NSTs could be awakened. (Fondren & Brinkman, 2022), for instance, mention a hiker in the PCT who said he had "caught the long-distance bug" hiking the AT. This more generic sense of place for a certain type of place was speculated by Proshansky (1978) and described by Williams et al. (1992) for wilderness areas. The increase in visits to protected areas redesignated as national parks (Weiler & Seidl, 2004) is also evidence of how the brand effect influences the choice of places to experience nature.

Furthermore, NSTs can also represent a brand that goes beyond long-distance hikers. This brand effect reaches people who do not intend to thru-hike the trail but are fascinated by the idea. During fieldwork, one resident that lives near the CDT said: "I could just go out my back door and walk to Canada. Even if you never do that, the concept that it is right there gives this feeling of freedom or just that the wilderness is right there." That some people do exactly this probably helps create and reinforce this perception.

With regard to nature conservation strategies, mega trails seem to influence the sense of place of day hikers and even people who do not even use them. If they can contribute to a better understanding of the importance of large-scale landscape connectivity, this finding suggests that they can also help a broader audience understand the value of landscape-level conservation, typically a challenge for conservation (Gobster et al., 2007). As such, these trails can positively impact millions of people, not just a few thousand long-distance hikers. Even if thru-hikers on these NSTs do not exceed 3,000 per year, a rough estimate of 3 to 4 million people visit at least one point of the AT each year (NPS, 2015).

The small number of day hikers motivated by PCT and CDT, however, highlights the importance of reinforcing the trail brands to create this place meaning on a broad spatial scale. The SoP of day hikers motivated by the NST was higher than that of non-NST-motivated hikers for both trails, but the small sample size made the differences not significant. Thru-hikers are essential to give concreteness to the idea of the trail and to the identity of the trail itself (Cerveny et al., 2022) but developing strategies to reach and engage day hikers is important to multiply the benefits for conservation. These trails are supported by public resources, and the fact that they serve many more people besides long-distance hikers can help to justify spending on them.

Analyzing the spatial scale of sense of place forces us to be careful with these statements. NST-motivated hikers have a broader sense of place than non-NST-motivated, but this pattern is unclear among day hikers. Despite a trend of day hikers motivated by the NST showing a broader sense of place, the difference was only significant for the CDT, and the small number of day hikers motivated by the CDT and PCT does not allow for more assertive conclusions.

Regarding all NST-motivated hikers, the spatial scale of sense of place is similar between the trails, but non-NST-motivated hikers in PCT have a broader spatial scale than the others. Exploring the national park brand's strength is out of this study's scope; however, during the fieldwork, we noticed that many respondents spontaneously mentioned national parks when choosing the sites that especially matter to them on the map. We can speculate that the broader sense of place in PCT, even among day hikers, was influenced by having more national parks closer to its Northern and Southern ends than the other trails. More studies exploring the sense of place spatial scale trying to isolate other factors, such as national parks, are needed to better understand this matter.

2.4.3 Section Popularity

The third tested hypothesis was not confirmed, as there was no significant difference in sense of place between hikers interviewed in popular and moderately used sections. Scores on the latter tended to be higher, but the difference was not significant for any group. In the CDT, hikers in popular sections showed a stronger sense of place, but this difference was also not significant. Regarding the spatial scale of sense of place, hikers in moderately used sections showed significantly higher SSP than those in popular ones, but the effect size was minimal. Among the trails, the difference was significant only for the AT, and there is no clear pattern for PCT and CDT.

The non-significant differences contradict previous studies that reported higher levels of sense of place among people who seek solitude and opportunities for introspection (e.g., Kil et al., 2010; Kyle et al., 2004; Warzecha & Lime, 2001). Wynveen et al. (2020) analyzed protected areas in Europe and USA and found a negative relationship between sense of place and development of recreation zones. Kil et al. (2012) investigated place meanings among hikers in the Florida NST and found that highly attached hikers preferred natural areas with little to no evidence of human development. On the other hand, Williams and Stewart (1998) point out that tourists can also have strong attachments to places, and different social groups can create different meanings for the same place, with or without conflict between them. Thus, different factors can motivate a sense of place among different people, such as place for introspection, beauty, physical activities, self-confidence, or even social status. The classification of popularity was based on the number of registered users in the *Alltrails Pro* app, and among the popular sections are some notable and very crowded attractions, such as the Clingmans Dome (Great Smoky Mountains NP, AT), Crater Lake (Crater Lake NP, PCT), and St. Mary Falls (Glacier

NP, CDT). If, even in these crowded sites, people showed a high SoP, it seems possible to involve people and generate sense of place even in intensely visited attractions.

2.4.4 Limitations and Further Research

Because sense of place is a complex and multi-dimensional construct whose definition varies according to authors, it is difficult to capture it in its various dimensions (Convery et al., 2012). The lack of validated scales for different contexts is evidence of this difficulty. The objective was not to develop a validated scale but rather to explore the relationships between experiences on long-distance trails and sense of place developed by hikers. Here we slightly modified questions from several studies to minimize this problem. Different social groups can create different meanings for the same place (Williams and Roggenbuck 1989), and the scale used cannot identify differences. Developing more detailed scales could allow a better understanding of the phenomenon.

The high sense of place that participants reported was expected, but the small variation limited the statistical power and effect size of comparisons among groups. As Vaske et al. (2002) emphasized, standardized effect size indices are reliable references, but "a small effect size may have more practical significance than a large effect size in one instance, but not in another" (p.290). When dealing with a construct influenced by so many factors, it is natural that a single construct does not have a substantial effect size. Furthermore, we cannot rule out the possible effect of social desirability because of face-to-face surveys (Vaske, 2019).

The difficulty of sampling the great diversity of environments and contexts along the three mega trails also resulted in some limitations. Although we tried to represent the diversity of each trail, the time limitation and thru-hiking dynamics did not allow us to have equal sample sizes in all sub-groups. Thru-hikers tend to follow the seasons, starting early in the south in order

to complete the trail in one summer. Some sections were visited before or after the thru-hikers' high season, when the so-called *bubble* passes (Dolman & Marion, 2022); in others, the number of multi-day hikers was small because they were not popular destinations for overnight hikes. Unequal sample sizes forced us to deal with variance limitations and restricted the statistical analysis options and/or reduced their power. The small sample size of some subgroups also limited the combined analysis of different variables. Differences between the intermediate group of hike duration (multi-day hikers) and the extremes were not significant in most analyses. Multi-day hikers had smaller sample sizes, especially on PCT and CDT, which may not have enough power to detect statistical significance, possibly representing a false negative (Type II error).

Several non-US residents stated that they did not identify with terms and expressions used in the scales, regardless of language. The survey has been pre-tested with US residents only. If only US residents were considered, some analyses would show significant differences, such as SoP by hike duration in the PCT. As mentioned, this study intends to propose something other than a validated scale to assess sense of place among hikers. However, additional tests with non-US residents would be interesting to assess whether it is a limitation of the scale generalizability or whether non-residents develop a different relationship with the place even in intense experiences like long-distance hikes.

2.5 Conclusions

Long-distance hikers have a stronger and broader sense of place, suggesting that mega trails can enable extensive landscapes to become perceptible realms. This can help overcome one of the challenges of large-scale conservation projects: the general public's understanding of

ecological processes on this scale. Designating NSTs in strategic regions can create large meaningful places and help promote large-scale nature conservation.

Through the brand effect, mega trails also seem to have the potential to reach a wider audience, going beyond long-distance hikers and raising the awareness of millions of people who visit natural attractions about the importance of large-scale conservation. The relationship between sense of place and NST-motivation and the strong sense of place found even among people in popular sections reinforce this potential. Intensive outreach and signage in popular sections and road crossings, among other initiatives, can increase the engagement of day hikers and other visitors and strengthen trail brands. Associating side trails with NST brands could spread these effects even further. On the other hand, long-distance hikers are essential to give concreteness to the idea of mega trails. Trail management must consider the quality of experience to promote sense of place and maintain their engagement. Balancing these two apparently conflicting points seems to be strategic for the success of mega trails.

Considering the importance of trail brands in motivating hikers and their relationship to a stronger sense of place, the US National Trail System and other national trail systems should value each trail and its own brand. Creating trail systems planned in an integrated way but taking into account each trail to reach specific audiences can be an effective strategy to help promote the connection of large-scale landscapes and adapt to the effects of climate change with greater support from society.

Figure 2-1. Map of the Triple Crown of Hiking (trails in red) showing the sections sampled: popular sections (orange circles) and moderately used sections (green circles). [a]Basemap from ESRI ArcGIS

Table 2-1. Internal Consistency of Sense of Place scale

	2021 (AT[a]) (n = 226)			2022 (PCT[b] + CDT[c]) (n = 376)			All Trails (n = 602)
Measurement item	Initial Corrected Item-Total Correlation	Crombach's Alpha if Item Deleted	Final Corrected Item-Total Correlation	Initial Corrected Item-Total Correlation	Crombach's Alpha if Item Deleted	Final Corrected Item-Total Correlation	Final Corrected Item-Total Correlation
1- I feel like these places are part of me	.690	.800	.700	.656	.780	.687	.694
2- These places are the best places for what I like to do	.613	.811	.646	.666	.785	.700	.681
3- I identify strongly with these places	.731	.797	.740	.733	.773	.757	.753
4- I get more satisfaction out of being here than anywhere else	.634	.804	.670	.504	.796	.528	.573
5- I am very attached to these places	.782	.787	.783	.666	.778	.655	.706
6- Coming or being here says a lot about who I am	.661	.803	.695	.608	.786	.646	.668
7- The things I do here, I would enjoy doing just as much somewhere else*	-.027**	.866**	**	-.141	.857*	**	**
8- Because of my lifestyle, these places are important to me	.502	.820	.526	.582	.793	.599	.574
9- Most of my family/friends are, in some way, connected with this place	.308**	.845**	**	.328	.820*	**	**
10- I identify with the physical landscape of these places	.498	.818	.513	.583	.789	.581	.559
11- I am interested in the plants and animals that live in this place	.477	.819	.505	.343	.810	.363	.418
Crombach's Alpha		.831	.887		.813	.872	.878

[a]AT = Appalachian Trail; [b]PCT = Pacific crest Trail; [c]CDT = Continental Divide Trail; n = sample size. * Item with inverted scale score. ** Item excluded by not meeting the minimum thresholds

Table 2-2. Hikers' demographic profiles by trail

	Appalachian Trail	Pacific Crest Trail	Continental Divide Trail
Hike duration			
Day hikers	141 (62.4%)	104 (59%)	121 (66%)
Multi-day hikers	49 (21.7%)	16 (9%)	16 (8%)
Long-distance hikers	36 (15.9%)	65 (35%)	54 (28%)
Gender			
Female	94 (41.6%)	75 (36.2%)	67 (39.3%)
Male	131 (58%)	116 (63.8%)	118 (60.7%)
Other/Prefer not to say	1 (0.4%)	0	0
Age Class			
18-30 years	75 (33.2%)	48 (25.9%)	59 (30.9%)
31-45 years	71 (31.4%)	60 (32.4%)	56 (29.3%)
46-60 years	48 (21.2%)	48 (25.9%)	41 (21.5%)
> 60 years	28 (12.4%)	25 (13.5%)	30 (15.7%)
Race/Ethnicity			
White/European American	194 (85.8%)	148 (80%)	170 (89%)
Asian	15 (6.6%)	20 (10.8%)	6 (3.1%)
Hispanic/Latino	8 (3.5%)	9 (4.9%)	8 (4.2%)
Black/African American	2 (0.9%)	4 (2.2%)	3 (1.6%)
Native American	1 (0.4%)	2 (1.1%)	2 (1.0%)
Native Hawaiian	0 (0%)	0 (0%)	1 (0.5%)
Other/mixed	3 (1.3%)	3 (1.6%)	5 (2.6%)
Prefer not to say	3 (1.3%)	0	0
Higher Education Level			
Graduate Degree or beyond	68 (30.1%)	71 (38.4%)	65 (34.0%)
College Complete	99 (43.6%)	80 (43.2%)	94 (49.2%)
Some College	30 (13.3%)	18 (9.7%)	17 (8.9%)
High School Complete	27 (11.9%)	14 (8%)	11 (5.8%)
Some High School	2 (0.9%)	0	1 (0.5%)
Employment status			
Employed Full Time	137 (60.6%)	107 (57.8%)	106 (55.5%)
Employed Part Time	10 (4.3%)	8 (4.3%)	15 (7.9%)
Unemployed looking for work	6 (2.6%)	5 (2.7%)	1 (0.5%)
Unemployed not looking for work	18 (7.9%)	27 (14.6%)	31 (16.2%
Student	25 (10.9%)	10 (5.4%)	12 (6.3%)
Retired	19 (8.4%)	26 (14.1%)	21 (11.0%)
Disabled	2 (0.8%)	1 (0.5%)	0

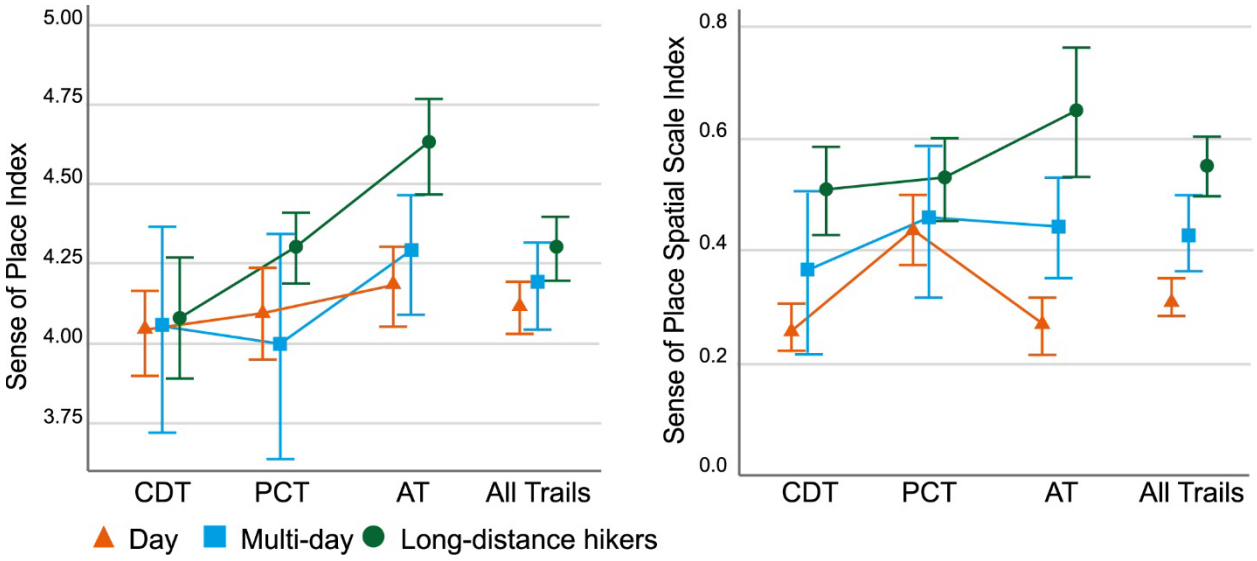


Figure 2-2. Means of SoP and SSP by hike duration with 95% confidence intervals estimated with BCa bootstrapping with 1,000 repetitions.

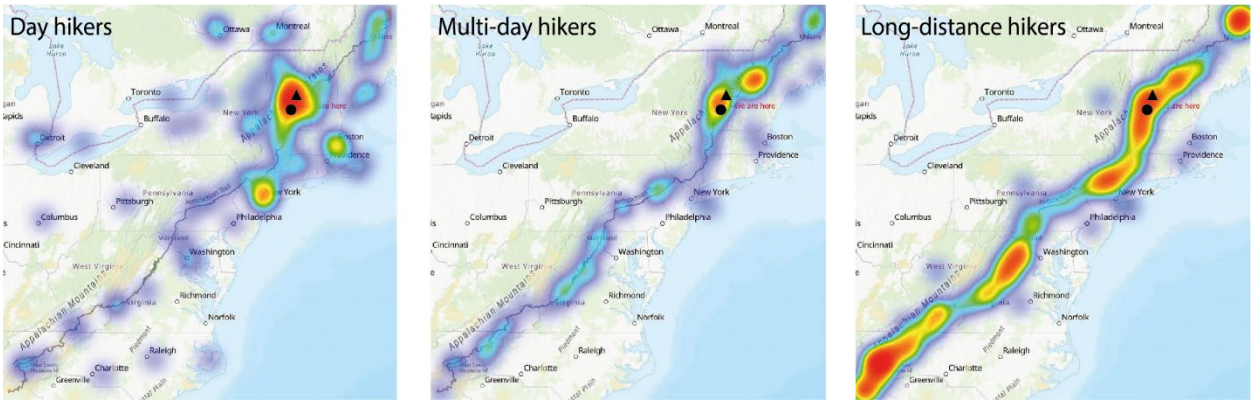


Figure 2-3. Heatmaps showing the "places that matters" for hikers surveyed in the Northern Appalachian Trail sections: Clarendon Gorge (moderately used; circle) and Killington Peak (popular; triangle). *Basemaps from ESRI ArcGIS.

Table 2-3. One-way ANOVA, pairwise comparisons, and effect sizes for hike duration

	F	Significance (Eta index)[a]	Pairwise comparisons Significance (Cohen's d)[b] Day-Multi	Day-Long	Multi-Long
Sense of Place Score					
All trails	4.151	0.017* (0.11)	0.697	0.012* (0.251)	0.431
AT	9.446	< 0.001* (0.21)	0.385	< 0.001* (0.612)	0.009* (0.469)
PCT	2.950	0.063			
CDT	0.025	0.975			
Sense of Place Spatial Scale Index					
All trails	31.596	< 0.001* (0.31)	0.009* (0.366)	< 0.001* (0.753)	0.015* (0.387)
AT	20.337	< 0.001*	0.006 (0.520)	< 0.001* (1.14)	0.015 (0.623)
PCT	1.956	.144			
CDT	14.787	< 0.001* (0.37)	0.526	< 0.001* (0.888)	0.198

* Significant at 95% level. [a] Effect size: Eta index > 0.10 = minimal relationship, typical > 0.243, substantial > 0.371. [b] Cohen's d > 0.2 = minimal relationship, typical > 0.5, and substantial > 0.8. (Vaske et al. 2002)

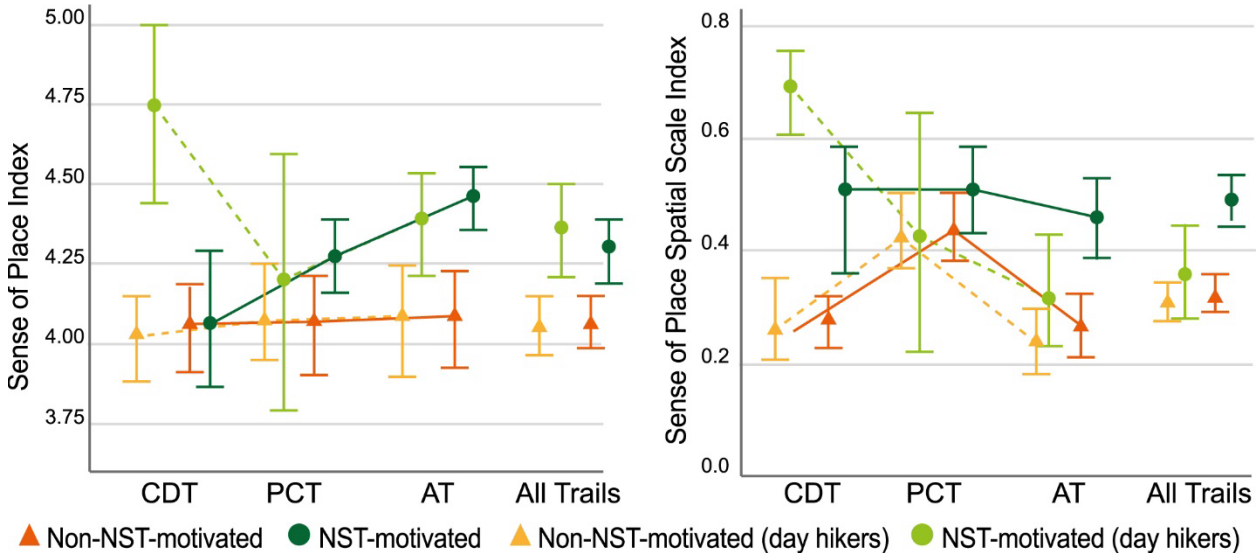


Figure 2-4. Means of SoP and SSP graphs by motivation with 95% confidence intervals estimated with BCa bootstrapping with 1,000 repetitions.

Table 2-4. T-tests for motivation

	All hikers			Only day hikers		
	F	Significance (p-level)	Effect size (Cohen's d)	F	Significance	Effect size (Cohen's d)
Sense of Place Score						
All trails	18.316	< 0.001*	0.340	11.613	0.001*	0.390
AT	15.760	< 0.001*	0.531	6.334	0.013*	0.397
PCT	4.337	0.039*	0.298	0.261	0.610	
CDT	.005	0.945		2.396	0.124	
Sense of Place Spatial Scale Index						
All trails	37.888	< 0.001*	0.521	1.388	0.242	
AT	17.047	< 0.001*	0.547	1.836	0.179	
PCT	2.275	0.133		0.004	0.951	
CDT	29.622	< 0.001*	0.870	8.741	0.004*	1.728

Effect size: Cohen's d > 0.2 minimal relationship, typical > 0.5, and substantial > 0.8. (Vaske et al. 2002)
* Significant at 95% level

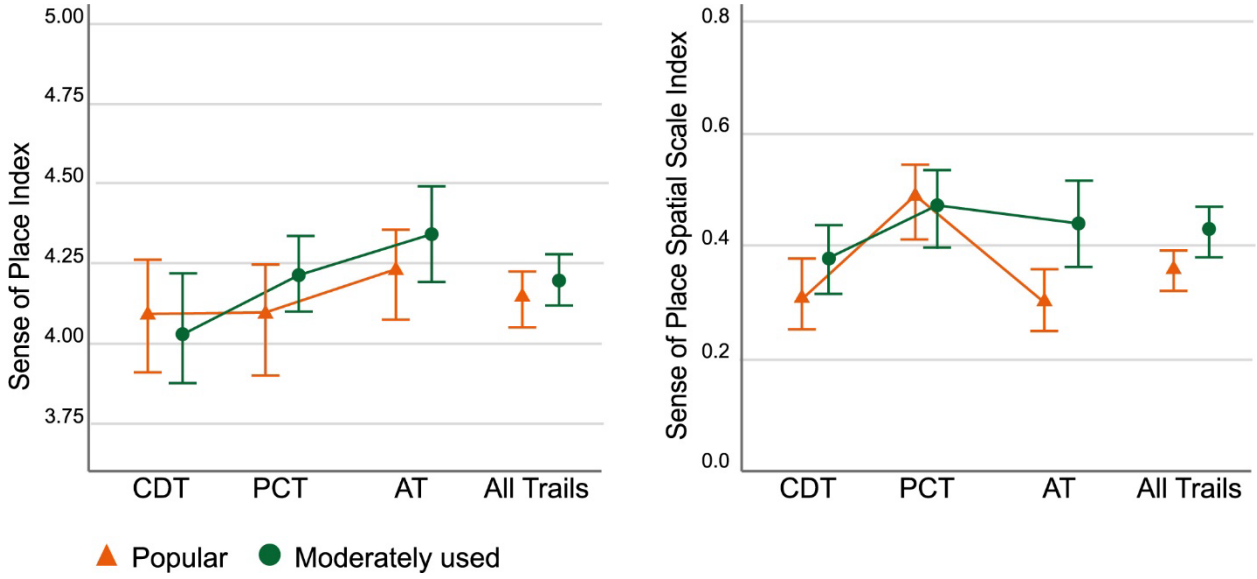


Figure 2-5. Means of SoP and SSP graphs by section popularity with 95% confidence intervals estimated with BCa bootstrapping with 1,000 repetitions.

Table 2-5: T-tests for section popularity

	Sense of Place Score		**Sense of Place Spatial Scale Index**		
	F	Significance (p-level)	F	Significance (p-level)	Effect size (Cohen's d)
All trails	0.719	0.397	7.089	.008*	0.217
AT	1.443	0.231	8.689	.004*	0.397
PCT	0.050	0.823	.050	.823	
CDT	0.422	0.517	2.557	.111	

Effect size: Cohen's d > 0.2 minimal relationship, typical > 0.5, and substantial > 0.8. (Vaske et al. 2002). * Significant at 95% level

CHAPTER 3
CAN SENSE OF PLACE PROMOTE PRO-ENVIRONMENTAL BEHAVIORS?

Since its origins, the environmental movement has been strongly influenced by individuals who experienced the outdoors and were strongly committed to natural places. In the US, seminal environmentalists like Henry Thoreau and John Muir are known for detailed observations at Walden Pond and tramping through the Sierras (Brulle, 1996; Manning, 1984). Many iconic natural areas worldwide were legally protected after campaigns led by outdoor recreationists (Ehringhaus, 2012; Viveiros de Castro, 2018). People who develop a strong feeling about natural places, often through recreational opportunities, tend to show more responsible environmental behavior (Theodori et al., 1998; Vaske & Kobrin, 2001), greater willingness to financially support conservation (Russell & Russell, 2010; Zaradic et al., 2009), and more frequent socially and politically actions against environmental impacts (Horwitz, 1996; Matsuba & Pratt, 2013).

One factor frequently used to explain pro environmental behavior (PEB) is developing a sense of place for natural sites or landscapes (Vaske & Kobrin, 2001). Sense of place (SoP) is a multi-dimensional construct that can be defined as "a collection of meanings, beliefs, symbols, values, and feelings that individuals or groups associate with a particular locality" (Williams & Stewart, 1998, p. 19). Several studies relate activities in nature to SoP (e.g., Beery & Jönsson, 2017; Kil et al., 2010; Williams et al., 1992) and SoP to pro-environmental behaviors (e.g., Vorkinn & Riese, 2001; Walker & Ryan, 2008). However, some authors point out that PEB is related to one specific dimension of SoP, place identity (Halpenny, 2010; Vaske & Kobrin, 2001). Place identity involves feelings, values, and beliefs related to the environment (Jorgensen & Stedman, 2001), approaching the broader concept of connection to nature, defined as a self-perceived relationship of interconnection between the self and the natural world, which reflects a

sensation of kinship and an affective individual experience (Olivos et al., 2011). Hence, SoP would be a "necessary but not sufficient" condition to generate PEB (Wakefield et al., 2001, p. 175), which would depend on a bond not only with a specific place but on an emotional affinity toward nature as a whole (Kals et al., 1999).

Understanding how the relationship with nature is associated with geographically bound spaces and the extent to which these constructs predict pro-environmental behaviors is useful for environmental management and conservation planning (Brehm et al., 2013; Larson et al., 2015; Restall & Conrad, 2015). This chapter uses a structural equation model to explore the relationship between sense of place and pro-environmental behaviors, with connection to nature as a possible mediator. Determining if these constructs are related could make it possible to design new recreation and interpretation opportunities in natural areas to increase the potential impact on visitors and their support of conservation.

3.1 Theoretical Background and Hypotheses Formulation

3.1.1 Sense of Place

The definition of sense of place can vary enormously among fields of knowledge and even among authors in the same field, including different dimensions of the relationship between people and places (Ardoin, 2006). Jorgensen & Stedman (2001) define it as a construct formed by three dimensions: place identity (cognition, beliefs, and perceptions), place attachment (affective and emotional connection), and place dependence (behavioral advantage). Other authors use *place attachment* as a more general concept, in a similar way to many definitions of sense of place (e.g., Halpenny, 2010; Low & Altman., 1992) However, Giuliani (2003) states that place attachment originated in attachment theory, which focuses on interpersonal relationships and "has an extremely restricted meaning compared with the extremely broad

concept of place attachment" (p.160). Ardoin (2006) considers place identity and dependence to be parts of a superior psychological dimension of sense of place and explores other dimensions, such as biophysical, sociocultural, political, and economic conceptions of place. As Jorgensen & Stedman (2001, p. 233) pointed out, "there are a plethora of concepts describing the relationship between people and spatial settings, but sense of place is perhaps the most general."
The multidimensionality of sense of place makes measuring this construct challenging (Convery et al., 2012). Some anthropologists argue that sense of place is essentially qualitative and cannot be treated as a dataset to be sampled, tabulated, and manipulated like quantitative data (e.g., Geertz, 1996). Other authors warn about problems related to the subjectivity of the proposed questions (Graham et al., 2009) or for the difficulty of identifying different elements and avoiding conceptual overlaps (Lewicka, 2005). Despite some controversies, measuring sense of place is helpful in comparing how different groups relate to the environment and for understanding the construct (Williams & Vaske, 2003).

The use of scales to assess sense of place has increased in recent decades. However, the complexity of the construct, the different dimensions emphasized in each study, and the need to adapt the words to specific contexts meant that there are no standardized, widely used, and validated scales. Several other measures have already been proposed (see Jorgensen & Stedman, 2001, for a review), but most scales derive from Williams & Roggenbuck's (1989) scale (e.g., Ardoin et al., 2012; Halpenny, 2010; Kyle et al., 2004).

3.1.2 Pro-Environmental Behaviors

Steg & Vlek (2009, p.309) described pro-environmental behavior as "behavior that harms the environment as little as possible, or even benefit the environment." Although defining environmentally appropriate behaviors seems straightforward, there is no agreement on what this

behavior should be called. Competing suggestions include: *environmentally significant behaviors* (Stern, 2000), *responsible environmental behaviors* (Vaske & Kobrin, 2001), *environmentally responsible behaviors* (Thøgersen, 2006), *environmentally conscious behavior* (Lee & Holden, 1999), and *conservation behaviors* (Gosling & Williams, 2010; Monroe, 2003). *Pro-environmental behavior* (PEB) is the most general and widespread term. It, however, has several components, and a scale may or may not measure individual or collective behaviors, intention or result, direct or indirect impacts, or local to global scale (Larson et al., 2015).

Most measures developed to assess PEB focus on individual behaviors in the private sphere, which are more easily quantified (e.g., Gatersleben et al., 2002; Markle, 2013). However, individual actions represent a small fraction of global environmental impacts (Bogert et al., 2022). Engagement in collective actions that lead to changes in governments or large corporations' policies tends to be more relevant and deserve greater attention (Steg & Vlek, 2009; Stern, 2000). Alisat & Riemer (2015) developed the Environmental Action Scale, focusing on engagement in civic actions with collective impact on system-level changes. Larson et al. (2015) developed a scale encompassing the diversity of PEB, divided into four categories: *conservation lifestyle behaviors* (e.g., household actions in the private sphere); *social environmentalism* (e.g., peer interactions and group membership); *environmental citizenship* (e.g., civic engagement in the policy arena); and *land stewardship* (e.g., support for wildlife and habitat conservation).

Such diversity of contexts makes it difficult to develop a scale that fully cover PEB, and there is a lack of consistency among behavior measures (Markle, 2013). Even dealing with only one PEB category, translating scales to other environments (*e.g.*, urban to rural), or cultures can be challenging, compromising their generalizability. Another problem is that behaviors may be

conducted daily, rarely, or only once, making frequency valuable to assess, but challenging to consider on the same scale (Larson et al., 2015).

Concerning nature conservation, what is often evaluated is the willingness to protect a given environment against eventual threats. In this case, questions that focus on the frequency of behavior adoption do not reflect the issue well. Using *pro-environment behavioral intentions* (Halpenny, 2010) or *willingness to take action* (Floress et al., 2017; L. M. Gigliotti, 1994) are alternatives in these cases since the Theory of Planned Behavior supports the idea that the intention to perform a behavior is the most important determinant of behavior (Ajzen, 1985).

3.1.3 Connection to Nature

As a possible mediator between SoP and PEB we evaluated the *connection to nature* (CN) construct. It represents a straightforward and intuitive idea related to the human-nature relationship and the importance each person gives to nature. Nevertheless, the multiple processes (e.g., Beery et al., 2020; Wolsko & Lindberg, 2013) and components (e.g., Kals et al., 1999; Schultz, 2002) involved in this relationship make its discussion complex. Very different terms, such as *emotional affinity toward nature* (Kals et al., 1999), *environmental identity* (Clayton, 2003), *love and care for nature* (Perkins, 2010) or slight variations, such as *connectedness with nature* (Schultz, 2002; Zylstra et al., 2014), *connectedness to nature* (F. S. Mayer & Frantz, 2004; Restall & Conrad, 2015) and *connectivity with nature* (Dutcher et al., 2007) are used with different definitions. However, all these terms refer to similar feelings (connection, affinity, inclusion) and always relating the same subject (people) and object (nature). Salazar et al. (2021) suggest that *connection to nature* can be used to encompass all these related terms.

These many terms were used to name scales that emphasize one or another dimension of the phenomenon, based on different principles or approaches, using visual or Likert scales, and focusing on different audiences (Salazar et al., 2021). Some scales are unidimensional and assess affective (Kals et al., 1999; F. S. Mayer & Frantz, 2004) or cognitive aspects (Schultz, 2002). Others are multidimensional and encompass the two aspects mentioned and others, such as the experiential (Clayton, 2003; Nisbet et al., 2009). However, Tam (2013) analyzed seven of the most frequently used measures and concluded that they could be considered "markers of a common construct." Here, we adopt the term connection to nature broadly, encompassing affective and cognitive aspects of the people-nature relationship.

3.1.4 Conceptual Model and Hypotheses

Several studies have empirically demonstrated relationships between sense of place and PEB (*e.g.*, Buta et al., 2014; Wakefield et al., 2001; Walker & Ryan, 2008). Since SoP, as well as CN, can be viewed as environmental attitudes (Cheng & Monroe, 2012; Jorgensen & Stedman, 2001), models to explain their relationship with pro-environmental behaviors are based on theories of environmental psychology. Fazio & Zanna (1978) found that attitudes are a good predictor of behavior, what is also true to PEB (Kil et al., 2014). The ABC model (Affective-Behavioral-Cognitive) suggests that behavior is one of the components of attitude, along with affective and cognitive elements (Breckler, 1984). Stern et al. (1999) associated personal values (i.e., biocentrism, altruism, and egoism) and beliefs related to the New Environmental Paradigm (Dunlap & Van Liere, 1978) with the Norm-Activation theory (Schwartz, 1973) to explain support for environmentalism. Their Value-Belief-Norm Theory of Environmentalism (VBN) postulates that there is a causal chain between the elements that give it its name. It bears to note

that the words *values* and *beliefs* are part of many definitions of sense of place (*e.g.*, Williams & Stewart, 1998).

Vaske & Kobrin (2001) proposed and tested a model relating recreational activities to pro-environmental behavior with two dimensions of sense of place as mediators. They found place identity as a full mediator between experiences and PEB. This prominence of the identity dimension in the relation SoP-PEB draws attention to the concept of self-identity, which underlies both the concepts of place identity (Proshansky et al., 1983) and connection to nature (Schultz & Tabanico, 2007), perhaps through the construct of Environmental Identity (Clayton, 2003). Agnew (1987) refers to SoP as a "subjective territorial identity" (p.28). Several studies that show place identity as the dimension of SoP more related to PEB (e.g., Halpenny, 2010; Stedman, 2002; Vaske & Kobrin, 2001) suggest that connection to nature can be a mediator between sense of place and pro-environmental behavior.

Regarding different dimensions of PEB, Halpenny (2010) tested different models relating identity and dependence to *place-specific PEB intentions* and *everyday PEB intentions.* She found a more robust relationship of SoP with *place-specific PEB intentions* than with *everyday PEB intentions*, and the first predicting the latter. The bond to a particular site would affect PEB unrelated to that specific site, representing a spill-over effect (Halpenny, 2010).

Studies exploring SoP, CN, and PEB together are relatively rare. Gosling & Williams (2010) proposed a model exploring in parallel the relationships between SoP and PEB, and CN and PEB, but did not test how the three constructs are related in the same model. Here, we explore different dimensions of SoP and PEB, how they are related, and if CN is a mediator between these constructs. Our conceptual model (Figure 3-1) accounts for up to three dimensions of the sense of place construct: attachment, dependence, and identity (Ardoin et al., 2012;

Jorgensen & Stedman, 2001). The model accounts for up to three dimensions of the pro-environmental behaviors construct, adapted from Larson et al. (2015): *conservation lifestyle*, *neighborhood stewardship*, and *willingness to protect the trail landscape*. Connection to nature is treated as unidimensional in the model, since there are many validated scales that make it possible to explore relationships from this assumption (Tam, 2013). Based on the literature and regarding the relationships between the constructs, we developed hypotheses to explore the relationships between these constructs and some of their dimensions:

- The relationship between sense of place and pro-environmental behavior is direct and significant (H1)
- The relationship between sense of place and pro-environmental behavior in indirect, mediated by CN. In this case, CN can be a partial (H2) or a full mediator (H3; Figure 1).
- Place identity is a mediator between place dependence and PEB (H4).
- Place-based PEB dimension (willingness to protect the trail landscape) is a partial (H5) or full (H6) mediator between SoP and CN and daily behaviors.

3.2 Methods

3.2.1 Study Areas

The survey was carried out on two renowned US national scenic trails between the international borders with Mexico and Canada. The Continental Divide Trail (CDT) is a 4,873-km long trail that runs through the Rocky Mountain Range, separating watersheds to the Atlantic and Pacific oceans. The CDT crosses a well-conserved corridor (Wilson & Belote, 2022), predominantly in public areas, including 27 wilderness areas and three renowned national parks – Yellowstone, Rocky Mountain, and Glacier. The Pacific Crest Trail is a 4,265-km long trail that extends across the Sierra Nevada and Cascade mountain ranges. It crosses mostly public lands with a relatively well-protected corridor (Wilson & Belote, 2022), including seven national

parks, three national monuments, 24 national forests, and 33 federal wilderness areas (Goldenberg & Soule, 2014). Some famous attractions are Yosemite, Crater Lake, and Mount Rainier national parks. Both trails are managed by the US Forest Service in partnership with non-profits CDT Coalition and PCT Association), the US National Park Service, and the Bureau of Land Management.

3.2.2 Data Collection

This study is based on surveys with 376 hikers (191 in CDT and 185 in PCT), between May and August 2022. A pilot study including the sense of place construct was completed on the Appalachian Trail (AT; n=226; July-August 2021). On each trail, the sample consisted of an on-trail intercept survey in six trail sections, with paired popular and moderately used sections and samples of between 30 and 40 people in each. Expert opinions were used to select sections, and popularity followed the *AllTrails* app categories based on data generated by its users. The first adult hiker from each group passing through the interview point was approached, and no more than one person from the same group was interviewed. The survey was conducted using the Qualtrics offline survey tool in a tablet. All interviews were conducted in-person by only the first author to ensure greater consistency. The application was only in English, and additional explanations were provided in Spanish in case of difficulty with the language. The questionnaires were anonymous and included questions related to previous experiences, motivation, hiking characteristics, and some demographic data, as well as Likert scales associated with sense of place, connection to nature, and pro-environmental behaviors.

3.2.3 Procedures and Constructs Measurement

The constructs (SoP, CN, and PEB) were evaluated using five-point scales developed and tested by other authors or items tailored to this context. All scales were anchored by 1 indicating an extreme negative response (e.g., 'strongly disagree' or 'not willing at all') and 5 indicating an extreme positive response (e.g., 'strongly agree' or 'definitely would'). Six of the 376 interviews were discarded due to incomplete answers. Identical responses for all items by the same respondent (Standard deviation < 0.25) were considered unengaged responses (Collier, 2020), but no case was excluded by this criterion. Four missing values (0.037% of the total sample) were replaced based on the median of the variable. The sample size was greater than 10 times the number of observed variables (29), considered appropriate for structural equation modeling (Nunnaly & Bernstein, 1994). The normality of the data was assessed following the thresholds proposed by Kline (2011) for skewness (> -3 and < +3) and kurtosis (> -10 and < +10). The internal consistency was examined for each construct through Cronbach's alpha reliability coefficients, and items with a corrected item-total correlation < 0.4 were not included in the analyses (Vaske, 2019).

Exploratory Factor Analyses (EFA) were performed in SPSS to examine scale items and identify poorly fitting items using the maximum likelihood estimation method with Promax rotation. Assumptions of sampling adequacy and sphericity were examined using the Kaiser–Meyer–Olkin (KMO) and Bartlett's tests. The minimum variance explained accepted was >50%, and the variables with the lowest factor loading were excluded from the model until the variance reached the minimum threshold. The number of factors that best fit the data was defined with parallel analyses (Fabrigar & Wegener, 2011) using an engine developed by Vivek et al. (2017).

3.2.3.1 Sense of place scale

The sense of place construct was assessed through 11 questions based on Williams & Roggenbuck (1989) and Ardoin et al. (2012) with word adaptations for the context of trails. The Sense of Place Scale (SoP) was tested initially in a survey with 226 hikers along the Appalachian Trail. The data from CDT and PCT survey were used to validate the item selection. No items were excluded by skewness and kurtosis criteria, but two items were excluded due to low item-total correlations (Table 3-1). An exploratory factor analysis (EFA) was carried out with nine remaining items to find the model that best fits the data. Three models were hypothesized:

4. One-factor model: all nine items represent a single, homogeneous SoP construct measure.
5. Two-factor model: the nine items divide into two factors related to place identity and dependence as proposed by Ardoin et al. (2012) for psychological dimensions.
6. Three-factor model: the nine items divide into three factors associated with place attachment, place dependence, and place identity, following the Jorgensen & Stedman (2001) model.

The EFA with parallel analysis showed the one-factor model as the best fit to the data, with a second factor having only a marginal effect. However, this one-factor model had a poor fit to the data, explaining only 47.45% of the variance, below the minimum threshold. After excluding the item with the lowest factor loading, the variance explained was 50.10%. Then, a second EFA was run using the data from this study (CDT and PCT) using the remaining eight items. The one-factor model was confirmed, but the variance explained was slightly below the minimum threshold (49.06%). After excluding the item with the lowest factor loading, the variance explained was 51.28% with all the items above the recommended thresholds for Confirmatory Factor Analysis - extraction values > 0.40 individual factor loading > 0.5, and mean factor loading > 0.7 (Collier, 2020). The final SoP scale, therefore, has seven items (Table

3-1). As the SoP scale was unidimensional, it was not possible to test the hypothesis of place identity as a mediator between place dependence and the other constructs (H4).

3.2.3.2 Pro-environmental behavior and intentions scales

To assess pro-environmental behavior and intentions in this context, 15 questions derived from three PEB scales (Alisat & Riemer, 2015; Larson et al., 2015; Markle, 2013; Table 3-2). Nine questions focused on the intention to protect the trail's landscape and were stated as "If something threatened to change the landscape or environment of this place, such as permanent clear cuts for commercial purposes, how willing would you be to take each of the following actions?", being one not willing at all' and five 'definitely would'. The *willingness to protect the trail landscape* dimension brings together some questions related to *social environmentalism* and *environmental citizenship* categories proposed by Larson et al. (2015) with a place-based approach related to the location of the interview. The other six questions involved everyday self-reported behaviors outside the trails and were stated as "Thinking about your everyday actions, please tell me how frequently you actually adopt these behaviors", being one 'never', and five 'always'. An Exploratory Factor Analysis was performed using only the CDT data (n=188). Then, data from PCT (n=182) was used as a hold-out sample to validate the model after item selection and factor identification.

As with the sense of place construct, concerning the pro-environmental behavior construct, three models were hypothesized:

1. One-factor model: represented by a single, homogeneous pro-environmental behavior construct, joining all the PEB measures.
2. Two-factor model: the PEB items would be divided into two factors related to willingness to protect the trail landscape and daily behaviors.
3. Three-factor model: the PEB items would be divided into three factors also related to willingness to protect the trail landscape and daily behaviors, but with the latter group

being divided into conservation lifestyle and neighborhood stewardship behaviors, following Larson et al. (2015).

The EFA with CDT data was performed and no items were excluded by skewness and kurtosis criteria, but four items were excluded due to low factor loadings (Table 3-2). The model indicated three factors, clearly dividing the items related to the *willingness to protect the trail landscape* (WPT) and subdividing the *everyday behaviors* into two factors. the sub-group of everyday behaviors was separated into two groups, which we called *lifestyle behavior* and *neighborhood stewardship*, adapted from Larson *et al*. (2015; Table 3-2). We adapted the name of *land stewardship* to *neighborhood stewardship* to clarify that this behavior refers to the respondent's area of residence and to avoid confusion with the *willingness to protect the trail landscape* dimension. The internal consistency was confirmed (Cronbach's alpha = 0.821), and the KMO (0.807) and Bartlett's tests ($p<0.001$) showed the data adequacy for factor analysis. The total variance explained was 50.09%, slightly above the minimum threshold. In the second analysis, with the PCT data, the same pattern emerged, dividing the same three factors identified for the CDT (Table 3-2). The Cronbach's alpha was 0.820, the KMO was slightly higher than that of the CDT (0.811), and Bartlett's tests ($p<0.001$) also confirmed the sample adequacy for factor analysis. The total variance explained was also slightly above the threshold (51.61%).

3.2.3.3 Connection to nature scale

Connection to nature was assessed using the Connectedness with Nature Scale proposed by Mayer & Frantz (2004) in the 7-item reduced version proposed and tested by Pasca et al. (2017). Mayer & Frantz (2004) claim that their scale is affective and experiential, which is contested by other authors, who claim that the scale measures beliefs about people's connection to nature and not proper emotional connections (Perrin & Benassi, 2009). Pasca et al. (2017)

treat the Connectedness with Nature Scale as a subjective cognitive scale. This scale was chosen because it is unidimensional, a necessary condition for CFA, and does not contain statements associated with activities in nature or behaviors. Scales that contain statements with these characteristics, such as the Love and Care for Nature Scale (LCN; Perkins, 2010), could create a bias and compromise the validity of the factor analysis when associated with sense of place or pro-environmental behavior scales. Using data from this study, there was no skewness and kurtosis issues, and the internal consistency was confirmed (Cronbach's alpha = 0.899). An EFA was performed and KMO (0.913) and Bartlett's tests ($p<0.001$) showed the sampling adequacy of the data for factor analysis. The unidimensionality was also confirmed and only one factor was extracted, which explained 56.99% of the variance. No items were excluded based on factor loadings.

3.2.4 Data Analysis

After selecting items and validating each scale separately, another EFA was performed with the variables of all constructs to identify possible cross-loadings, check how the variables grouped into factors, and generate a clear pattern matrix for the next steps. The same EFA cut-off values from the previous analyzes were used. The Harman's single factor test was used to check if a common method bias influenced the result (Collier, 2020).

Subsequently, a Confirmatory Factor Analysis was performed in AMOS 26.0 to estimate a comprehensive full measurement model with the pre-specified constructs. The goodness of fit was examined using the Relative Chi-square test (χ^2/dF must be between 1 and 3), Comparative Fit Indices (CFI acceptable > 0.90), Root Mean Square Error of Approximation (RMSEA acceptable <0.08), and the Standardized Root Mean Square Residual (SRMR acceptable < 0.08), following thresholds suggested by Collier (2020). Composite Reliability (C.R. must be > 0.70)

was used to ensure reliability, Average Variance Extracted (AVE must be > 0.50) to assess convergent validity, and Maximum Shared variances (MSV) compared to AVE to discriminant validity, following the thresholds proposed by Hair *et al*. (2010).

Finally, we built a full structural model to examine the relationships between constructs and test our hypotheses about the relationship between sense of place and pro-environmental behaviors and the role of connection to nature as a mediator. Since the pro-environmental behavior was divided into three factors, we also tested the hypotheses with *Willingness to Protect the Trail Landscape – WPT* as a possible partial (H5) or full (H6) mediator between *connection to nature* and the daily behaviors *(Conservation Lifestyle Behavior* and *Neighborhood Stewardship Behaviors)*, based on Halpenny (2010). Because the thresholds proposed by many authors are reasonable rules of thumb but not absolute limits (Kline, 2011), when only one assumption was not fulfilled by a narrow margin for any variable, two models were built, removing the recommended variables, or keeping them trying to capture the maximum complexity of the respective construct. Bootstraps with 5,000 samples with 95% confidence intervals were performed to test the mediation hypotheses and their significance, and changes in Akaike Information Criterion (AIC; Kline, 2011) was used to identify the most parsimonious model.

3.3 Results

On the CDT, the response rate was 91% (191/210). Day hikers represented 66% of the sample, multi-day/section hikers 10%, and thru-hikers 24%. The profile of respondents was predominantly male (60.7%), and white (87.4%), with ages ranging from 19 to 91 years: a predominance in the ranges of 18-30 years (30.9%) and 31-45 years (29.3%). The majority have completed college (80.6%) and were employed full-time (55.5%). On the PCT, the response rate

was 89% (185/208). Day hikers comprised 59% of the sample, multi-day/section hikers 14%, and thru-hikers 27%. The profile of respondents was predominantly male (63.8%), white (78.9%), with ages ranging from 18 to 77 years old, with a predominance in the range of 31-45 years old (32.4%), followed by 18-30 years old and 46- 60 (both with 25.9%). Most have completed college (80.2%) and were employed full-time (57.8%).

The mean SoP for the whole population was 4.12 (S.D. = 0.78) and the mean CN was 4.31 (S.D. = 0.79). Regarding pro-environmental behaviors, the mean for *willingness to protect the trail landscape* was 4.19 (S.D. = 0.80), the mean for *conservation lifestyle* was 3.55 (S.D. = 0.99), and 3.18 (S.D. = 1.17) for *neighborhood stewardship* (Table 3-3).

3.3.1 Factor Analyses

The EFA with all items identified five factors, confirming the separation of variables: - Sense of Place, Connectedness with Nature, and within Pro-Environmental Behaviors - *willingness to protect the trail landscape*, *conservation lifestyle,* and *neighborhood stewardship*. These five factors explain 53.74% of the variance. Regarding internal consistency, only the *neighborhood stewardship* construct showed a low Cronbach's alpha (0.641; Table 3-4). The KMO (0.911) and Bartlett's tests ($p<0.001$) showed the sample adequacy for factor analysis, and the minimum limits for extraction values and factor loadings were achieved (Table 3-4), as well as the goodness of fit test (chi-square/dF = 1.83; $p<0.001$). Harman's single-factor test showed no common method bias in this study, as indicated by the low variance explained (33.42%) by one factor after unrotated factor analysis.

In the CFA, the model fit was *excellent* for $\chi 2$/dF (2.137), SRMR (0.055), RMSEA (0.056), and *acceptable* for CFI (0.929) according to Collier (2020) criteria. Construct reliability was demonstrated by C.R. values greater than 0.70, except for *neighborhood stewardship* (NS;

0.65). Convergent validity was established by AVE > 0.50, except for *willingness to protect the trail landscape* (WPT; 0.455) and again NS (0.479). Considering that the AVE values were slightly below the threshold and that the discriminant validity confirmed the separation between the constructs, with maximum shared variance much lower than the square root of AVE, two models were built, one maintaining all items and another excluding recommended items until all established criteria were met (Table 3-4). In the second model, after excluding the *neighborhood stewardship* construct and three items of *willingness to protect the trail landscape* (WPT_4, WPT _5, and WPT _8), all remaining constructs met the criteria, and the fit measures remained practically the same ($\chi 2/dF = 2.317$; SRMR = 0.055; RMSEA = 0.060; CFI = 0.939). After the exclusion of the three items, the C.R. for WPT was reduced from 0.83 to 0.75, and Cronbach's alpha decreased from 0.819 to 0.751, but both remained above the minimum acceptable threshold (Table3- 4).

3.3.2 Full Structural Model

The results of SEM indicated that both models (the first keeping all variables, and a second excluding those that did not meet the criteria) had a good fit, as the overall fit measures showed values above the established minimum thresholds (Table 3-5). The two models built showed the same results in terms of statistical significance with small variation in estimates.

Sense of place (SoP) has significant direct effects on *connection to nature* (CN) but not on any pro-environmental behavior. CN showed significant direct effects on *willingness to protect the trail landscape* (WPT) and *conservation lifestyle* (CL) but not on *neighborhood stewardship* (NS). WPT, in turn, showed significant direct effects on CL and NS. The indirect effects of SoP on all pro-environmental behavior with CN as a mediator were significant (Table

3-6), with bootstrap analysis showing $p < 0.001$ for all cases. The two models built confirmed the hypothesis of CN as a full mediator between the SoP and all PEBs (H3; Figure 3-2). The indirect effects of CN on CL and NS with WPT as a mediator were also significant. In this case, both models confirmed the hypotheses of WPT as a partial mediator between CN and CL (H4), and as a full mediator between CN and NS (H5; Figure 3-2). Finally, the AIC model selection showed the model with interactions between *willingness to protect the trail landscape* and the daily behaviors as more robust than the one without these relationships: in the first model with all variables, AIC = 752.530 with interactions between WPT and CL/NS and AIC = 769,470 without these interactions. In the second model excluding variables AIC = 512.023 with the WPT-CL interaction and AIC = 521.199 without this interaction.

3.4 Discussion

3.4.1 Constructs, Dimensions, and Scales

Respondent profiles were very similar on both trails, suggesting that CDT and PCT hikers can be considered a single population. Although the CDT is less developed and passes through more remote areas, the sampling also included popular attractions along this trail, such as St. Mary's Falls (Glacier NP, MT), which may have balanced the sampling and contributed to its profile being closer to the PCT.

Regarding the SoP, two items were eliminated from the scale due to low correlation, and another two in the EFA to meet the established minimum criteria of factor loading and explained variance. The final seven-item scale was one-dimensional. These remaining seven itens were classified by Ardoin et al. (2012) to be in the psychological (6) and biophysical (1) dimensions of SoP, and the six psychological items were divided in place identity (4) and place dependence (2) subdimensions (Ardoin 2009). Nevertheless, these classifications are debatable, as one item

(SoP4 in this study) was classified in place identity by Ardoin (2009) and place dependence by Vaske & Kobrin (2001). Controversies about sense of place dimensions make this discussion more complex.

Concerning CN, the EFA confirmed the unidimensionality of the reduced version and maintained all seven items tested by Pasca et al. (2017). The CN Scale has been heavily tested, and this result suggests this scale has been more developed than the scales developed for other constructs addressed in this study.

The PEB split into different dimensions, as expected. The willingness to take action items were grouped into one dimension, which we called *willingness to protect the trail landscape*. The daily behaviors were divided into two, associated with *conservation lifestyle* and *neighborhood stewardship*. All items were grouped as expected, except for "I try to eat local food as much as possible," which was grouped with neighborhood stewardship. As a consumption behavior it is commonly related to *conservation lifestyle* (Larson et al., 2015), but when prioritizing local producers, it also makes sense to relate it to neighborhood care. Prioritizing local food not only saves transport energy and reduces food waste but also influences land use and, therefore, the local landscape.

The overall means were relatively high for all scales, with highest means for CN (4.29/5), closely followed by WPT (4.19/5) and SoP (4.12/5). Means for daily behaviors were lower (CL = 3.55/5; NS = 2.93/5), suggesting that they are less related to SoP and CN, as confirmed by the full structural model. The high overall means were somewhat expected because the interviews were conducted on trails, and only people seeking activities in natural environments were interviewed. However, further research comparing different audiences with standardized scales would allow a better assessment of the reliability and generalizability of these findings.

3.4.2 Relationships Between Sense of Place, Connection to Nature, and Pro-Environmental Behaviors

The model suggests that sense of place is directly related to connection to nature but not to pro-environmental behaviors. As a full mediator, connection to nature appears to be an essential step in linking these constructs. Even the clearly place-related PEB, such as the items of *willingness to protect the trail landscape*, did not show a direct relationship with SoP, but were mediated by CN. Outdoor recreationists can develop SoP motivated by reasons unrelated to nature, such as practicing recreational activities, developing skills, or ensuring health (Anderson & Fulton, 2008; Kyle et al., 2004), but we can speculate that only when this SoP is associated with CN, would it influence PEBs. Scannell & Gifford (2010) divided sense of place in civic and natural dimensions and found only the natural dimension influencing PEB. Wakefield et al. (2001) studied civic action against pollution threats in an urban industrial neighborhood and found sense of place as a "necessary but not sufficient" condition to generate pro-environmental behavior. Their respondents engaged in civic action showed sense of place, but not everyone who reported sense of place engaged in civic action in an urban setting.

At first glance, our result seems to contradict some authors that found a direct relationship between SoP and PEB (Halpenny, 2010; Vaske & Kobrin, 2001). However, these studies did not assess the possibility of this relationship being mediated by a third factor, such as connection to nature. If we excluded CN from our model, the direct effects of SoP on all pro-environment intentions and behaviors would be significant, and the previously cited studies would be corroborated. On the other hand, both explored subdimensions of sense of place: identity and dependence, which was not possible in our study because our scale turned out to be

one-dimensional. They found place identity as a full mediator between place dependence and PEB. Place identity and connection to nature have common roots (Clayton, 2003; Proshansky et al., 1983) and discussing the importance of place identity, Halpenny (2010) speculated that "individuals may transfer the importance they assign to the place they love and value to the more abstract concept of the environment, increasing the possibility of their engagement in environmentally-responsible behaviors as a result" (p.417). Our model confirms this statement and represents an improvement over previous models by incorporating a new construct and identifying connection to nature as a full mediator between SoP and PEB.

Regarding the relationship between CN and PEBs, we found direct effects on *willingness to protect the trail landscape* and *conservation lifestyle* but not on *neighborhood stewardship*. WPT has direct effects on the two other PEBs, representing a partial mediator between CN and CL and a full mediator between CN and NS. Alisat & Riemer (2015) found that CN seems to relate more strongly to activist behaviors than to personal practices, which can be influenced by other factors such as personal health or monetary incentives. Our model corroborates this finding by presenting behavior intentions associated with activism (WPT) as a mediator between CN and personal practices (CL and NS). The model also reinforces findings by Halpenny (2010), who studied national park visitors and found park-specific behavioral intentions as a possible mediator between place identity and general pro-environment intentions. We cannot rule out the influence of the interview environment on the emphasis given to place-based pro-environmental behaviors. Hikers could be more aware of the trail's context or just be thinking about problems and actions closer to their reality at the moment when responding. However, these seem to influence behavior in other environments and contexts positively. In this case, hikers who become aware of the importance of landscape conservation during a journey on a mega trail

would project part of these concerns into their everyday life, adopting pro-environmental behaviors after the experience. The existence of this *spillover effect* in *pro-environmental behaviors* is controversial (Thøgersen, 1999). However, the most parsimonious model we found suggests it, with *willingness to protect the trail landscape* positively influencing daily behaviors.

3.4.3 Implications for Conservation

Our results suggest that developing sense of place alone is not enough to generate pro-environmental behaviors and these behaviors are only adopted by people who also present a strong connection to nature. On the other hand, the importance of hikers developing a relationship with the trail's landscape is evident in the role of place-based behavior intentions as a mediator between CN and daily PEBs. The awareness of the importance of protecting the trail's landscape seems to encourage hikers to adopt PEBs also in their daily lives away from the trails.

As Zylstra et al. (2014) pointed out, the knowledge about people's relationship with natural environments from fields such as ecopsychology and outdoor learning "rarely find their way into mainstream conservation." (p.134). Therefore, identifying which aspects relate experiences and sense of place to connection to nature and pro-environmental behaviors, and encouraging activities that generate greater involvement with the environment is strategic to promote these behaviors among outdoor recreationists. By being an appreciative and relatively slow activity (Nord et al., 1998; Thapa & Graefe, 2003), hiking allows greater involvement with the environment. It is accessible in terms of the skills, equipment, and facilities needed (Mitten et al., 2016) and practiced by millions of people worldwide, offering hiking opportunities seems to be a valuable strategy to engage people in pro-environmental behaviors.

3.4.4 Limitations and Future Directions

The objective of this study is exploring the relationships between sense of place and pro-environmental behaviors and not to develop validated scales. However, the lack of standardized scales for SoP and PEB made their operationalization difficult. It was necessary to test new scales adapted from other studies, and some items were excluded for failing to meet the minimum criteria for analysis. The unidimensionality determined by the EFA limited the hypothesis test on sense of place subdimensions. In addition, PEB was divided into three factors, with few items in two of them, limiting its validity and making the analysis difficult. Another difficulty is adapting the items to different profiles of respondents. Some residents of dense urban areas, for example, questioned items such as “I take steps to improve habitat for wildlife near my home.” The development of standardized scales and the inclusion of items that fit different contexts would be of great value for further research.

The model fit evaluation in SEM is also complex, and many authors question the commonly used thresholds (e.g., Kline, 2011). The limits for recommended fit measures are not absolute and are considered rules of thumb (Collier, 2020). Defining which threshold should prevail when several fit measures are close to the considered thresholds is challenging. The minimum value for Cronbach's alpha reliability coefficient is also debatable. It is usually considered acceptable above 0.65 in human dimensions research, but some authors accept > 0.60, while others suggest a minimum of up to 0.80 (Vaske, 2019). To minimize these limitations, we ran two full structural models varying the thresholds for including items. A model with more variables tends to represent these constructs' complexity better and improve content validity (Collier, 2020). On the other hand, the result can be compromised, for example, by low discriminant validity.

Another factor that must be considered is the effect of social desirability, especially for pro-environmental behaviors. Although behavior intentions are considered a good predictor of behavior (Ajzen, 1985), some authors reported low correlations between self-reported and observed behavior (e.g., Corral-Verdugo, 1997). Social desirability bias is a limitation of any survey, especially those with in-person interviews (Vaske, 2019).

Finally, the generalizability of this model must be evaluated. Hiking is probably the least specialized outdoor activity (Mitten et al., 2016), theoretically favoring generalizability. However, SoP for hikers seems to be more associated with place identity (Kyle et al., 2003), while for other activities with more specific requirements, such as hunting, place dependence seems more relevant (Anderson & Fulton, 2008). Thus, the SoP-CN-PEB relationship can be different for place-dependent recreationists and further research testing our model for other outdoor activities could answer about the generalizability of these relationships between sense of place, connection to nature, and pro-environmental behaviors.

3.5 Conclusions

The direct relationship between sense of place and connection to nature suggests that experiences in natural environments may help forge this connection to nature in general. However, sense of place is not sufficient to explain pro-environmental behaviors, and connection to nature seems to be a fundamental step in the process from nature experiences to engaging people in conservation. If connection to nature is essential to generate willingness to take action, the intention to engage civically to protect the trails and their landscape also seems important for connection to nature results in pro-environmental behaviors in the hikers' off-trail everyday life. The relationship between sense of place and pro-environmental behavior, through connection to

nature, in this study suggests that hiking should be encouraged and can be a valuable strategy to promote engagement in conservation.

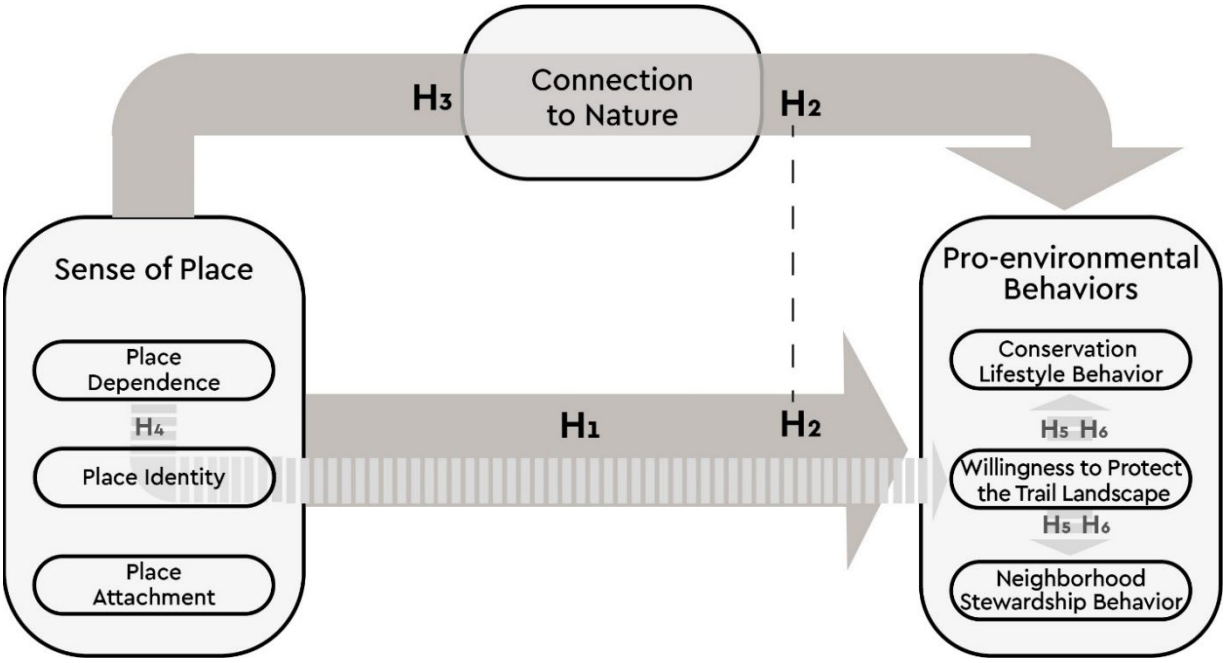


Figure 3-1. Conceptual model and hypotheses (H_x) on the relationships between sense of place and pro-environmental behavior (dark gray arrows), including their subdimensions (dashed light gray arrows) and connection to nature as possible mediators.

Table 3-1. EFA results with Sense of Place items factor loadings and total variance explained

		AT (n= 226) Factor loadings		CDT + PCT (n=376) Factor loadings	
Sense of Place items		Round 1	Round 2	Round 1	Round 2
SoP_1	I feel like this place are part of me	.760	.761	.761	.764
SoP _2	This place are the best place for what I like to do	.692	.693	.733	.711
SoP _3	I identify strongly with this place	.822	.838	.846	.851
SoP _4	I get more satisfaction out of being here than anywhere else	.723	.718	.583**	***
SoP _5	I am very attached to this place	.860	.865	.720	.711
SoP _6	Coming or being here says a lot about who I am	.706	.688	.666	.661
SoP _7	The things I do here, I would enjoy doing just as much somewhere else	*	***	***	***
SoP _8	Because of my lifestyle, this place is important to me	.507	.488	.618	.633
SoP _9	Most of my family/friends are, in some way, connected with this place	*	***	***	***
SoP _10	I identify with the physical landscape of this place	.527	.521	.640	.657
SoP _11	I am interested in the plants and animals that live in this place	.491**	***	***	***
	Total Variance explained:	47.45%	50.10%	49.06%	51.28%

AT: Appalachian Trail; CDT: Continental Divide Trail; PCT: Pacific Crest Trail. * Item not included in EFA because of low correlations; **Lowest factor loading item excluded because of total variance explained <50%; Item excluded in previous rounds.

Table 3-2. Pro-Environmental Behavior items tested and EFA results for CDT and PCT

		CDT (n= 188)			PCT (n=182)		
		Factor loadings (% Variance explained)			Factor loadings (% Variance explained)		
		1 (27.1%)	2 (15.5%)	3 (7.5%)	1 (33.6%)	2 (12.8%)	3 (5.3%)
Willingness to Protect the Trail Landscape - WPT							
WPT_1	Talk to family/friends/community about it	.583			.687		
WPT _2	Use online tools (e.g. post on internet/social media) to gather attention	Excluded			Not included		
WPT _3	Sign a petition	.800			.759		
WPT _4	Write to authorities (e.g. congress people)	.697			.780		
WPT _5	Attend a protest/rally	.509			.633		
WPT _6	Take this issue in account when voting	.652			.734		
WPT _7	Stop consuming products from companies that threaten the landscape	Excluded			Not included		
WPT _8	Donate money to ensure the protection of the land	.438			.622		
WPT _9	Volunteer to protect or keep this place in good conditions	Excluded			Not included		
Conservation Lifestyle Behavior - CL							
CL_1	I try to adapt my diet to reduce my impact on nature		.532			.422	
CL _2	I try to reduce my energy consumption		.749			.796	
CL _3	I try to reduce my carbon footprint.		.948			.873	
Neighborhood Stewardship Behaviors- NS							
NS_1	I try to eat local food as much as possible	Excluded			Not included		
NS_2	I take steps to improve habitat for wildlife near my home			.776			.652
NS_3	I do volunteer work to care for a natural area near my home			.709			.607
		Total Variance explained: 50.1%			Total Variance explained: 51.6%		

Table 3-3. Mean values of hikers' responses for each construct

Constructs/dimensions	**Mean (out of 5)**	**Standard deviation**
Sense of Place	4.12	0.78
Connection to Nature	4.31	0.79
Pro-environmental behaviors dimensions		
Willingness to Protect the Trail Landscape	4.19	0.80
Conservation Lifestyle	3.55	0.99
Neighborhood Stewardship	3.18	1.17

Table 3-4. Confirmatory factor and reliability analysis

Construct	Measurement item	Stand. Factor loading	t-value	Crombach's alpha	AVE	MSV
Sense of Place (C.R.= .88)				0.876	0.514	0.236
SoP_1	I feel like these places are part of me	0.772	*			
SoP_2	These places are the best places for what I like to do	0.705	13.686			
SoP_3	I identify strongly with these places	0.838	16.624			
SoP_5	I am very attached to these places	0.701	13.611			
SoP_6	Coming or being here says a lot about who I am	0.671	12.948			
SoP_8	Because of my lifestyle, these places are important to me	0.651	12.507			
SoP_10	I identify with the physical landscape of these places	0.662	12.755			
Reduced Connectedness with Nature Scale (C.R.= .90)				0.899	0.570	0.289
CN_1	I think of the natural world as a community to which I belong	0.698	*			
CN_2	When I think of my life, I imagine myself to be part of a larger cyclical process of living	0.799	14.249			
CN_3	I often feel a kinship with animals and plants	0.729	13.066			
CN_4	I feel as though I belong to the Earth as equally as it belongs to me	0.735	13.179			
CN_5	I often feel part of the web of life	0.802	14.303			
CN_6	I feel that all inhabitants of Earth, human, and nonhuman, share a common "life force"	0.712	12.784			
CN_7	Like a tree can be part of a forest, I feel embedded within the broader natural world	0.803	14.316			
*Willingness to Protect the Trail Landscape (C.R.= .83; 0.75**)*				0.819 (0.751)**	0.455 (0.502)**	0.289
WPT_1	Talk to family/friends/community about it	0.667	*			
WPT _3	Sign a petition	0.717	11.598			
WPT _4	Write to authorities (e.g. congress people)	0.731	11.775			
WPT _5	Attend a protest/rally	0.620	10.285			
WPT _6	Take this issue in account when voting	0.676	11.060			

WPT _8	Donate money to ensure the protection of the land	0.626	10.370			
Conservation Lifestyle Behavior (C.R.= .80)				0.774	0.574	0.176
CL_1	I try to adapt my diet to reduce my impact on nature (e.g. reducing meat consumption or being vegetarian)	0.593	*			
CL _2	I try to reduce my energy consumption (e.g. using bikes or public transport, turning off air conditioning)	0.739	10.751			
CL _3	I try to reduce my carbon footprint.	0.907	10.982			
*Neighborhood Stewardship Behavior (C.R.= .65 ***)*				0.641***	0.479***	0.135
NS_2	I take steps to improve habitat for wildlife near my home	0.744	*			
NS_3	I do volunteer work to care for a natural area near my home	0.635	6.514			

Table 3-4. Continued

Model Fit Statistics: χ^2 = 566.301 (380.023**), df = 265 (164**); CFI = 0.93 (0.94**), RMSEA = 0.056 0(.060**)
C.R. = Composite reliability; AVE = Average Variance Extracted; MSV = Maximum Shared variance
* Items constrained for identification; ** Results after excluded WPT _4, WPT _5, WPT _8, and NS Construct; *** Excluded if AVE > 0.5 minimum threshold or the Crombach's alpha > 0.65 are adopted.

Table 3-5. Direct effects in structural model tests

Relationships	*Standardized Estimates*	*Composite Reliability*	*p-values*
Sense of Place – Connection to Nature	0.527 (0.527)	8.415 (8.424)	< 0.001 (< 0.001)
Sense of Place – Will. to Protect Trail	0.044 (0.01)	0.717 (0.152)	0.473 (0.879)
Sense of Place – Conservation Lifestyle	-0.023 (-0.024)	-0.359 (-0.360)	0.720 (0.719)
Sense of Place – Neighborhood Stewardship	0.137 (*)	1.752 (*)	0.080 (*)
Connection to Nature – Will. to Protect Trail	0.606 (0.631)	7.749 (7.801)	< 0.001 (< 0.001)
Connection to Nature - Conservation Lifestyle	0.291 (0.2926)	3.411 (3.227)	< 0.001 (0.001)
Connection to Nature - Neighborhood Stewardship	0.161 (*)	1.653 (*)	< 0.102 (*)
Will. to Protect Trail - Conservation Lifestyle	0.300 (0.284)	3.715 (3.232)	< 0.001 (0.001)
Will. to Protect Trail - Neighborhood Stewardship	0.259 (**)	2.758 (*)	0.006 (*)

Values in parentheses correspond to the second structural model after excluding variables that did not meet the criteria. Model Fit Statistics: χ^2/dF = 2.1979, SRMR = 0.063, RMSEA = 0.057, CFI = 0.925 (χ^2/dF = 2.317; SRMR = 0.058; RMSEA = 0.060; CFI = 0.939). * Neighborhood Stewardship was excluded in the second structural model.

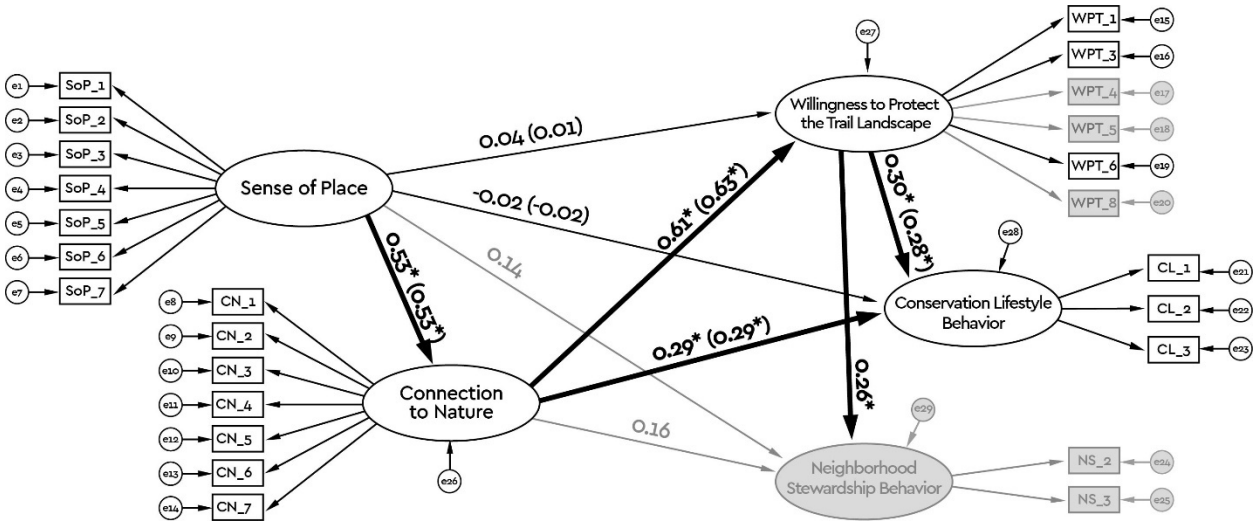


Figure 3-2. Full structural models associating the constructs (ellipses), including the variables contributing to each construct (rectangles) and residual errors (circles). In light grey constructs and variables excluded in the second structural model (values in parentheses correspond to the second structural model after excluding variables that did not meet the criteria). * Significant values at p<0.01 level in bold.

Table 3-6. Test for Mediation using Bootstrap Analysis

	Direct Effects		*Indirect Effects*				
Relationships	*Standardized estimates*	*p-value*	*Standardized estimates*	*Confidence interval (Lower – upper)*		*p-values*	*Conclusion*
Sense of place – pro-environmental behaviors (CN as a mediator)							
Sense of Place → Willingness to Protect the Trail	1: 0.044 2: 0.019	0.547 0.844	0.320 0.332	0.225 0.226	0.429 0.462	< 0.001 < 0.001	Full mediation
Sense of Place → Conservation Lifestyle	1: - 0.023 2: - 0.016	0.709 0.803	0.262 0.253	0.167 0.153	0.377 0.365	< 0.001 < 0.001	Full mediation
Sense of Place → Neighborhood Stewardship	1: 0.316	0.130	0.179	0.088	0.291	< 0.001	Full mediation
Connection to nature – daily behaviors (WPT as a mediator)							
Connection to Nature → Conservation Lifestyle	1: 0.291 2: 0.290	< 0.001 < 0.001	0.182 0.179	0.074 - 0.312 0.060 – 0.326		0.002 0.006	Partial mediation
Connection to Nature → Neighborhood Stewardship	1: 0.161	0.140	0.157	0.043 – 0.302		0.007	Full mediation

1: Full structural model with all variables; 2: Full structural model after excluding variables that did not meet the criteria. Indirect effects tested with Bootstrap sample (5,000) with replacement (95% Confidence Interval).

CHAPTER 4
A COMPARATIVE ANALYSIS OF PERCEPTIONS ON THE ROLE OF MEGA TRAILS IN GATEWAY COMMUNITIES' ECONOMY AND IDENTITY

Since the pioneering proposal to implement the Appalachian Trail (AT) a century ago, long-distance hiking trails have promoted local economic development through outdoor recreation (Cerveny et al., 2022; Foresta, 1987). In the visionary article in which he presents the idea of the AT, Mackaye (1921) highlights its potential as an alternative for leisure and contact with nature for urban workers, while generating a series of economic opportunities that would enable small rural communities along the trail to thrive. By combining outdoor activities in a conserved landscape with efforts to meet the needs of hikers and residents, Mackaye seemed to anticipate the concept of sustainable tourism, which is proposed to be economically viable, environmentally appropriate, and socially acceptable (McCool, 2016).

Tourism is often perceived to be an alternative for regions suffering economic decline, where agriculture and other primary sectors are less competitive (Harris et al., 1998; Li et al., 2019; A. Mayer, 2021). However, negative consequences of intensifying tourism have been noted in gateway communities, defined as small rural towns near major public lands or notable natural attractions (Stoker et al., 2021), such as higher costs of living, real estate appreciation, and gentrification (McMahon, 1999; Stoker et al., 2021). The concerns with identifying and controlling unplanned negative effects of tourism and the resistance they can cause in local communities date back many decades (Butler, 1975).

Unlike the logic of large tourist clusters, which concentrate facilities and their impacts in a few communities (Cunha & Cunha, 2005), mega trails disperse their users over vast areas, diluting the positive and negative effects of tourism over thousands of kilometers. While many gateway communities concentrate the impact of major tourist attractions and grow until the

quality of the experience is compromised, facing a boom and collapse lifecycle associated with a tourism destination (Butler, 1980; Monterrubio Cordero, 2008), each mega trail spreads these effects in dozens of gateway communities. Instead of large tourism facilities, mega trails create many small-scale business opportunities, which avoid boom and tends to be more sustainable. At the same time, these communities are the main source for resupplying hikers, without which there is no long-distance hiking, but they also serve other visitors attracted to the trail (see Chapter 2).

Estimating the total economic impact of a mega trail is challenging since its length and multiple access points make it difficult to even estimate the total number of users (Pollock et al., 2007; Zarnoch et al., 2011). Estimates of the economic impact of long-distance trails range from just over $1.5 million per year in two counties (Bowker et al., 2007) to over $120 million for a trail crossing 12 towns (GAPC, 2021). Even the lowest estimated values can represent a significant output for small communities, eventually offsetting impacts seen as negative by residents. While many tourist destinations invest in growth and massification and seek to generate significant economic benefits to offset negative impacts, minimizing impacts, even if economic benefits are limited, seems to result in a positive balance and is more in line with the principles of sustainable tourism. The Social Exchange Theory (Emerson, 1976), widely used in tourism research (Ap, 1992), predicts that a balance between positive and negative impacts influences residents' perception of tourism (Frauman & Banks, 2012; Harrill, 2004).

In recent years, Trail Town programs were implemented to enhance and highlight the benefits of trails, reinforce links, and raise support for the trail and its conservation (Camp, 2020). Being a trail town can forge a new community identity, which “refers to the feeling of ‘we’ of individual residents that connect them to each other” (Stewart et al., 2004, p. 316). These

authors argue that the environment can be part of this connection and "become emblematic of stories residents tell about themselves to explain their values and life contexts," with the potential to create and reaffirm community identities (Stewart et al., 2004, p. 316). This process seems particularly intense in towns that had their identity related to an economically collapsed activity (Phillips, 1988). Aiming to engage communities, enhance sustainable economic development, and support regional conservation planning (Camp, 2020; CDTC, 2023a), Trail Town programs reinforce the principles of sustainable tourism. However, few studies assess the extent to which mega trails and trail towns programs influence economic development, stewardship, and community identity (Cerveny et al., 2022).

Having the support and involvement of local communities is considered relevant to the success of a tourism destination (Andereck & Vogt, 2000; Koo, 2018; Yuksel et al., 1999). If residents' perception of the social impacts of natural areas results in local support for their conservation (Jones et al., 2020; McGinlay et al., 2023), knowing how local communities perceive the trails and what factors influence this perception is essential to evaluate these trails as conservation tools. It should be understood to assist communities and trail managers to best plan for how trails and communities can partner together to achieve a variety of socioeconomic and conservation outcomes.

In this study, we interviewed key actors in ten gateway communities along the three most renowned US national scenic trails (NST) to explore factors influencing their perceptions of the trail. We used qualitative comparative analysis to assess the designation as an official trail town, the actual economic impact of tourism, and respondents' personal experiences hiking the trail as factors that potentially explain their perceptions about the importance of trails in the local economy and community identity and eventual negative impacts in their communities. We discuss factors that influence perceptions and their implications for management and conservation of these trails from the perspective of sustainable tourism principles.

4.1 Methods

4.1.1 Exploratory Research and Hypotheses Development

This study had a preliminary exploratory phase developed along the Appalachian Trail between July and August 2021. In a grounded theory approach, we sought to understand the relationship between gateway communities and the trail, the perceptions of key actors (*sensu* Ap, 1992) on the importance of the trail in the economy and local identity, and if trail town (TT) programs are effective in generating awareness and engagement.

Six towns along the trail were studied: three AT Communities Program participants (Damascus, VA; Harpers Ferry, WV; and Manchester, VT) and three closely matched towns with similar economic and demographic characteristics (Glade Spring, VA; Brunswick, MD; and Wallingford, VT). During the visits, aspects such as the visibility and use of the trail's brand and the number of services associated with the trail and tourism were observed. In each town, key actors were identified and contacted, such as town officials, representatives of the chamber of commerce, local business owners, and Appalachian Trail Conservancy (ATC) staff members or volunteers. Informal conversations and unstructured interviews served to identify relevant topics and generate research questions and hypotheses. To allow new topics to emerge in conversations, we defined guiding questions and moved from there to other topics mentioned by interviewees (Miles & Huberman, 1994).

From the literature review, preliminary interviews, and field observations, the following hypotheses were developed to guide research examining key actors' perceptions of mega trails' role in the economy and identity of each gateway community:

1. The perception of the trail as important to the local economy and community identity is greater, and the perceived negative impacts are lower, in towns engaged in trail town programs.

2. The perception of the trail as important to the local economy and community identity is greater, and the perceived negative impacts are lower in towns where the tourism and outdoor activities are more relevant to the local economy.

3. Key actors with personal experiences hiking the trail perceive it as more important and the negative impacts as low important than other key actors.

4.1.2 Study Areas

The second stage of the study involved a cross-case study approach in gateway communities along the three NSTs known as the Triple Crown of Hiking in the US (Wilson & Belote, 2022) to test the hypotheses developed and explore residents' perceptions. According to Borman et al. (2012), the comparison of different sites or cases allows one to establish "the range of generality of a finding or explanation and, at the same time, pin down the conditions under which that finding will occur" (p. 123). As in the preliminary phase, cities were chosen in pairs along the three trails studied in order to control geographic and demographic characteristics. Five towns involved in the official trail town programs of each trail were selected, paired with other nearby cities with similar conditions but that are not part of the programs (Figure 1).

The Appalachian Trail (AT) is a 3,524-km long trail that follows the Appalachian Mountains along the US Eastern Coast, crossing 14 states from Georgia to Maine. Proposed in 1921 (MacKaye, 1921) and first thru-hiked in 1948, the AT was the pioneer mega trail in the US (NPS, 2015). Annually, more than 1,000 people thru-hike the AT, and an estimated three million people visit some section of the trail (ATC, 2023b). The AT Communities Program launched in 2010 was the first in an NST (Camp, 2020). Today, there are 51 towns officially in the program run by the Appalachian Trail Conservancy. In November 2022, two towns were visited. Damascus, in Virginia, was revisited as it is considered an iconic trail town. It has 788 inhabitants (US Census Bureau, 2023), sits at the crossroads of seven trails, calls itself the Trail Town USA (Damico, 2005), and has been promoting this brand for a long time (Garvey, 1978).

During preliminary fieldwork, we identified a different town that was a better match for Damascus due to the size and proximity of the AT and visited it in the second stage. Hampton is an unincorporated community in Tennessee with a population of 2,030 (US Census Bureau, 2023). The town is adjacent to Watauga Lake and less than 2 km from the AT, but the tourism-related businesses focus on fishing and water activities.

The Continental Divide Trail (CDT) is a 4,873-km long trail between the international borders with Mexico and Canada. It runs through the Rocky Mountain Range, separating the Atlantic and Pacific oceans basins. The CDT crosses a well-conserved corridor (Wilson & Belote, 2022), predominantly in public lands and protected areas, including three renowned national parks – Yellowstone, Rocky Mountain, and Glacier. Just over 100 people successfully thru-hike the CDT annually, but this number is increasing (CDTC, 2023b). Since 2014, the CDT Coalition has developed the CDT Gateway Communities Program (CDT-GCP; Camp, 2020) with 20 officially recognized towns (CDTC, 2023). This study included four towns visited between May and August 2022, two in New Mexico (NM) and two in Colorado (CO). Silver City (NM) has 9,704 inhabitants (US Census Bureau, 2023), and as the name suggests, it originated in silver mining. Today tourism is one of its main economic activities and 97% of the thru hikers resupplied there in 2021 (Halfway Anywhere, 2023). The trail crosses downtown Silver City, which was the first CDT Gateway Community, certified in 2014. Lordsburg (NM) is a city of about 2,335 people (US Census Bureau, 2023) located on the edge of the I-10 highway. The city is not part of the TT program but is the southernmost city of the trail and is used as a base before starting the trail. The town is visited a second time during the hike since the CDT crosses downtown (Halfway Anywhere, 2023). The CDT traverses mountain areas for long stretches without approaching any towns. Hikers often hitchhike on roads that cross the trail to

resupply in not-so-close towns. Salida (CO) is a certified TT with 5,666 inhabitants (US Census Bureau, 2023) 30 km from the trail by road (Table 1), with good tourist infrastructure; 86% of thru-hikers resupplied there in 2021 (Halfway Anywhere, 2023). Buena Vista (CO) is 35 km from the trail by road (Table 1) and has a population of 2,855 (US Census Bureau, 2023). Because it closely follows Salida, only 9% of thru-hikers resupplied there in 2021 (Halfway Anywhere, 2023).

The Pacific Crest Trail is a 4,265-km long trail that extends across the Sierra Nevada and Cascade mountain ranges from Mexico to Canada. It crosses mostly public lands and protected areas, including seven national parks and 24 national forests (Goldenberg & Soule, 2014). Over 4,000 people attempt to thru-hike the PCT annually, but only about 20% complete the trail (PCTA, 2023) due to injuries, poor planning or section closures by fire or snow (Halfway Anywhere, 2023). Two towns in the central portion (Mount Shasta and McCloud) and two in the southernmost portion of the trail (Bishop and Mammoth Lakes), all in California, were visited between June and July 2022. The PCT Association started its TT program in 2018, and only Mount Shasta is an official TT to date (PCTA, 2023). The city has 3,223 inhabitants (US Census Bureau, 2023) and is 15 km from the trail by road (Table 1). Other activities attract outdoor recreationists, such as climbing Mount Shasta. McCloud is a small historical logging town of 945 people (US Census Bureau, 2023) 16 km off the trail by road (Table 1). Local tourism prioritizes the historic district and other outdoor activities, with only some thru-hikers resupplying there (Halfway Anywhere, 2023). Mammoth Lakes has a population of 7,191 (US Census Bureau, 2023) and is a renowned winter destination, attracting skiers. The city is 10 km from the trail by road (Table 1). Mammoth started the process of joining the TT program, but this was interrupted due to the COVID-19 pandemic. Bishop has 6,573 inhabitants, including West Bishop (US

Census Bureau, 2023). It is the city farthest from the trail in this study, 43 km by road (Table 1), but 79% of thru-hikers in 2021 resupplied there due to the long stretch without cities to the south (Halfway Anywhere, 2023).

4.1.3 Interviews, Processing and Data Analysis

In each gateway community, four to seven key actors were interviewed in a purposive sampling, including public managers, chamber of commerce directors, NGO managers, and owner or manager of businesses used by hikers, such as lodging, restaurants, grocery shops and outdoor gear shops. Business owners were contacted at their establishments, while public managers were previously contacted or sought out directly.

The interviews employed a semi-structured, open-ended format and were designed to provide insights into how people think about complex issues (Yuksel et al., 1999) and allow previously unidentified issues to emerge (Bernard, 2011). Most interviews were conducted by the first author in English and in person, except for two respondents who were unavailable during the site visit and were willing to speak later online. An adaptation of the pre-structured case method was used to collect data in several towns with multiple respondents in a limited time and ensure comparability (Miles, 1990). This method minimizes data overload, facilitates data processing and cross-case analyses, and is useful when research questions are clear and aim for hypothesis testing (Miles, 1990). In the transcription, statements were kept as in the original, and only repetitions and unnecessary filler words were removed for clarity.

Qualitative Comparative Analysis (QCA; Rihoux & Ragin, 2009) was used to identify conditions associated with perceptions about the economic importance of NSTs, their influence on local identity, and the magnitude of negative impacts. The QCA is a case-oriented analysis ideal for working with small samples and may be used to corroborate or falsify hypotheses by

defining conditions (independent variables) that should yield a particular outcome (dependent variables) (Rihoux & Ragin, 2009). The ten gateway communities were the cases, and the proportion of responses from actors in each town was used to define the predominant perception in each town. Individuals' perceptions do not just reflect how they are personally achieved but are socially defined (Smith et al., 2013). Thus, the prevailing perceptions, especially from the actor involved in decision-making processes, could represent a community perception (Smith et al., 2013; Wyman & Stein, 2010).

The QCA was run in TOSMANA software (Cronqvist, 2019) using contradictions between same outcomes with different conditions, and logical remainders and Boolean minimization to fill information gaps and identify necessary and sufficient conditions to explain outcomes. (Rihoux & Ragin, 2009). A condition is considered necessary if the outcome never occurs in the absence of the condition. It is considered sufficient if the outcome always occurs when the condition is present, but could also occur when the condition is absent (Rihoux & Ragin, 2009). Consistency and coverage were calculated to assess the proportion of conditions and outcomes covered by each result (Qin et al., 2017).

The outcomes, or dependent variables, were the proportion of key actors who considered the trail important to the local economy and to community identity, and those who perceived important negative impacts of the trail on the community. The open responses were rated for standardizing the data into the same metric to make them comparable (Miles & Huberman, 1994). Explicit mentions of dimensions in the responses, such as *high*, *low*, or *only seasonally*, were considered, and other statements were interpreted by the researcher. The answers about the importance of the trail in the local economy and identity and about perceived negative impacts of the trail were rated as unimportant, important, or unclear. The proportion of 'important' answers

was used to define the prevalent perception for each town, using dichotomous categories. The Tosmana software threshold-setter tool, which uses distance cluster analysis to define the thresholds that best fit the data (Vink & Van Vliet, 2009), was used to define the thresholds between categories.

The conditions, or independent variables, tested were *designation as a trail town*, the *measured relevance of tourism in the local economy*, and the *proportion of respondents with hiking experience in the trail*. The *designation as a TT* variable considered only officially designated towns by the non-profits that manage the programs AT Communities, CDT Gateway Communities and PCT Towns. The economic relevance of tourism was measured using the Location Quotient (LQ) indicator as a proxy. The LQ is a regional economic indicator that measures a region's industry specialization relative to a larger geographic unit. In this study, LQ was defined as the tourism sector's share in total employment for each town divided by the tourism weight on total employment for the state. An LQ > 1.0 means that the city has a greater share of tourism employment than the state, while LQ < 1.0 means a lower concentration (M. M. Miller et al., 1991). LQ of 1.0 was used as the threshold between negative and positive conditions. The *personal experiences* variable was based on any mention of personal hiking experience in the trail during interviews, regardless the duration.

An in-depth analysis of each case, crossing actors' responses with local history and contexts helped to understand the critical factors that can explain different outcomes in a multiple-case study approach (Greene & David, 1984). The perceptions of each key actor were also evaluated, as an analysis at different levels of organization can be helpful to assess the generalizability of a finding from the identification of commonalities and differences within each case and across cases (Abbott, 1992). Statements from the interviews were selected to represent

the prevailing perception in each community, exemplifying perceptions and supporting discussion.

4.2 Results

Fifty-four people were interviewed. This included 11 public officials, 32 business owners/managers, and 11 NGO managers. Gender was evenly split, with 27 females, and 27 males. Their ages ranged from 27 to 72 years and experience in the job or position ranged from less than 1 to 31 years. The proportion of respondents with personal experiences in the trail ranged from 25% in Hampton (AT) to 100% in Silver City (CDT) and Bishop (PCT). The total response rate was 88.5%, and the few actors who refused the interview justified the difficulty in stopping their activities, especially in hotels and restaurants. In some cases, the interview was scheduled for another moment.

All respondents said they value having the NST close to their community. However, perceptions of the importance of the trail to the local economy varied widely, with few (20%) of respondents considering the trail important to the local economy in Lordsburg (CDT) and all (100%) in Silver City and Salida (CDT). Regarding the influence of the NST on local identity, the proportion of respondents who considered it significant ranged from none (0%) in Lordsburg and Hampton (AT) to all 100% in Silver City, Salida, and Damascus (AT; Table 2).

Regarding the perception of the economic importance of the trail, towns with similar conditions had similar outcomes, with no contradictions. Four towns had a positive outcome, regarding the trail as important for the local economy (Table 3). The QCA indicates no relationship between the actual importance of tourism in the local economy, based on LQ, and the key actors' perception of this outcome. All cases with a positive outcome have a high proportion of respondents with personal hiking experiences in the trail. However, not all cases

with most actors with personal hiking experiences have a positive outcome. Therefore, this condition is necessary but not sufficient to explain the positive perception of the economic importance of trails. All trail towns had a high proportion of *important* responses. In contrast, all towns that do not participate in these programs had a low proportion of *important* responses (Table 3). Therefore, this condition is necessary and sufficient to explain the positive outcome, and the analysis showed that participation in TT programs alone explains the positive outcome (Table 4).

Respecting the influence on local identity, there was also no contradiction, and four cities had a positive outcome (Table 3). However, the result shows two solutions to explain the positive outcomes. The first includes participation in the TT program and having tourism as an important economic activity (LQ > 1), represented by Silver City, Salida, and Damascus. If we consider only the CDT and the AT, being a certified TT is a necessary and sufficient condition, but the same does not apply to the PCT. The second solution does not include participation in the TT program but a high frequency of respondents with previous hiking experience and low relevance of tourism in the local economy (LQ < 1), represented only by Bishop (Table 4). As with perceptions about the economy, all cases with a high proportion of respondents perceiving the NST as important for local identity had a high proportion of respondents with previous personal experiences in NSTs, but not all cases with this condition had a positive outcome. Therefore, a high proportion of respondents with personal experiences is a necessary condition but not sufficient to explain the outcome. Once again, there is no relationship between the importance of tourism in the local economy, based on LQ, and the key actors' perception of this outcome.

When asked about the negative impacts of the trail on the community, the vast majority answered that they do not perceive negative impacts or if they do, those impacts are limited. In 5 towns, no respondent considered the impacts important; in another 4, up to 25% of the actors mentioned negative impacts, and only in Bishop a high proportion (75%) of actors considered the impacts significant (Table 1). Thus, no condition clearly explains the outcomes, and results only list Bishop's conditions as necessary but not sufficient to explain the perception of negative impacts (Table 4).

4.3 Discussion and Conclusions

4.3.1 Influence of Trail Town Programs on Perceptions

The QCA showed participation in trail town programs as the condition that best explains positive perceptions about trails. These programs typically require towns to be hiker friendly, create advisory committees, promote events, and recognize the trail in land-use plans and other planning tools (Bristow et al., 2022). In exchange, the towns receive support in plans and actions for sustainable development and tourism promotion, among other advantages (CDTC, 2023a). The four gateway communities where actors perceive the trail as important to the economy are those certified as trail towns. Regarding the influence of NSTs on local identity, this result is repeated for the TTs of AT (Damascus) and CDT (Silver City and Salida) but not for PCT, where the only TT (Mount Shasta) does not perceive the trail as important, but Bishop does.

Regarding local identity, the result is related to TT programs only in the trails where they are more consolidated. The AT Communities Program started in 2010 and is the oldest among the NSTs (Camp, 2020). CDT is the newest trail yet to be fully implemented (Wilson & Belote, 2022), but since 2013, it has invested in the CDT Gateway Communities program as a priority and its results (CDTC, 2023a). The two official CDT TTs included in the study had 100% of

actors perceiving it as important for both the economy and identity. The same occurs for AT, where Damascus, the only AT community studied, scored 83% and 100%, respectively. These three TTs had the highest outcomes of the entire study. On the other hand, the Pacific Crest Trail Towns program has barely started, with only one city designated a trail town. Its implementation was interrupted due to the COVID-19 pandemic and has not yet been resumed (J. Tripp, personal communication, 2023) and shows no influence on the outcomes.

Apart from participation in TT programs covering 100% of positive outcomes for the economy and 75% for identity, the Mammoth Lakes case reinforces the finding of this condition as an explanation for the actors' perceptions. Mammoth was preparing to be recognized as a trail town just before the pandemic in 2020 but did not conclude the process. This intermediate position coincides with the distance cluster analysis, which indicated the thresholds between negative and positive outcomes very close to Mammoth's values.

The relationship between being a TT and positive outcomes is clear, but it is not possible to know whether the perception is influenced by participation in the trail town programs or if the interest in the trail, based on proximity and the experiences of community leaders, generated the positive perception and prompted interest in becoming a trail town. These two factors are likely related, and there is positive feedback between them. The initiative to join the programs is necessarily the result of some previous level of identification with the trail (Koo, 2018). A survey in several AT communities also found that most respondents perceive the program as economically beneficial for TT (Bristow et al., 2022). Damascus identity clearly predates the existence of any program (Garvey, 1978; Phillips, 1988). Still, Silver City appears to be developing its identity out of program-related initiatives, such as trail days. The PCT's contradictory results, in turn, suggest that the lack of a structured program is related to a lower

perception of the trail as an important driver in the local economy and identity. Community involvement is considered essential for TT programs' success, and results can take a few years (Koo, 2018). Thus, the lack of support resulting from the interruption of the PCT program may have influenced the Mount Shasta outcome. On the other hand, the positive outcome for Bishop suggests that the community has the potential to be an official trail town and evidences that the community identity can come before the official trail town designation.

Looking deeper into the cases of positive outcomes, using the trail brand and holding events related to the trails seem to influence the perception of local actors about their importance (quotes in Table 2) and help to forge a community identity (Stewart et al., 2004). Once considered a logging town and later having an industrial identity, Damascus faced an economic decay after the closure of a dye plant and a railroad (Phillips, 1988). This led the town to reinvent itself, creating a new identity based on the AT. The town identifies itself as the Trail Town USA and has invested for decades in using the AT brand (Garvey, 1978). Since 1987, Damascus has hosted the Appalachian Trail Days festival each May (Jenner, 1987). Although the Virginia Creeper National Recreation Trail (VCT), a rail-to-trail recognized in 1987, attracts more users and has a greater economic impact (Bowker et al., 2007), it is the AT brand that is everywhere, on sidewalks, street names, and the visitor center (Figure 2). A restaurant owner highlighted VCT as the biggest source of income, but when asked why she had the AT sign carved in wood on her wall, she replied: "*The AT is more of a staple. It's been here for forever. The VCT is a relatively newer thing.*" The trail festival's name shows the AT as the most used brand to attract visitors and strengthen the local identity. Most actors spontaneously mentioned the term trail town when asked about the influence of AT on local identity, including the business owner:

"*Sure, of course, trail town*"; and the city clerk: "*We're Trail Town USA for a reason. And the Appalachian Trail was a big part of that.*"

Silver City also features the CDT in its visitor center (Figure 2) and, since 2015, promotes the Trail Days Festival annually, which reinforces the connection and helps to publicize the CDT and other outdoor activities. This initiative was mentioned, among others, by an NGO manager: "*We are a gateway community, we have the trail days, and more people are taking pride in that.*"

In the PCT, the trail logo is used in signage but rarely appears in gateway communities. In Mammoth Lakes, for example, a welcome sign shows brands of several local institutions but does not mention the PCT (Figure 2). It runs farther from towns on much of the route and isolated resupply points that welcome hikers are quite common (Figure 2). This may limit contact with hikers and reduce the trail's influence on towns. The only city that hosts a festival is Cascade Locks, Oregon. PCT crosses the town, which also has plenty of trail signage (Figure 2). But this is not an official TT and was not included in this study. Mount Shasta, in contrast, despite being the only certified PCT Trail Town, is not crossed by the trail and rarely uses its brand. Although the trail is perceived as important for the economy, climbing Mount Shasta is seen as more relevant to the local identity (quotes in Table 1). The PCT is seen as one of several attractions, as in the words of a restaurant manager: "*I don't always hear a lot of people talking about it. But there are also so many more miles of trails that aren't the PCT around here, too. It's a big hiking community for sure.*"

The relationship between being a TT and positive outcomes is clear, but it is not possible to know whether the perception is influenced by participation in the trail town programs or if the interest in the trail, based on proximity and the experiences of community leaders, generated the

positive perception and prompted interest in becoming a trail town. These two factors are likely related, and there is positive feedback between them. The initiative to join the programs is necessarily the result of some previous level of identification with the trail (Koo, 2018). A survey in several AT communities also found that most respondents perceive the program as economically beneficial for TT (Bristow et al., 2022). Damascus identity clearly predates the existence of any program (Garvey, 1978; Phillips, 1988). Still, Silver City appears to be developing its identity out of program-related initiatives, such as trail days. The PCT's contradictory results, in turn, suggest that the lack of a structured program is related to a lower perception of the trail as an important driver in the local economy and identity. Community involvement is considered essential for TT programs' success, and results can take a few years (Koo, 2018). Thus, the lack of support resulting from the interruption of the PCT program may have influenced the Mount Shasta outcome. On the other hand, the positive outcome for Bishop suggests that the community has the potential to be an official trail town and evidences that the community identity can come before the official trail town designation.

4.3.2 Influence of the Economic Importance of Tourism on Perceptions

The QCA results suggest no relationship between the actual relevance of tourism in the local economy and the perception of the interviewed actors. The conditions and outcomes coincide in five communities, while the results are contradictory in the other five. However, this may be due to the use of LQ as an indicator. It compares the relative weight of employment in specific industries, which can be particularly suitable for tourism in rural areas (M. M. Miller et al., 1991; Yang & Smith, 2023) given the absence of better data (for example, industry revenues or number of tourists). However, LQ is a relative measure and has two limitations. First, a lower value may not imply an absolute lower relevance of tourism but simply that the region has

another industry that hires a large number of people (Court et al., 2023). Second, tourism can be important due to other activities unrelated to the trail (for example, the ski resorts in Mammoth).

The four towns where LQ indicates that accommodations, restaurants, and recreation are important to the local economy and the trail is not perceived as important have other tourist activities in the spotlight. Mammoth has tourism as its leading economic activity, with 36% of total employment (IMPLAN, 2022). Nontheless, this is a renowned ski destination, and the number of jobs in the sector compared to other TTs suggests that PCT represents only a small part of the economic impact of tourism (around 1,300 jobs, while the second largest is Salida, with 246; IMPLAN, 2022). McCloud has only 40 jobs in the sector, but it represents 27% of the total jobs in this small town (IMPLAN, 2022). However, this local tourism is more related to historical attractions (Table 2), and there is no record of thru-hikers resupplying there in 2021 (Halfway Anywhere, 2023).

In Lordsburg, all jobs in the sector are related to accommodation and restaurants and none to recreation services. The town has no other renowned natural attractions and does not attract other hikers, which limits the economic effects of the trail to the few CDT thru-hikers (CDTC, 2023b). Lordsburg is located along the I-10 highway, suggesting that the jobs in accommodation and food services are more related to highway users than recreationists. In Buena Vista, outdoor activities are important, and the city has several outdoor gear stores, restaurants, and hostels, but only 9.2% of CDT thru-hikers used the city for resupply in 2021 (Halfwayanywhere, 2023). Although mega trails have the potential to attract other types of visitors, such as day-hikers, in the CDT this effect is still limited (see Chapter 2), and many respondents attribute the trail effects to thru-hikers (quotes in table 2)

On the other hand, the LQ shows tourism as unimportant to Mount Shasta. However, most respondents (80%) consider the trail significant for the local economy, such as a restaurant chef: “There’s a lot of people stopping off to resupply here. So, I would say it probably has a significant benefit.” It should be noted that the US Census is done on a sample basis, and when this sample process is applied to small towns generates a significant margin of error (US Census Bureau, 2021). So, despite the city having several hostels and outdoor gear stores, the US Census estimated the number of jobs in the sector to be 0 ± 13.

Despite the limitation of LQ, this apparent lack of pattern may indicate that the dominant perception in each city is the result of a combination of different factors. If we use the relationship between tourism services and the local population (accommodations and outdoor gear stores/1,000 residents) as an indicator, other cities, such as Damascus, stand out. Silver City is among the highest if we consider the proportion of thru-hikers that use the city for resupply (Halfway Anywhere, 2023). The difficulty of identifying a single economic indicator that explains local actors’ perception reinforces the findings of other authors on the complex relationship between economic development, tourism, and perceptions by residents, involving changes in expectations over time and the balance between positive and negative socioeconomic impacts (Frauman & Banks, 2011; Johnson et al., 1994). The QCA results showing that participation in TT programs is a necessary and sufficient condition to explain the positive outcomes may indicate that communities where the trail is economically important perceive this in practice and tend to join the programs.

4.3.3 Influence of Previous Experiences on Perception

All towns with positive outcomes for economic and identity perceptions had most respondents with previous hiking experience in the trail. According to our results, a high

proportion of respondents with previous experience is necessary to perceive the trail as important. However, this condition is not sufficient since there are cases with negative outcomes. Among the trails with this positive condition, Silver City, Salida, and Damascus consider the trail important for both economy and identity. In contrast, Mount Shasta considers it important only for the economy, Bishop only for identity, and Buena Vista for neither. Only in Bishop does a high proportion of respondents consider the trail's negative impacts on the community as important.

Previous studies did not find a difference in the perception of outdoor recreationists and non-recreationists about tourism negative impacts (Perdue et al., 1987) or community benefits (Smith & Moore, 2011). Jurowski et al. (1997) argue that residents who practice outdoor activities may have a positive perception of tourism because improvements in facilities favor them. On the other hand, they observe, from a certain level of tourism development local recreationists can react negatively to tourism due to competition for space and loss of quality of experience. The QCA results corroborate the first statement of Jurowski et al. (1997), and we can speculate that NSTs do not generate such a large demand that they negatively interfere with the experience of local hikers, prevailing a positive perception.

Frequent users tend to value trails and perceive their benefits (Fondren & Brinkman, 2022; Hill et al., 2009). The owner of an outdoor gear store said: "*I never hiked the entire trail. But I've hiked a lot of different sections, and it's a very important resource for me, both personally from my own recreation as well as professionally.*" For some, the experience on the trail can create new business opportunities. A hostel owner from Damascus reported: "*I thru-hiked in 2019 and really missed the trail. During the pandemic, I came down here to do some*

hiking. There was a sign in this house, and I thought it would make a great bed and breakfast, so I bought it, and that's what it is."

While the other conditions, such as participation in TT programs, are related to town attributes, this condition is more related to individual experiences. Dumez (2015) argues that, in qualitative analysis, "*every case is made of cases*" (p.51), and combining different levels of organization helps assess the generalizability of a finding and helps determine how respondents' personal experiences affect outcomes in each town (Abbott, 1992).

4.3.4 Perceptions About Negative Impacts

Unlike the other outcomes, only one town (Bishop) had a high proportion of actors (75%) who considered the negative impacts of the trail as important. Being also the only non-TT who perceives the trail as important in local identity, Bishop seems to be an outlier among the case studies. This town is the furthest from the trail among the case studies. However, at the same time, it is used by almost 80% of hikers to resupply (Halfway Anywhere, 2023), and the factors that generated such different responses from the other cities would deserve further research.

A single actor, an NGO manager in Silver City, mentioned a socioeconomic conflict: "*I have heard that ranchers are not happy about having hikers walk through their property, whether that's trash or invasion of their private property. They're concerned about that. Even though majority of hikers are not throwing trash. In general, our community is very receptive to hikers.*" No other respondents mentioned social or economic impacts, such as those recorded in gateway communities of national parks and other public lands (Stoker et al., 2021). Most (83% of valid responses) denied perceiving negative effects or reaffirmed that their perceptions are all positive (quotes in Table 2).

Besides the above finding, the few actors who mentioned negative impacts (17% of valid responses) referred mainly to garbage or other inappropriate behavior by hikers more related to the trail itself than the community, such as not burying toilet paper (quotes in Table 2). For example, an outdoor gear shop manager in Bishop has a positive view of the trail but worries about hiker behavior: "*It's really great how popular PCT has become in the last couple years. Because of that, there's a lot of people that don't know how to behave and not leave a big impact. I think it's important to educate people on how to recreate responsibly in the backcountry and our backyard.*"

The low perception of negative impacts combined with other positive impressions aligns with the Social Exchange Theory (Emerson, 1976). Residents' support for tourism development relates to their perception of gains and losses (Jurowski et al., 1997). As stated by Frauman & Banks (2012), usually, "*tourism development brings economic benefits in exchange for social and environmental impacts*" (p. 14). If the impacts are small, even limited economic benefits may be enough to generate a positive perception. In fact, when asked about their impression of how the local population sees hikers, 71% of key actors gave positive answers and only one (3%) negative, while 26% gave neutral responses.

A theme that emerged from several interviews was the perception of the hygiene practices of long-distance hikers. Seven interviewees from six different cities on the three trails directly or indirectly compared thru-hikers to homeless persons, and another six mentioned their bad smell, sometimes with very strong words. The lack of showers on the trail is a known issue (Fondren & Brinkman, 2022). However, frequent references suggest this issue may negatively affect residents' perception of hikers and the trail.

4.3.5 Limitations and Further Research

The initial use of predetermined questions was necessary for data handling and comparative analysis, but it may also direct respondents' statements (Yuksel et al., 1999). This problem was minimized by using more open-ended questions about general topics such as impacts, views on hikers, and a final question like "Is there anything else you would like to add on this subject?" but respondents did not often introduce new topics.

The QCA analysis has a deterministic approach that can make it challenging to interpret the results by not considering the influence of outliers (Lieberson, 1992). The relationship between conditions and outcomes may not be explicit in these cases. Furthermore, the difficulty of finding a single indicator that represents the economy's complexity and fits the requirements for QCA has already been discussed. The economy's influence on the actors' perceptions deserves further in-depth research. New studies using the same approach could benefit from previously established information to be collected in the field to characterize the local economies. Better data, such as sectorial employment, could help to understand what happens in these towns. Increasing the number of respondents per community and including pre-established scales can also be a way to reduce subjectivity and possible bias and facilitate comparison between cases.

The small sample size also increases the possibility of coincidental conditions creating noise in the analysis and suggesting false relationships between conditions and outcomes, equivalent to multicollinearity and spurious relationships in quantitative analysis. It may be that the apparent relationship between hiking experiences with positive outcomes, for example, is just an effect of the coincidence with participation in TT programs since both were considered necessary, but the latter showed more consistent relationships with the outcomes. It is worth

noting that any mention of any hiking experience was considered, even if the respondent was not a frequent hiker. Further investigation with a larger sample that includes a larger number of non-hikers would help determine how respondents' personal hiking experience affects the outcomes.

Despite its limitations, the QCA proved to be an adequate method to identify patterns across cases that are too small for quantitative statistical analysis but too large for a non-systematized analysis. As a case-centered method, the QCA should be seen as a preliminary step for identifying commonalities and relevant conditions that explain the outcomes, guiding the research toward an in-depth analysis of each case. It facilitates the identification of possible common factors or peculiarities that explain different outcomes based on similar conditions.

Our findings should be seen as a portrait of the perceptions of the key actors who were interviewed and their communities. The small number of respondents in each community may lack representativeness, with some views underrepresented. A few actors refused the interview. However, acceptance can mean interest in trails and generate some response bias, in addition to a possible social desirability effect because of face-to-face interviews (Vaske, 2019). The fact that some communities have a higher proportion of respondents who use trails also can bias the results. On the other hand, a high number of trail users suggests greater local involvement since this was not a criterion for selecting respondents. Despite the limitations of time and means, the systematic comparison of 10 gateway communities along three national scenic trails throughout the US can serve as a basis for further research on gateway communities, especially trail towns. Beyond the perceptions, studies on the concrete effects of these programs on the economy and quality of life of communities are also essential to assess their effectiveness.

4.3.6 Outcomes and Implications for Trail Planning and Management

Our results show that the positive perceptions of economic benefits may not be based on reality, suggesting that these perceptions are based more on subjective than objective factors. Some communities that economically depend on tourism perceive the trail as less important than communities where tourism generates a lower percentage of income and jobs. The confused perceptions in these gateway communities about the economic impact of NSTs deserves attention from trail and community decision-makers. Assessing and disseminating figures on the economic impact and other benefits of NSTs in gateway communities where their brands are less established should help build greater local support for managing and conserving the trail and its landscapes.

Regarding local community identity, Smith et al. (2011) found it as the best predictor for a set of many desirable natural resource management outcomes, such as ecological, behavioral, and social solidarity outcomes. If in some towns studied the trails are part of the community identity with conservation gains, even in towns where NSTs are not yet considered important, several actors mentioned the interest of outsiders as a positive aspect, such as a coffee shop owner in Lordsburg: "*I never was told growing up in this town that it was such a unique thing. To hear other people from literally all around the world that are arriving here and just know this area is beautiful. Like we're here to do this trail. It's exciting.*" A Mammoth's public official said: "*It gives the local community access to a world-class recreation experience,*" while an outdoor gear shop owner in Damascus said: "*People take pride in that the whole world is coming to their town by foot.*" These statements suggest that working on the interest of hikers worldwide in the region's nature can raise residents' self-esteem and engage then in its protection.

Regarding the negative impacts mentioned, the hygiene issue seems to be an opportunity for improvement. Several TTs offer free showers. Providing these facilities in strategic locations, publicizing them, and encouraging hikers to use them on arrival can result in a better impression on the part of residents, as an outdoor gear shop owner of Mammoth Lakes suggested: "*Most of them realize they need to clean up before they go out to get food."*

The strong relationship between the participation of communities in trail town programs and the positive perception of the importance of the trail in the economy and identity in these communities suggests that these programs work to build, or at least strengthen, these perceptions. Cuba & Hummon (1993) pointed out that social participation is essential for community identity, and Stewart et al. (2004) concluded that this identity empowers local communities to influence decision-making processes about landscape changes. Schottanes (2021) argues that AT Communities is more a 'paper program' related to branding and recognition than to actually favoring local communities and businesses, and the initiative benefits the hikers more than the communities. However, our findings suggest that even if they are not effective in generating direct benefits, by engaging the local community and influencing their perceptions, these programs can generate positive feedback, encouraging investments that attract more hikers and, ultimately, result in real improvements for the communities. Investing in TT programs seems to be a useful strategy to garner support, which can generate a virtuous cycle for the community identity and economy.

Finally, if the economic importance of the trails is not perceived by many actors, negative impacts are even less so. According to the Social Exchange Theory (Emerson, 1976), this positive balance justifies a general positive perception of the trails and hikers. This finding reinforces the idea that mega trails spread the economic benefits and negative impacts among

many gateway communities, keeping tourist activity on a limited scale and representing an alternative to large tourist clusters. By involving the local community, promoting conservation actions, and not registering reports of significant negative socioeconomic impacts, the NSTs gateway communities seem to be a favorable context for sustainable tourism.

Figure 4-1. Map of the Triple Crown of Hiking (trails in red) showing the communities studied: designated trail towns popular sections (green circles) and non-trail town (orange circles). [a]Basemap from ESRI ArcGIS.

Table 4-1. Trail towns and their geographic and demographic contexts

Trail	Town (State)	Population (2020)	Distance from the trail - km (min.)	Resupply (%)	Interviews
AT	Damascus*	788	0 (0)	High	6 (2 Pub, 4 Bus)
	Hampton	2030	2 (3)	Limited	4 (4 Bus)
CDT	Silver City*	9704	0 (0)	97.1	5 (2 Pub, 2 NGO, 1 Bus)
	Lordsburg	2335	0 (0)	97.7	5 (1 Pub, 1 NGO, 3 Bus)
	Buena Vista	2855	30 (30)	9.2	4 (1 Pub, 2 NGO, 1 Bus)
	Salida*	5666	35 (30)	85.9	5 (1 NGO, 4 Bus)
PCT	Bishop	6573	43 (180)	78.6	4 (1 Pub, 3 Bus)
	Mammoth Lakes	7191	10 (20)	86.6	5 (1 Pub, 4 Bus)
	Mt. Shasta*	3223	15 (10)	62.8	5 (1 Pub, 1 NGO, 3 Bus)
	McCloud	945	16 (20)	0	4 (1 NGO, 3 Bus)

Population from The US Census 2020; Distance data calculated using ArcGIS for distance and Google Maps for driving time (plus estimated side trail hiking time, if necessary); AT resupply data are qualitative from interviews, and CDT and PCT data are quantitative from 2021/2022 surveys on the halfwayanywhere.com website; Number of

interviewees by town (Pub = Public manager; NGO = NGO manager; Bus = Business owner/manager).
*Official Trail Town

Table 4-2. Conditions, outcomes, and thresholds for each town.

		Conditions			*Outcomes (perceptions)*		
Trail	*Town*	*Trail Town program*	*Personal experiences (%)*	*Tourism economy (LQ)*	*Economic importance (%)*	*Local Identity (%)*	*Negative impacts (%)*
CDT	*Silver City*	Yes (1)	100 (1)	1.59 (1)	100 (1)	100 (1)	20 (0)
	Lordsburg	No (0)	0 (0)	1.33 (1)	40 (0)	0 (0)	0 (0)
	Buena Vista	No (0)	75 (1)	2.25 (1)	50 (0)	33 (0)	0 (0)
	Salida	Yes (1)	75 (1)	2.52 (1)	100 (1)	100 (1)	0 (0)
PCT	*Bishop*	No (0)	100 (1)	0.17 (0)	50 (0)	75 (1)	75 (1)
	Mammoth Lakes	No (0)*	40 (0)	5.34 (1)	60 (0)	50 (0)	25 (0)
	Mount Shasta	Yes (1)	60 (1)	0.00 (0)	80 (1)	20 (0)	25 (0)
	McCloud	No (0)	50 (0)	4.02 (1)	25 (0)	0 (0)	0 (0)
AT	*Damascus*	Yes (1)1	83 (1)	2.05 (1)	83 (1)	100 (1)	0 (0)
	Hampton	No (0)	25 (0)	0 (0)	25 (0)	0 (0)	25 (0)
Threshold			51	1	62.5	50	37.5

Percentages for Personal experiences and the Outcomes refer to the proportion of valid responses that were positive/important. In parentheses the binary values used in QCA: (0) = No/Low for conditions and unimportant for outcomes; (1) = Yes/High for conditions and important for outcomes. * The process of recognizing Mammoth Lakes as a Trail Town was interrupted at the beginning due to the COVID-19 pandemic.

Table 4-3. Truth Table grouping towns with similar conditions and outcomes

Cases	*Conditions*			*Outcomes (perceptions)*		
Towns	*Trail Town*	*Personal Experiences*	*Tourism Economy*	*Economic importance*	*Local identity*	*Negative impacts*
Hampton	0	0	0	0	0	0
Lordsburg, Mammoth, McCloud	0	0	1	0	0	0
Bishop	0	1	0	0	1	1
B_Vista	0	1	1	0	0	0
M. Shasta	1	1	0	1	0	0
Silver City, Salida, Damascus	1	1	1	1	1	0

(0) = No/Low for conditions and unimportant for outcomes; (1) = Yes/High for conditions and important for outcomes.

Table 4-4. QCA results for positive outcomes after Boolean minimization and remainders.

QCA configurations	Consistency[a]	Coverage[b]
Significant importance on local economy (Perc_Econ = 1)		
Trail Town {1} *Silver City, Salida, Damascus + M. Shasta,*	1.00	1.00
Significant influence on local identity (Perc_Iden = 1)		
1. Trail Town {1}* Economy {1} *Silver City, Salida, Damascus*	1.00	0.75
2. Trail Town {0}* Personal Experience {1}* Economy {0} *Bishop*	1.00	0.25
Significant negative impacts (Perc_Iden = 1)		
Trail Town {0}* Personal Experience {1} * Economy {0} *Bishop*	1.00	1.00

* = AND; [a] Consistency measures the proportion of cases with a given combination of conditions that display a specific outcome; [b] Coverage reflects the proportion of total cases with a specific outcome covered by a given set of conditions.

Table 4-5. Illustrative quotes of predominant perceptions in each town.

Trail	*Town*	*Perceptions of Economic importance of the trail*	*Perceptions of influence on local identity*	*Perceptions on negative impacts*
Continental Divide Trail	*Silver City*	I (100%): *"It's a boost for our local economy, when we have hikers coming through. They're spending dollars at our restaurants and our local businesses"* (NGO manager)	I (100%): *"We're the first ever gateway community for the CDT. So, I would say that I feel lucky, that sort of city has decided to make that part of its identity."* (Outdoor shop owner)	U (20%): *"We really don't have a lot of issues with the hikers, they generally are really good about cleaning up after themselves and being respectful."* (Resupply point owner)
	Lordsburg	U (40%): *"The CDT is part of our economy for a couple of months."* (Restaurant owner)	U (0%): *"I don't think it has yet, but it might in the future."* City Clerk	U (0%): *"I know some of the ranchers feel there are impacts, but to me not. Sometimes they are not responsible for the land."* (Restaurant owner)
	Buena Vista	U (50%): *"We see so many hikers come through this area, that it's hard to know if it was the CDT that brought him in, or if it was one of our local trails or one of the 14,000's. It must have some impact"* (Chamber of Commerce)	U (33%): *"With our shops, our culture, this is a very obviously outdoorsy town. It's tough because the CDT doesn't define our town, but it brings people to our town."* (Recreation Projects Manager)	U (0%): *"I think any effect is on the positive side and not on the negative side."* (Trail board chair)
	Salida	I (100%): *"It's probably not an exaggeration to say we see every thru-hiker that comes on the trail, because Salida is a very important resupply point. It's a great resource, both economically, and socially, for our community."* (Outdoor gear shop owner)	I (100%): *"I think the trail itself is sort of almost a mythical kind of thing. Like, that'd be cool to go do the whole CDT but it's, whatever, 3000 miles. But I can go do a little bit. And Salida... check it out in this cool town, and I think it's part of our identity, for sure."* (Bar owner)	U (0%): *"No, in fact, because it's not as close as some other places, like in New Mexico, where their trail is like, boom, you're right there in town. Ours is a little more remote."* (Chamber of Commerce)
Pacific Crest Trail	*Bishop*	U (50%): *"I think, to a very small degree, there's, some economic benefit associated with thru hikers."* (City development planner)	I (75%): *"We like being a trail town. I think we just like the influx of visitors because it just brings it fun energy to the community."* (Outdoor gear shop owner)	I (75%): *"There's a lot of people who read that book with Reese Witherspoon, and they thought: Oh, I'm gonna go do that. But they have no outdoor experience. They don't understand that they can't bury their toilet paper, they're leaving their waste too close*

				to the waters, and things like that." (Outdoor shop manager)
	Mammoth Lakes	U (60%): *"The economic impact is not huge. I think we make a lot of money out of it but compared with ski and skiing people coming up with RVs. They have much more impact."* (NGO manager)	U (50%): *"Increasingly. I would say 10 years ago, the answer is no. I think that identity is emerging."* (Outdoor Gear shop manager)	U (25%): *"No impact that I've seen."* (Outdoor gear shop owner)
	Mount Shasta	I (80%): *"There's absolutely benefits to having the trail connected to the community in a couple of different ways. I think one of them is economically".* (State Economist)	U (20%): *"The identity of Mt. Shasta is kind of weird. They're more into the mountain than the PCT. It's just part of their area."* (Lodge manager)	U (25%): *"Most PCT hikers are pretty cool. I think they're not leaving trash and stuff."* (Outdoor gear shop owner)
	McCloud	U (25%): *"Most of the hikers get supplied at Mount Shasta"* (Outdoor gear shop owner)	U (0%): *"We're a historical logging town."* (Brewery owner)	U (0%): *"Oh, absolutely not. I mean, PCT has always been a very positive impact for Siskiyou County, Shasta County, everybody."* (Brewery owner)
Appalachian Trail	*Damascus*	I (100%): *"It is definitely important. I don't know the percentage of like the tourism dollars that come in because of the hikers, but it is a pretty big deal."* (Town clerk)	I (100%): *"Damascus considers itself the Trail Town USA. And that's one of the big contributors to that. For sure it is part of our identity. Yeah."* (Outdoor gear owner)	U (0%): *"I really hadn't seen any impact. Most hikers that come through it are really great people. You've got a few that you can tell that are kind of on their trail just to party a little bit. But most of them are nature lovers and just that they're great guys."* (Restaurant manager)
	Hampton	U (25%): *"Not really important. It helps."* (Restaurant owner)	U (0%): *"Not so much the local identity, we would be identified more. There's a lot of people from around here to probably never hike"* (Grocery shop owner)	U (25%): *The only negative thing that I can think of is the increase of trash. And I don't think it's just hikers. It's overall on just the use of the trail.* (Hostel owner)

Table 4-5. Continued

I: most actors in the town perceived the trail as important; U: most actors in the town perceived the trail as unimportant.
In parenthesis the % of valid responses that were positive.

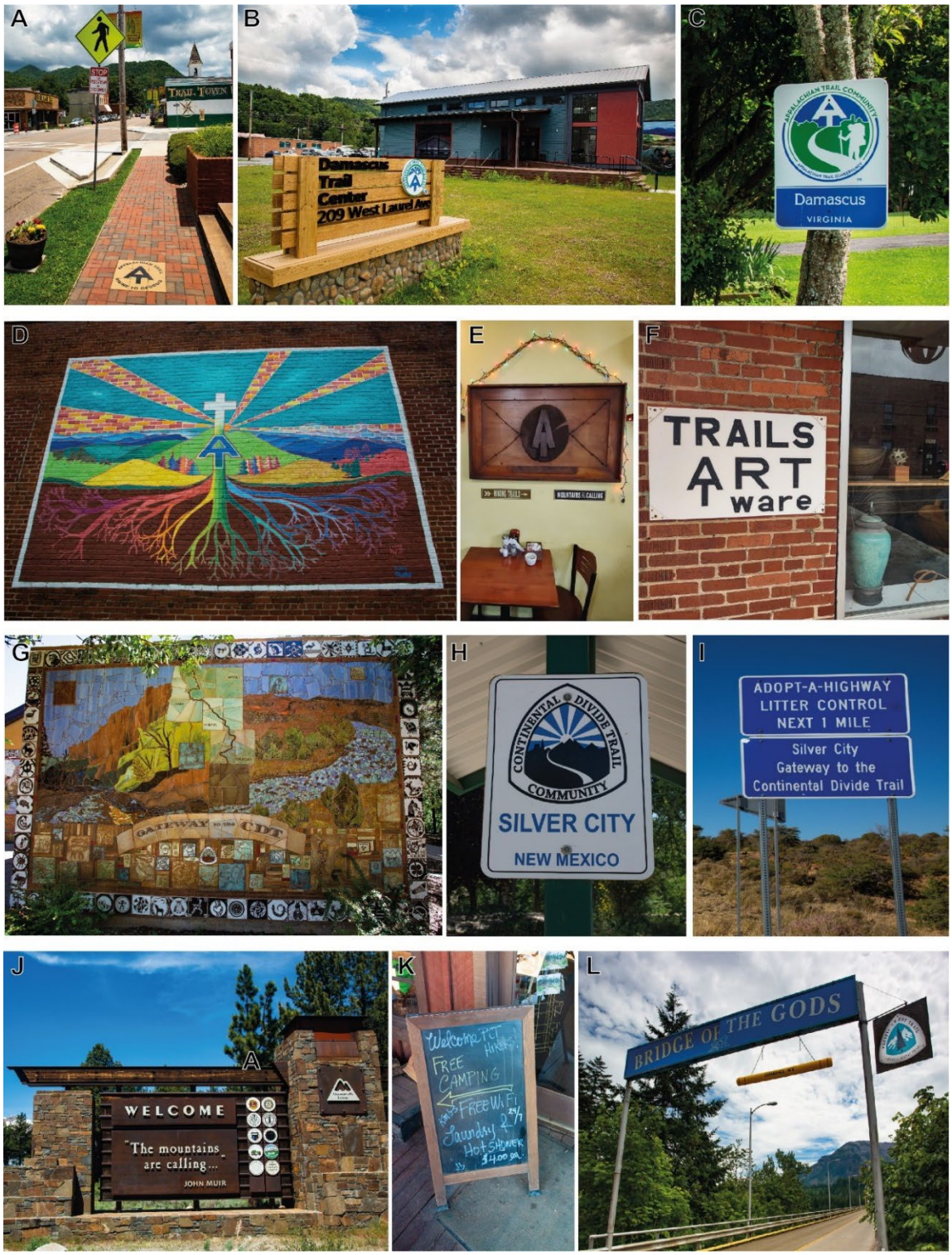


Figure 4-2. Trail brands in gateway communities – A: The At brand on sidewalks and walls in Damascus; B: Damascus Visitor center; C: AT Community sign; D: AT brand in wall art; E/F: AT brand in local business; G: Mural in Silver City Visitor Center; H: CDT Gateway Community sign; I: CDT in a highway sign; J: Mammoth sign not mentioning PCT; K: Hiker friendly business along the PCT (Kennedy Meadows, CA); L: PCT sign in Cascade Locks (OR). Photos by E.B. Viveiros de Castro.

CHAPTER 5
DOES THE APPALACHIAN TRAIL CONTRIBUTE TO LANDSCAPE CONNECTIVITY?

Habitat loss and fragmentation are major causes of wildlife population decline, local extinctions, and a global threat to biodiversity (Fletcher et al., 2018; Haddad et al., 2015; Newbold et al., 2015). Conserving large landscapes involves planning land use, identifying and protecting areas of particular interest for conservation, and ensuring connectivity between them (Hebblewhite et al., 2022; Heller & Zavaleta, 2009). Protected areas can be established with different levels of land use restrictions, which can alter deforestation rates (Andam et al., 2008; Vuohelainen et al., 2012). However, this protection depends on studies that support its designation, demonstrate its relevance, and foster political support (Cumming, 2016).

Landscape connectivity can be promoted through several interventions, such as increasing matrix permeability or maintaining *stepping stones* (Baum et al., 2004), but habitat corridors have been the primary option in landscapes dominated by human uses and are considered a valuable conservation tool (Beier, 2019; Gilbert-Norton et al., 2010). *Corridors* can be defined as "a linear habitat, embedded in a dissimilar matrix, that connects two or more larger blocks of habitat and that is proposed for conservation on the grounds that it will enhance or maintain the viability of specific wildlife populations in the habitat blocks" (Beier & Noss, 1998, p.1242). The structural characteristics of corridors that influence effectiveness involve aspects such as minimum width (Beier, 2019), the extent of conflict with human activities (Ford et al., 2020), and minimum conditions that motivate animals to enter and use the corridor (Beier & Loe, 1992). When dealing with large-scale corridors, planning needs to consider environmental gradients (Rouget et al., 2006) and not only the ability of species to move through them but also the capacity to enhance populations for a longer time, sometimes for many generations (Beier & Loe, 1992).

The more extensive the area for conservation, the more challenging the action can be. Some of the challenges to implementing corridors and other conservation actions in large landscapes are the complexity of political and institutional arrangements, the difficulty of monitoring, and lack of support due to society's limited understanding of large-scale ecological processes (Heller & Zavaleta, 2009; Redford et al., 2015; Sandbrook et al., 2023). One of the several initiatives to protect large landscapes and maintain corridors are mega trails, which are thousands of kilometers-long and cross large landscapes (Timothy & Boyd, 2015). Trail advocates argue that mega trails are an alternative to attract allies among recreationists, local communities, and the tourism industry (ATC, 2023a; Cerveny et al., 2020). Trails promote experiences and contact with nature, generate income for local communities, and demonstrate how large natural areas are or should be connected, bringing large landscapes to the perceptible realm of people and society (Gobster et al., 2007; see also Chapter 2) and generating civic action for their corridor protection (Cerveny et al., 2022).

The Appalachian Trail (AT), the first mega trail proposed and structured for recreational use in the world, was conceived as a regional planning tool (MacKaye, 1921) and has a long history of mobilizing advocates for the protection of its corridor (Mittlefehldt, 2010). Its poleward orientation acts as a potential climate corridor, which may allow species range shifts in response to climate change (AT Landscape Climate Advisory Group, 2022; Carroll et al., 2018; Hunter Jr. et al., 1988; Lawler et al., 2013). The AT is co-managed by the National Park Service (NPS), the US Forest Service (USFS) and the non-profit Appalachian Trail Conservancy (ATC), created in 1925 as the Appalachian Trail Conference to implement and protect the AT (King et al., 2000). Many authors highlight the importance of experiences in nature to generate environmental action (e.g., Chawla, 1999; Dresner et al., 2015), and there are several examples

of civic action to protect the AT landscape, such as campaigns against impacting infrastructure (ATC, 1964b, 2006; Bernstein, 2010; Igelman, 2017a; Koerber, 1966) or for protected areas designation (Coffey, 1975; Cover, 1958; Shaffer, 2016; Strong, 1966).

Assessing the effectiveness of large-scale conservation initiatives is challenging, and there is a lack of understanding of whether these initiatives affect conservation outcomes (Wauchope et al., 2021). These assessments are essential to guide decision making, directing conservation funds, and tackling rapid biodiversity loss (Ferraro & Pattanayak, 2006; Schleicher et al., 2020). However, few studies have used consistent methods to evaluate the effectiveness of large-landscape conservation initiatives (Hebblewhite et al., 2022).

Regarding the effects of trails on conservation, most studies focus on local scale and negative impacts, such as soil compaction, trail widening, or avoidance by animals (Erb et al., 2012; Longshore et al., 2013; Marion et al., 2016), while studies on the positive effects focus on awareness, behavior change, and economic impacts (Godtman Kling et al., 2017). Recently, some studies have evaluated the ecological integrity (McKinley et al., 2019) and connectivity along mega trails (Wilson & Belote, 2022), but they do not use methods, such as using longitudinal data assessing changes over time or comparisons to control areas (Schleicher et al., 2020; Wauchope et al., 2021), which allow assessing the effect of the trails themselves and whether they influence eventual positive outcomes or if these trails were only implemented in well-preserved sites.

In this study, we used a quasi-experimental approach (Butsic et al., 2017; Schleicher et al., 2020) to compare the temporal changes in connectivity along the Appalachian Trail corridor in comparison to control areas in the same region. Differences between observed trail conditions and counterfactual conditions in time and space have been used to make causal inferences and

assess the effectiveness of large-scale conservation initiatives in situations where designing an experiment under controlled conditions would be infeasible (Butsic et al., 2017; Ferraro & Pressey, 2015; Hebblewhite et al., 2022). Here, we review historical documents from the ATC collecting examples of actions in favor of protecting the trail corridor and evaluate the evolution of the ATC conservation discourse around the trail. The objective is to assess whether the AT is a conservation tool that results in greater land protection and increases landscape connectivity, answering these specific research questions:

- Have legal protection and civic actions in favor of the AT resulted in greater protected area coverage along the AT corridor?
- Is connectivity along the AT corridor greater than would be expected in the absence of the trail? If so, to what extent does the trail influence connectivity?

5.1 Methods

5.1.1 Study Area

The Appalachian Trail is a 3,524-km long trail following the Appalachian Mountains on the Eastern US, from Springer Mountain (Georgia) to Mount Katahdin (Maine). It has a predominant north-south orientation with a range of 16 degrees latitude. The elevation ranges from 0 m close to Hudson River (New York) to 2,024 m in Clingmans Dome (North Carolina). Vegetation is dominated by mixed, broadleaf, and coniferous forests, with patches of meadows in the north and in southern mountains (Zhao et al., 2013). The Atlantic Region was the first colonized by Europeans in the country and has been subjected to intense exploitation for centuries (McKinley et al., 2019). The Appalachian Mountains are among the areas facing the highest speeds of change due to climate and land use change in the U.S. (Ordonez et al, 2014). Today, the 14 US States crossed by the AT have areas of dense human population and host more than 100 million people (WPR, 2023).

The Appalachian Trail was chosen as a case study due to its 100-years history, the intensity of human land use in the region, the landscape perspective adopted in trail management, and documentation available about civic actions. The Appalachian region can be delimited by different criteria, considering geographical features, political borders, or ecoregions (AT Landscape Climate Advisory Group, 2022; Bailey, 1998; TNC, 2023). To define the study area, we used an objective criterion, considering a buffer of 100km around the whole trail, only including lands in the U.S.

5.1.2 Research on the ATC Magazine Collection

To reconstitute the history of protection measures and civic action around the AT and identify relevant temporal landmarks, we performed a bibliographic review and researched the collection of the official ATC magazines, *Appalachian Trailway News* (ATN), and *AT Journeys*. ATN was edited between 1939 and 2005, producing three to five issues yearly. Since the AT Conference's name changed to AT Conservancy (2005), the official ATC magazine is *AT Journeys*, with 3 to 4 issues annually.

There is an almost complete ATN collection at ATC Headquarters in Harpers Ferry, but it is not digitized. Over 300 issues since 1939 were reviewed looking for mentions of protected areas, trail corridors, land acquisition, trail relocation, landscape or wildlife conservation, threats to the trail, and infrastructure projects. All news and articles related to these themes were digitized and read in full. The use of newspapers and magazines in environmental historical research provides a day-to-day record from the past and allows an understanding of how each topic was treated at the time (Keeley & Syphard, 2021; Tosh, 2013). One criticism for using newspapers and magazines as sources in historical research is that it can induce bias and

concerns of validity (Earl et al., 2004; Franzosi, 1987). However, in this case, the publication is by the ATC itself, and possible biases are of interest to illustrate the ATC perspective on conservation issues at each instant and how this vision has evolved over time, which was our goal.

5.1.3 Landscape Analyses

To assess the contribution of the AT to landscape connectivity and conservation, we used a quasi-experimental approach combining temporal comparisons (before-and-after) and spatial comparisons (trail area vs. control areas, or trail area vs. the study region as a whole) (Ferraro & Pressey, 2015; Hebblewhite et al., 2022). This quasi-experimental approach is considered a suitable alternative to evaluate the impact of conservation measures and make causal inferences when it is impossible to control conditions experimentally (Butsic et al., 2017; Larsen et al., 2019; Schleicher et al., 2020). The NTS Act (1968), which gave the trail a legal conservation status, was used as the threshold to define the before and after scenarios.

5.1.3.1 Legal Protection of the AT Corridor

To evaluate if and how the trail has influenced the designation of protected areas and other forms of land protection along the corridor, we compared the trends of land protection observed for the study region as a whole with those of the trail corridor, using a before-after-time-series comparative approach (Hebblewhite et al., 2022). We performed the comparative analysis using three different corridor widths: a corridor 300m wide (150 m buffer of the trail), based on the legal width established for AT protection (Startzell, 1989); 2 km wide (1 km buffer of the trail), considering Beier's rule of thumb for minimum effective corridor width (Beier, 2019); and 10 km wide (5 km buffer of the trail), having effective corridor widths found by Ford

et al. (2020) for different species and land use conditions as a reference (Figure 1). For each corridor width, we compared the cumulative protected area coverage trend in the 50 years before and after the NTS Act (1918-1968 and 1968-2018).

Protected area coverages were obtained from the PADUS 3.0 database (USGS, 2023), complemented by the AT database (NPS, 2023a) and the National Conservation Easement Database (NCED, 2023) to fill information gaps. These databases use the GAP status from the National Inventory of Protected Areas, which classifies each area accordingly with restrictions on land cover changes and management goals (Prior-Magee et al., 1998). This classification does not correspond to the categories internationally recognized by the IUCN (Dudley et al., 2010) but has a roughly corresponding ranking. However, it considers specific US legal instruments not covered by the IUCN but significant in the study context, such as conservation easements. These easements are voluntary legal agreements that permanently limit the uses of private land to protect conservation values, have varying degrees of restriction, and can be classified between GAP 1 and 3, depending on the agreed conditions (Chapman et al., 2023). We sought information from the NPS to classify as many land parcels as possible whose degree of protection was considered unknown (GAP 4) in the PADUS database. In case of doubt, the less restrictive category was used. Information gaps on dates of establishment were filled in, when possible, from an internet search. The protected areas coverage by GAP Status was characterized for each corridor width, and only land parcels with a known designation date were included in the analysis. The NTS Act (1968) was used as the threshold for before versus after scenarios.

5.1.3.2 Landscape Connectivity

To assess the influence of the AT on landscape connectivity, we built resistance maps (Keeley et al., 2016) for two different moments in time to compare the temporal variation in

connectivity. We then compared the connectivity along the trail corridor with control points in the same overall region, using a before-after-control-intervention contrast (BACI), or difference-in-difference, approach (Butsic et al., 2017; Schleicher et al., 2020; Wauchope et al., 2021).

Resistance Maps

Resistance maps describe the potential that different areas act as barriers to the movement of any target subject (Zeller et al., 2012). We built a resistance map combining land use, distance from roads and land protection layers to compose a map as a proxy for the needs of multiple animal species (Belote et al., 2016). This *naturalness* approach is considered suitable for large-scale connectivity analysis (Beier et al., 2008; Krosby et al., 2015) and is supported by the fact that animals tend to move more as more conserved is the environment (Tucker et al., 2018). Several indices have been developed to evaluate *naturalness* using different terms, such as *wildness* (Aplet et al., 2000), *human footprint* (Sanderson et al., 2002), or *ecological integrity* (Theobald, 2013). However, these indices are not available for the 1960s and 1970s, and it was necessary to create a new resistance map from the available data.

Following the human footprint approach (Sanderson et al., 2002; Woolmer et al., 2008), we combined databases available and standardized for the 1970s and recent years to compose resistance maps with a resolution of 60m. The NWALT 1974–2012 (Falcone, 2015) combined data from the National Land Cover Database (Homer et al., 2012) with data from agriculture censuses, mining and forestry activities, and housing density to create a land use database for different years. This land-use map covers much of the information that comprises the human footprint. We use rankings that relate land use, habitat suitability, and resistance (Brown & Vivas, 2005; Falcone, 2015; Theobald, 2013, 2014) as references to produce a raster layer with

the costs of potential movement for each land use, ranging from 0 to 12 points (Table 1). The 1974 land use map was used as the *before* scenario, and the 2012 map as the *after* scenario.

Although roads are included in the major transportation land use class, their influence goes beyond the area of direct intervention, generating effects at different distances depending on the species or the effect evaluated (Benítez-López et al., 2010; Forman & Deblinger, 2000). Most naturalness indices use distance from roads as a separate variable from land use (Aplet et al., 2000; Sanderson et al., 2002; Woolmer et al., 2008). We extracted the roads identified in the land use map and added a raster layer with costs of potential movement related to the distance of each mapped road, considering a more intense effect in the first meters and the 300m limit for the road-effect zone proposed by Forman & Deblinger (2000). Distances from 0 to 60m were valued at 3, decreasing to 60-180m (2), 180-300m (1), and > 300m (0) (Table 1).

The NWALT 1974–2012 (Falcone, 2015) considered the legal protection in land use maps, but only areas with highly restricted use: GAP 1 lands were considered as the low-use-conservation class, but lands classified as GAP 2, 3, and 4 were not considered (Prior-Magee et al., 1998). The level of protection is associated not only to land use changes but also to species richness and abundance (Gray et al., 2016), and frequency of human and vehicles presence, which affects the behavior and presence of many species (Whittington et al., 2022). Therefore, the PAD-US GAP Status was used as a separate layer in the resistance maps. GAP Status 1 to 4 were valued ranging from 0 to 3 and no GAP areas were valued as 4 to establish the distance costs (Table 1).

The three layers (land use, protected areas, and road distances) were then summed for each raster cell, with the maximum possible resistance cost being 19 points. Considering that the

distance covered also represents a cost and that there is no 0 cost for movement, 1 point was added to all cells, with a final scale varying from 1 to 20 (Table 1).

To assess the sensitivity of the results to the resistance map, we reran the analyses varying the movement cost in several ways. First, we only considered land use (ranging from 1 to 13) to remove the effect of protected areas. Second, we only considered major classes of land use (conservation, low use, water, production, semi-developed, and developed, ranging from 1 to 6) to minimize possible problems in the ranking of land uses. Third, we consider the effects of the absolute values of resistance by determining the effect of squaring with the original resistance values (ranging from 1 to 400).

Changes in Movement Resistance Along the AT Through Time

To assess the trend in connectivity along the trail over time, we compared the AT with a least-cost path - LCP (Meegan & Maehr, 2002), used as a control trail in a BACI approach (Butsic et al., 2017). Using the resistance maps created, we estimated the cumulative costs of the AT path in *before* and *after* scenarios and calculated the difference between them. We modeled the LCP between the Appalachian Trail termini for the *before* scenario as a control trail, using the most preserved path and theoretically most suitable for wildlife movements as a reference in a conservative approach, then estimated the cumulative costs of this path in *before* and *after* scenarios. The comparison between the variation in cumulative costs between the AT path (observed) and the LCP (control) was used to assess whether the connectivity trend along the path was better or worse than in the control trail and to understand whether the path has a positive effect on connectivity. To avoid the effect of the legal protection of the AT on the results, we modeled a second LCP based on the resistance map built only with the land use raster layer. The same BACI procedure was repeated for this second LCP.

Extension of Trail Influence on Connectivity

To assess how far the Appalachian Trail's effect on connectivity extends, we compared the average resistance of sample areas along the trail with those of random sample areas in the study region. We added this matching method to the BACI approach to reduce the effect of possible confounding factors (Schleicher et al., 2020). We used 100 pairs of matched points to allow statistical significance tests. To compose these pairs, we sorted 100 random points (distant at least 10 km from each other) along the AT and 100 control points in the study region (distant at least 5km from the trail).

To match AT and control points with similar conditions as much as possible, we identified environmental variables related to current land use. We built a correlation matrix using values for each variable at 10,000 points randomly sampled in the study region. Values for each variable were obtained from rasters of current and past land use (NWALT 1974–2012), elevation, slopes, and aspects (from the Elevation Derivatives for National Applications EDNA/USGS) and precipitation (from the Air, Water, and Aquatic Environments research program AWAE/USFS). We adopted a conservative threshold of $r > 0.25$ to select variables related to current land use. Past land use ($r = 0.805$, $p < 0.001$), elevation ($r = -0.328$, $p < 0.001$), and slope ($r =- 0.269$, $p < 0.001$) were selected. Aspect explained only a small amount of variation ($r = 0.040$, $p < 0.001$), and precipitation was not significant ($r = 0.002$, $p = 0.852$), and both were not considered in the analysis. The total variation for each geographic variable was divided into ten bins: elevation (0-2,000m, 200m each bin) and slope (0-30%, 3% each bin) and each control point was sorted in the same land use and same elevation and slope bins of the paired AT point.

For each point along the AT and each control point, buffers were drawn with diameters related to the corridor widths considered in the first analysis (300m, 2km, and 10 km). Then we used the buffers to clip the resistance maps, and the average resistance value was calculated for each buffer in *before* and *after* scenarios (Figure 2). To answer whether connectivity along AT corridors of different widths varied differently from control areas, the variation in the average resistance values were compared between buffers with the same diameters around the AT points and paired points, using paired T-tests with 95 % confidence intervals. To answer whether the effect of AT varies significantly with distance, we used analysis of variance (ANOVA) comparing the average resistance values for the three buffer diameters, both for the AT and the control points.

5.4 Results

5.4.1 A Brief History of the Appalachian Trail Corridor

Based on the bibliographical review and consultation with the ATN collection, we reconstituted the most significant facts of the management of the corridor and land protection along the AT. Proposed in 1921 (MacKaye, 1921), the AT was considered fully implemented in 1937, and in 1938, the Appalachian Trailway Agreement, signed between the ATC, NPS, and USFS, gave official status to the AT (Mittlefehldt, 2013). The agreement established a lane of 200 feet on each trailside free of clear-cutting for timber production and one mile free of paralleling motor routes in federal lands (Koerber, 1967). The oldest record of trail corridor reforestation efforts is from abandoned pasturelands in New York in 1942 (Neisel, 1942). The main focus at that time was to protect the trail itself and a pleasant natural aspect for hikers, but ATC protests against road developments and ski resorts (ATC, 1945a; Schlapfer, 1971) already influenced landscape conservation.

In 1958, an article in the magazine of the Appalachian Trailway News (ATN) advocated the entire Appalachian Mountain to be included within forest preserves and declaring it a national wilderness area. The author lists arguments that include "natural beauty, noncommercial recreation, conservation of forests and water tables, fire control, and scientific study and experiments related to natural life" as well as "essential genuine offsets to the oppressive aspects of this man-made environment." (Cover, 1958, p.37). In 1964, the ATC created a Conservation Committee, focused on conserving the trail corridor, which "also includes conservation projects and problems not directly involving the trail" (ATC, 1964a, p.41). Also in 1964, the US Congress approved the Land and Water Conservation Fund Act, which allocated resources for purchase, easements, and agreements with landowners to ensure land conservation (Murray, 1965).

Initiatives for legally protecting the AT by the US Congress began in the 1940s (ATC, 1945b; Murray, 1965) and resulted in the National Trail System (NTS) Act of 1968 (Murray, 1968). In 1967, ATC began collaborating with The Nature Conservancy (TNC), which was already active in the region (Boardman, 1961), to acquire land and easements to protect the trail (Foster, 1968; Tabor Jr., 1970). The NTS Act maintained the 60 m (200 ft) strip of protection on each side of the trail, with a limit of 16 ha/km for land acquisition through condemnation (Murray, 1968). This limit was increased by a 1978 amendment to around 80 ha/km, enabling the acquisition of a 300m wide corridor (Startzell, 1989).

In 1978, about 60% of the AT corridor was in public lands (Mittlefeldt, 2013). The Federal Land Acquisition Program, led by the NPS, was intensified to protect the entire trail by 1985, and 90 million USD was assigned to this task (ATC, 1983). It is worth mentioning that these initiatives faced resistance from private landowners, who often supported the trail's

existence but questioned the excessive width of the corridor (K. Anderson, 2006). Mediation by the ATC and engagement of hikers hired by the program and local volunteers provided close and empathic contacts, minimizing conflicts and resistance against government actions during land acquisition (Mittlefehldt, 2013). There were also hikers arguing in favor of open landscapes and rural views, claiming that a forest corridor would compromise spectacular panoramic views and turn the AT into a "monotonous green tunnel" (Farmer, 1985, p.18; Garvey, 1985). As Mittlefehldt (2010) highlights, the 1981 Management Plan for the Appalachian Trail postulated that "agricultural use of corridor lands that conserved pastoral scenery was not only compatible but desirable" (p.654). Despite some resistance, in 1989, 160 km remained to be protected, and in 2001, the trail corridor was virtually fully protected, with only many a few short sections in towns and private lands without easements (totaling 0.7% of the trail) remaining unprotected (ATC, 2001b).

Progress in consolidating the narrow trail corridor opened new horizons and broadened the perspective to incorporate scenic views and the trail landscape (Shaffer, 2016). The first resolution favoring a wider Appalachian Greenway occurred at the 20th ATC meeting in 1975. The proposal included establishing "a narrow wilderness-type corridor along the spine of the Appalachian Trail with a much wider countryside zone on either side" (ATC, 1975, p.40). In 1989, an article in ATN dealt with viewsheds and landscape protection, including land and easements acquisition, but also negotiations with local governments for "land use plans, zoning, and limited development initiatives" to "protect the landscape and a sense of community" (Hoppes, 1989, p.10).

Attention to issues related to connectivity and wildlife corridors in the AT (Woodside, 2001) followed the scientific debate on the subject, which gained momentum in the 1990s (Beier

& Noss, 1998). This transition was made explicit in the change of name of the AT Conference to AT Conservancy, in 2005, with prioritization declared for corridor and land conservation (Mittlefehldt, 2013). Since 2000, the AT Mega Transect has engaged researchers and citizen scientists to monitor environmental conditions along the entire trail (Mittlefehldt, 2013), including endangered and invasive species, water and air quality, and landscapes (Dufour & Crisfield, 2008). In 2015, NPS and ATC launched the Appalachian Landscape Partnership with the mission of "connecting the wild, scenic, and cultural wonders of the Appalachian Trail and its surrounding landscape" (NPS & ATC, 2022, p.5). The ATC Strategic Plan 2023-2026 mentions among its objectives "conserve the biodiversity and functional connectivity of natural resource ecosystems in the A.T. landscape" and "increase awareness about the A.T. landscape's critical function in advancing climate resiliency in the Appalachians" (ATC, 2023, p.1).

5.4.2 Protected Areas Coverage Along the AT Corridor

Regarding the protected area coverage, the 300m wide corridor has 95% of its area protected. The 5% of the corridor that is not protected is found mainly in towns crossed by the trail, where rights-of-way easements cover corridors a few tens of meters wide, or in private lands adjacent to the AT. Around 48% of the corridor is protected in GAP 1 and 2 areas, which include wilderness areas, national parks, and many state parks and private reserves, and 46% in GAP 3, which includes most national forest lands and part of private reserves and conservation easements. Regarding the 2 km corridor, 75% of its area is protected (about 35% in GAP 1 and 2), while in the 10 km corridor the proportion of protected areas is lower (54%, with about 23% in GAP 1 and 2 areas).

Considering only protected areas with identified establishment dates, the coverage in the 300m corridor was 9.9% in 1918, rose to 38.4% in 1968, and then to 89.5% in 2018 (Table 3).

The coverage of the highly protected areas (GAP 1 and 2) grew from 2.8% in 1918, to 17.9% in 1968, and 47.8% in 2018. Land protection also grew in the 2km and 10km corridors, but to a lesser extent (Table 2; Figure 3). Public agencies or conservation organizations own most land. When we consider the entire study area, protected areas grew from 2.0% in 1918, to 17.0% in 2018 (Figure 3).

The protected area coverage grew across the 300m corridor at an average of 5.7 km^2/year from 1918 to 1968 and at a rate of 17.8 km^2/year between 1968 and 2018 (Table 2). In the 2 km corridor, the protected area coverage grew from 31.6 km2/year (1918-1968) to 84.8 km2/year (1968-2018). The pace also increased in the 10 km corridor, from 111.2 km^2/year in 1918-1968 to 255.1 km^2/year in 1968-2018. Across the whole study area, protected area growth was 516 km2/year between 1918-1968 and 1,511 km2/year between 1968-2018.

5.4.3 Temporal Changes in Resistance to Movement Along the AT

The least-cost path (LCP) modeled was similar to the AT route in the northern and southern portions but differed greatly in the central portion between Virginia and Massachusetts (Figure 4). The AT follows the Blue Ridge and crosses lower areas between Pennsylvania and New York to reach the Green Mountains in Vermont. The LCP follows the Allegheny and Catskill Mountains further west until it crosses the Hudson River valley and resumes a route very close to the AT in Vermont (Figure 4). The total length of the LCP was 1,984 km, 42% shorter than the AT (3,416 km). According to the resistance map built, the cumulative cost of the LCP was 43.3% lower than the AT cost in the *before* scenario and 23.0% lower in the *after* scenario.

The AT cumulative cost was reduced by 26.5% between before and after scenarios when considering the resistance maps, while the distance cost of LCP was practically stable between the studied scenarios (-0.2%; Table 3). If considering the least-cost path modeled on the

resistance map with only land uses (costs ranging from 1 to 13; Table 1), both AT and LCP had an increase in the cumulative cost, but the increase in AT was much smaller than that of LCP (11.7% and 51.3%, respectively; Table 3). The cumulative cost of the LCP was 50.9% lower than the AT in the before scenario and 33.5% lower in the after, showing a much smaller worsening in connectivity along the AT than along the LCP used for comparison.

5.4.4 Extension of Trail Influence on Connectivity

Regarding the distance at which the trail influence can be detected, in the 300m-diameter buffers around 100 AT random points, the average resistance varied negatively by 24.5% between the *before* and *after* scenarios, showing improved conditions for connectivity. The 300m-diameter control areas had a positive variation of 8.8%, showing worse conditions for potential connectivity with a significant difference between the AT corridor and control areas ($p < 0.001$). The result was similar for the 2km and 10km diameter buffers. However, the variations were smaller for the AT corridors compared to the 300m diameter, with 13.0% and 1.9% reduction in the average resistance, respectively. In control areas, the variation between the different diameters was smaller and positive, with an increase of 10.8% for 2 km and 9.2% for 10km, meaning a worst connectivity in the *after* scenario. All differences in variations between AT buffers and paired buffers were significant ($p < 0.001$; Table 4).

Referring to the variation in the influence of the trail on the corridors, ANOVA showed significant differences in the effect of the AT between the different widths ($F = 22.36$, $p < 0.001$), with pairwise analyses showing a significantly greater effect at 300m and gradually decreasing with increasing distance ($P < 0.001$ for all comparisons). In the control areas, there was no significant difference between buffers of 300m, 2km and 5km diameters ($F = 0.12$, $p = 0.89$).

The sensitivity analyses using modified resistance maps showed consistent results to above, highlighting low sensitivity of results to map changes. When considering only land use, there was a slight worsening in connectivity in the AT 300m corridor (7.6%), while in the control areas the average resistance increased by 58.8%. As in the first resistance map, the scenario for the 2km and 10km corridors was progressively worse compared to the 300m, with the average resistance growing 12.3% and 17.0%, respectively. The variation in control areas over time was slightly smaller for the different buffers, not showing a clear pattern, with an increase of 50.4% for 2km and 38.8% for 10km. Regarding all the resistance maps tested, the differences in temporal variation between the AT points and the paired points were significant for all modified maps and all buffer widths ($p < 0.001$), except for the 10km corridor in the map considering only six land use classes ($p = 0.189$).

5.5 Discussion

The results suggest that the closer to the AT, the greater the growth of potential connectivity and protected area coverage after the NTS Act and the legal protection of the trail corridor. The increase in protected area coverage is greater in areas closer to the trail (300m wide corridor). Likewise, the 300m wide corridor has the lowest resistance to potential movements, followed by the 2km and 10km corridors, suggesting that the AT positively influences connectivity.

5.5.1 Influence of the Appalachian Trail in Protected Area Designation

The changes in protected areas coverage indicates the degree of prioritization of a region and the perspective of future conservation (Andam et al., 2008). Although low-use areas adjacent to developed areas tend to have their land use changed over time (Falcone, 2015), within a public

protected area this trend is mitigated by restrictions (Vuohelainen et al., 2012). The Appalachian Mountains already had greater protected area coverage than the Eastern US as a whole before the implementation of the Appalachian Trail. However, legal protection of lands along the AT accelerated after the trail's implementation (1920s and 1930s) and even more after the NTS Act (1968), especially in the narrower corridor, which has since been officially protected (Murray, 1968). This difference highlights the influence of the NTS Act in protecting the corridor, which received new impetus after a 1978 NTS amendment. It enabled the acquisition of a 300m wide corridor, allocated funds, and determined that all land be acquired within three years (Startzell, 1989). In this corridor the pace of land protection grew from 0.6% of the corridor area per year between 1918 and 1968 to 1.8% over the next 50 years.

The Federal Land Acquisition Program protected a large part of the corridor, now mostly on public lands (Startzell, 1989). However, the possibility of negotiating rights-of-way and conservation easements, which limit land use change through agreements with landowners, also made conservation possible in private lands (Chapman et al., 2023). These arrangements and the direct action of a non-profit organization (ATC) as co-manager of the trail also facilitated the use of private funds and donations. In several cases, the ATC conducted the acquisition process (Hunt, 1986).

The effect of NTS Act on the narrow trail corridor is direct, but other AT-related actions have effects on adjoining lands. When considering the minimum width for an effective wildlife corridor, 2 km (Beier, 2019), the pace of protection also increased after the formal recognition of the AT (from 0.5% to 1.4% of the corridor area per year). When considering a 10 km corridor, the effect is smaller but still noticeable (from 0.4% to 1% per year). In addition to land acquisition in the trail corridor, campaigns led by hikers and mountain clubs contributed to the

designation of several protected areas. In 1973, for example, the ATC and four trail clubs engaged in the Great Smokies Park Wilderness Advocates coalition (Coffey, 1975), which resulted in the designation of several wilderness areas in the region between the 1970s and 1980s, such as Cohutta, Southern Nantahala, and Tray Mountains. In another example of civic action, in 1985, the ATC and the Green Mountain Club led the effort to protect Stratton Mountain, in Vermont, which was threatened by the expansion of a ski resort. After mobilizing Congress members but having funds cut off, the ATC obtained support from The Nature Conservancy to acquire the area and subsequently transmit it to the Green Mountain National Forest (Van Meter, 1986).

Of course other factors, and not only the AT, influenced the growth of protected area coverage in the region, as this is considered one of the main strategies for conserving biodiversity used worldwide (Rodrigues et al., 2004). Protection of natural areas in the Eastern US also grew over the period but covering a much smaller proportion of the territory. Today, 17.2% of the study region is protected, fulfilling the Aichi target 11 established by the Convention on Biological Diversity for 2020 (Lopoukhine & de Souza Dias, 2012), but still far from the target of 30% established for 2030, the so-called 30x30 (Chapman et al., 2023).

5.5.2 Influence of the Appalachian Trail on Connectivity

Regarding the analysis of changes in connectivity along the trail over time, the results suggest a positive influence of AT compared with the control trail (the least-cost path). The cumulative cost to travel the AT path decreased (-26.5%) while remained practically stable in the LCP (-0.2%) between *before* and *after* scenarios. When considering the resistance map only with land use, both had an increase in cumulative cost, but the rise in AT (11.7%) was much smaller than in LCP (51.3%). In regions heavily impacted by human activities, conserved areas tend to

be concentrated on slopes and areas less suitable for agriculture and most economic activities (Joppa & Pfaff, 2009), as the LCP suggests when following a route through the mountains and avoiding the lower parts of the AT (Figure 5). Even passing through lowland areas with high agricultural potential, the AT path had comparatively better results than the LCP in changes in potential connectivity.

The use of LCP to identify the best corridors has several limitations (Pinto & Keitt, 2009; Pullinger & Johnson, 2010), and its use in this study is intended only to establish a reference to compare the contribution of AT for connectivity. However, the similarity of the routes in the southern and northern sections suggests that in these sections the AT coincides with the most strategic areas for maintaining a climate corridor (Carroll et al., 2018). The central part is the most degraded along the AT (McKinley et al., 2019; Shriver et al., 2005), and the modeled LCP suggests that the Allegheny and Catskill mountains would form a more promising corridor. However, the Appalachian Mountains are not continuous, and between the Catskill and Green mountains, the LCP modeled in the *before* scenario crosses a lower and now developed area in New York. By protecting a corridor crossing lower and flatter areas more suitable for agriculture and other economic uses (Baker & Capel, 2011), the AT seems to contribute effectively to connectivity in critical areas. An example is the narrow corridor north of the Clarence Fahnestock Memorial State Park (New York),where the land parcels acquired by the NPS protect a narrow corridor amid anthropized areas that, until the 1970s, were predominantly classified as very low use (Figure 5).

The challenge of protecting corridors in areas suitable for other human activities can be illustrated by the conflicts to implement a narrow corridor along the Cumberland Valley (Pennsylvania), an area undergoing an intense process of population density and land use change

between the 1970s and 1980s (Startzell, 1984). Some landowners resisted land condemnation and created the CANT (Citizens Against New Trail) association. There was an explicit conflict among local residents, with another group creating the PRO-TRAIL (Pennsylvanians Rallied on a Trail Route Advocating) association. The first claimed that the Land Acquisition Program contradicted their property rights, while the latter argued that the trail was in the public and community interest. (ATC, 1986; Mittlefehldt, 2010; Startzell, 1984). After more than a decade of negotiation and management, the new trail corridor was officially opened (ATC, 1990). Landscape architects contributed to the design of a narrow forest corridor crossing agricultural areas with different special-use permits (ATC, 1990), and the land surrounding Boiling Springs Lake was acquired and transformed into a public recreation area, reinforcing the link with residents (King, 1987). The restored vegetation along this narrow corridor (around 40m wide in the narrowest sections) is the only continuous line of trees in the most critical areas of the valley (Figure 6).

Regarding the analysis of the extent of AT influence comparing AT and control areas, the AT 300m corridor had a reduction in resistance while the control areas had an increase (-24.5% and 8.8% in average resistance, respectively). The fact that resistance is lower now than in the 1970s can be explained by the legal protection of the AT corridor, with land acquisition, conservation and rights-of-way easements along the entire trail (Startzell, 1989). However, even when considering only land use, despite slightly worsening between the before and after scenarios, the AT 300m corridor trend is still significantly better than that of the control areas (7.6% and 58.8%, respectively). The results indicate that the AT 300m corridor protection policy effectively enhances connectivity along the trail.

If the purchase of conservation and rights-of-way easements can explain the effects in the 300m corridor, the differences found in the 2km and even the 10km corridors reinforce the findings of previous analyses and suggest that the positive effects of AT go beyond the direct land acquisitions and easements. Among the explanations for greater connectivity is the designation of protected areas far beyond the trail corridor, such as the aforementioned wilderness areas (Coffey, 1975). More recently, ATC and NPS have been leading the AT Landscape Partnership, joining several organizations with the express goal of "looking at the entire AT landscape as one whole system rather than a long, thin, linear corridor divided by boundaries and jurisdictions" (Shaffer, 2016, p.179). The declared intention of broadening the scale is relatively recent and may generate even more expressive results in terms of habitat connectivity in the future.

Another possible factor positively influencing connectivity is campaigns against development projects that threaten trail integrity and its landscapes. The intense pressure for development in the eastern US generates demands for roads, pipelines, and powerlines crossing the Appalachians (Gates, 1991). These linear structures constitute barriers to movement for many species and have a known effect on connectivity (Ascensão et al., 2019; Gregory et al., 2021; Karlson & Mörtberg, 2015). Campaigns against scenic roads following the mountain spine were successful in Georgia (ATC, 1964c) and Vermont (Strong, 1966). Proposals of highways cutting through the mountains were barred after protests in North Carolina (ATC, 1968) and Virginia (DeVaughn, 1994), and even forest roads for timber logging were the target of ATC campaigns (Sommerville, 1987). Civic actions against gas pipelines were successful in New York (ATC, 1988) and Virginia (Igelman, 2017a), and a powerline in Virginia had its route changed after five years of negotiation with the ATC, becoming a cut in the trail in a less conserved area (ATC,

2001a; King, 1996). The ATC also mobilized to prevent the implementation or reduce the impacts of ski resorts (ATC, 1989, 1997; Koerber, 1966), a windfarm (ATC, 2002, 2006), a gravel quarry (ATC, 2004) and even a racetrack in neighbor lands (ATC, 2003, 2005).

The evidence that the AT mobilized several campaigns against development projects combined with the results of the landscape analysis suggests that the engagement of hikers, volunteers, and organizations influences the protection of the trail corridor and the AT landscape as a whole. Although the involvement of users and local actors is often pointed out as important to maintain connectivity and sustainable landscapes (Opdam et al., 2006; Tompkins & Adger, 2004), Heller & Zavaleta (2009) point out that enlisting people and local communities to "soften" land use and restore habitats to improve landscape "were among the most poorly developed recommendations, limited mainly to very general actions without identification of kinds of actors that might need to be involved" and connectivity strategies should " bring together local governments, urban planners, community groups and conservation organizations" (p.25). The AT mobilizes actors that go beyond those directly involved in conservation, expanding the conservation audience, and involving people who directly act on the ground.

5.5.3 Implications for Trail Management and Landscape Conservation

Our results suggest that the AT made an effective contribution to landscape connectivity that goes beyond the legally protected 300m-wide corridor. However, if we consider the most challenging areas with lands more suitable for agriculture and other human activities, the corridor may be only tens of meters wide, which can be considered a bottleneck in the AT corridor. These are the most challenging stretches for connectivity, and where the AT is most strategic as a conservation tool (McKinley et al., 2019; Shriver et al., 2005). It is widely accepted

that the wider the corridor, the better (Ford et al., 2020; Harrison, 1992), and Beier suggests 2 km as a role of thumb for minimal effective corridor width (Beier, 2019). To be most effective, the AT conservation initiative should consider increasing the minimum width of the legally protected corridor and consider these aspects in the land acquisition and conservation easements strategy.

Another issue that must be considered is to what extent the use of the trail interferes with the use of the corridor by wildlife. Preferential use of trails has been recorded for several animal species (Ford et al., 2020; Kays et al., 2017), though others always avoid them or at least do so at times of intense use by humans (Gaynor et al., 2018; Whittington et al., 2022). Indeed, Erb et al. (2012) found that black bears avoid highly used areas in the AT, while red foxes use these same areas more intensely. Ford et al. (2020) found that different carnivore species flee from humans at varying distances, from 10 m for black bears to 488 m for wolves, which would interfer with the effective width of the corridor. These observations suggest that the 300-m-wide corridor with the AT in the middle may not serve as a functional corridor for many species.

On the other hand, some of the main bottlenecks, where narrow forest corridors cross open landscapes (Loro et al., 2015), are not particularly attractive to day-hikers and are predominantly used by thru-hikers, thus creating minimal conflicts between wildlife and people. Due to weather conditions, the ideal window for thru-hiking is narrow, and the *hiker bubble* is concentrated in short periods each year (Dolman & Marion, 2022), which would facilitate the use of these corridors by forest-dwelling species for a large part of the year (Nickel et al., 2020). In areas with human activities and significant limitations to implement wider corridors, it would be beneficial to locate the trail on the edge of the forest corridor, reducing its influence on the effective corridor width (Ford et al., 2020). Locating the trail at the edge can both reduce adverse

effects on wildlife and satisfy hikers who claim against a *green tunnel* and desire more open views (Farmer, 1985).

The other two most renowned US National Scenic Trails (Pacific Crest and Continental Divide) are better preserved than the AT (Wilson & Belote, 2022). These trails are located mostly in conserved public lands which were designated before the trail implementation, which suggests a smaller effective contribution of the trails to conservation. Due to its location in the oldest and most densely populated US region (WPR, 2023), the AT seems to be an important example of how mega trails can effectively promote and recover connectivity in large landscapes intensely altered by human activities.

In a broad review of recommendations for climate change strategies adaptation for biodiversity management, Heller & Zavaleta (2009) identified several recommendations to promote landscape connectivity, such as "the designation of new parks oriented longitudinally, (…) actions in non-reserve land, (…) and planting trees and shrubs to create shelterbelts and hedgerows in farmlands" (p.24). These authors also highlight the need to "integrate ecology with other disciplines and approaches that explicitly address the roles of institutions, policy, politics, and people in successful conservation strategies" (p.29). Our study seeks to answer this call, and the results suggest that AT meets most of their recommendations and is a valid conservation strategy. The long public-private partnership and the institutional arrangements that made AT protection possible can serve as an example not only for other mega trails but for other conservation projects involving land management (Mittlefehldt, 2010). Maintaining the integration of public engagement and landscape conservation around the AT and intensifying actions to protect as wide a corridor as possible seems to be strategic for long-term biodiversity conservation in the eastern U.S.

5.5.4 Limitations and Further Research

Connectivity models may not represent well real conditions influencing wildlife movements through landscapes (Baldwin et al., 2010), and resistance maps are sensitive to changes in the values assigned to the costs of potential movements (Savary et al., 2022). The scarcity of GIS databases with data from the 1970s and the lack of indices such as Human Footprint (Sanderson et al., 2002) and ecological integrity (Theobald, 2013) for that time made it necessary to develop a new resistance map, which is subject to errors such as ranking of costs to potential movements not based on empirical data (Sawyer et al., 2011). The effect of these possible errors was minimized by using the same criteria to build the resistance maps in the two moments analyzed and the same maps to compare the AT corridor and control areas. Despite the limitations of available data, the results of the modified resistance maps were consistent and showed low sensitivity to changes in the indices.

AT matching with control areas is not perfect. Even considering land use and including variables such as elevation and slope to define paired points, the initial AT values were lower than the paired control points. This difference may be due to unobserved confounding factors (Schleicher et al., 2020). However, the AT itself may also have influenced it since the trail already existed decades earlier than the *before* scenario. The extension of the study region would require high computing power, but using random corridors with the same length or initial cumulative cost equal to the AT could consider the entire length of the AT corridor in this analysis and minimize the matching problem.

To the best of our knowledge, this is the first study that evaluates the effect of a trail on landscape connectivity. Our results suggest that AT positively influences landscape connectivity. However, this is the oldest mega trail with the greatest mobilization to protect corridors. Studies on other mega trails would help to evaluate the generalizability of these findings and establish guidelines to ensure that they are effective tools to enhance connectivity in extensive landscapes.

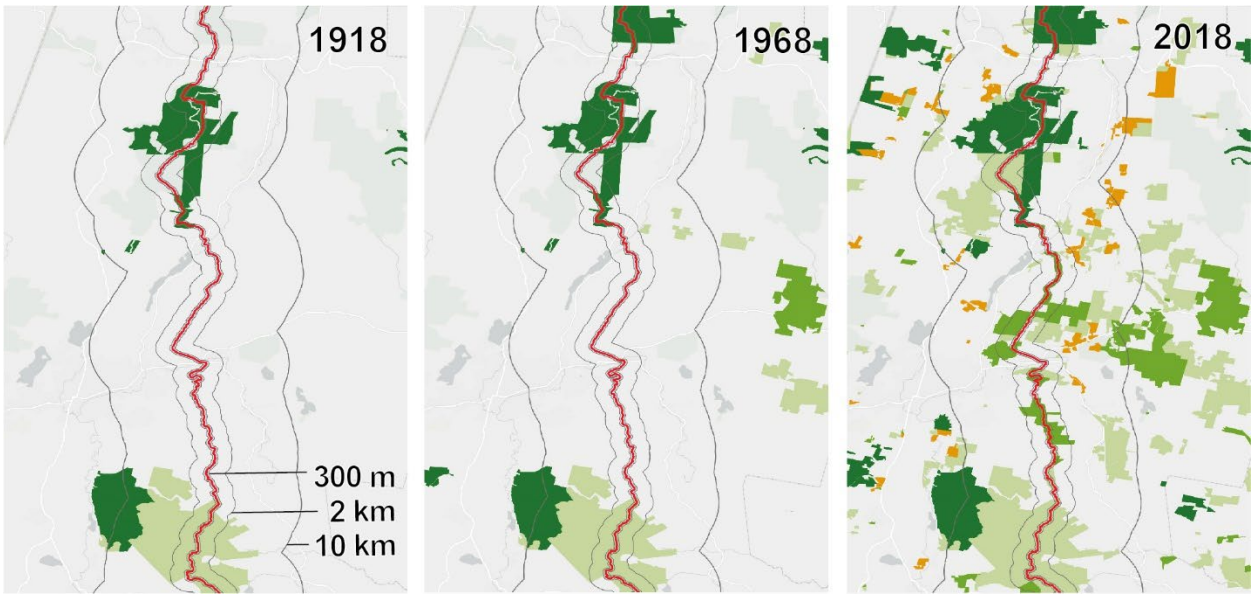


Figure 5-1. Buffers along the Appalachian Trail (300m, 2 km, and 10 km wide corridors) with existing protected areas in 1918, 1968, and 2018. Colors represent GAP-Status: 1 (dark green), 2 (leaf green); 3 (light green); and 4 (orange).

Table 5-1. Costs to potential movements in each raster layer.

Raster Layer	Cost
Land Use Classes	
Very Low or Very Low use, Conservation	0
Grazing potential	1
Wetlands	2
Pasture/Hay	3
Crops	4
Anthropogenic Other	5
Water	5
Urban Interface Low Medium	6
Developed, Other	7
Residential, Low-Medium Density	8
Recreation	9
Urban Interface High	9
Residential, High Density	10
Mining/Extraction	11
Commercial/Services	12
Major Transportation	12
Industrial/Military	12
Distance from Roads	
>300m	0
180-300m	1
60-180m	2
0-60m	3
PAD-US GAP Status	
GAP 1	0
GAP 2	1
GAP 3	2
GAP 4	3
No GAP protection	4

* 1 unit was added to each raster cell since there is no movements with 0 cost.

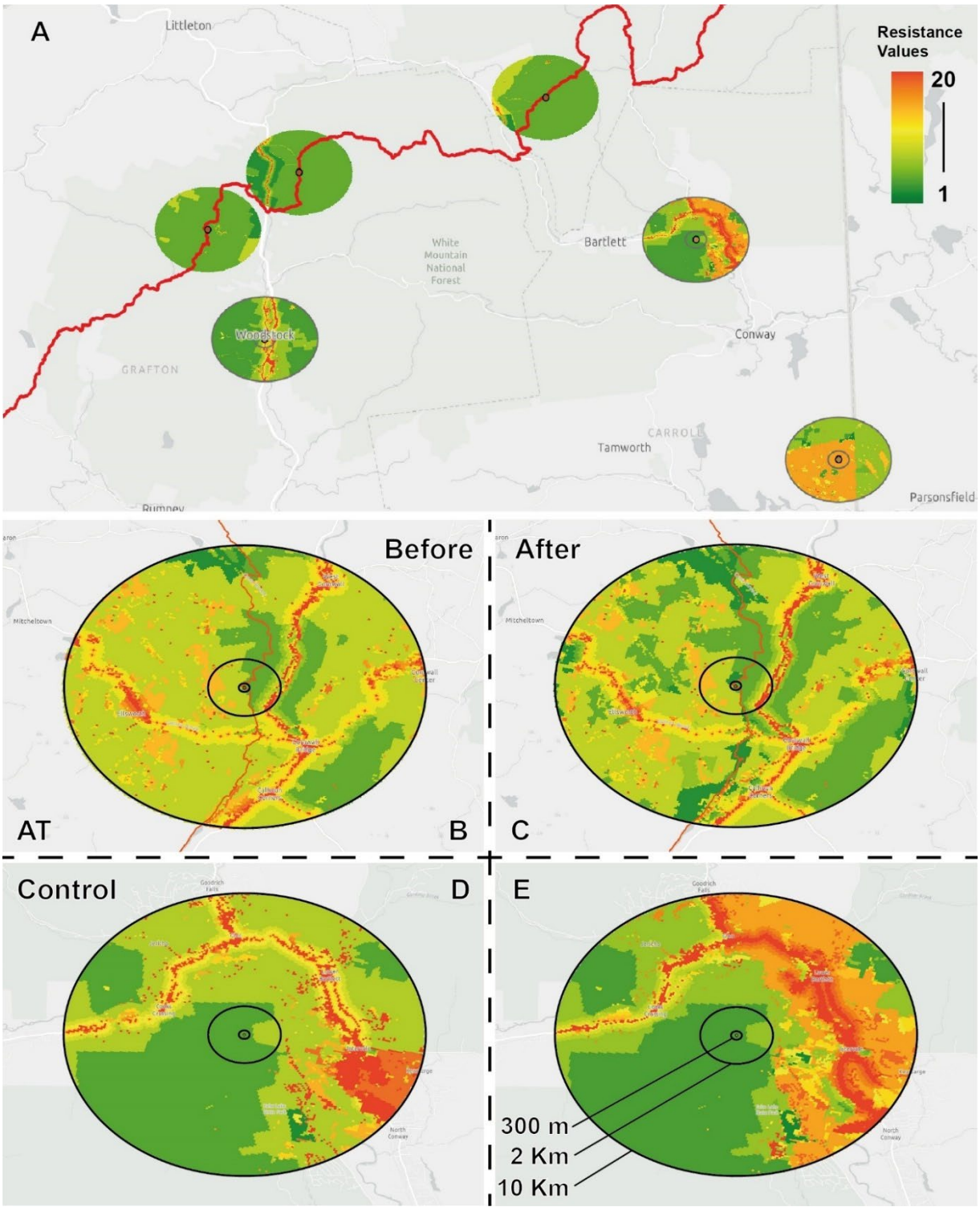


Figure 5-2. Before-After-Control-Intervention (BACI) comparison with matched samples. A: buffers around random points along the AT and control paired points selected randomly with similar land use, elevation, and slopes; B: Resistance map of point AT 70 with 300m, 2km, and 10km diameter buffers in the *before* scenario; C: Point AT 70 in after scenario; D: Point Control 70 in before scenario; E: Point Control 70 in the *after* scenario.

Table 5-2. Total protected area by GAP-status and their proportional coverage of the corridors of different widths and in the study region in 1918, 1968, and 2018

GAP-Status	Area in 300 m corridor			Area in 2 km corridor			Area in 10 km corridor			Area in study region (200km)		
	1918 (%)	1968 (%)	2018 (%)	1918 (%)	1968 (%)	2018 (%)	1918 (%)	1968 (%)	2018 (%)	1918 (%)	1968 (%)	2018 (%)
GAP 1	123 (1.3)	94 (9.4)	168 (16.8)	60 (1.0)	540 (9.1)	988 (16.6)	130 (0.5)	1,786 (6.7)	3,112 (11.8)	199 (0.04)	3,536 (0.8)	7,271 (1.6)
GAP 2	15 (1.5)	85 (8.5)	310 (31.0)	79 (1.3)	465 (7.8)	1,064 (17.9)	248 (0.9)	1,700 (6.4)	2,979 (11.3)	826 (0.2)	8,902 (2.0)	21,251 (4.8)
GAP 3	71 (7.0)	204 (20.5)	412 (41.2)	391 (6.6.)	1,098 (18.4)	2,182 (36.6)	1,395 (5.3)	3,827 (14.5)	6,355 (24.0)	7,548 (1.7)	21,070 (4.7)	36,011 (8.1)
GAP 4	0 (0)	0.3 (0.03)	5 (0.5)	0.1 (0)	5 (0.1)	39 (0.7)	29 (0.1)	48 (0.2)	421 (1.6)	276 (0.1)	1,143 (0.3)	11,553 (2.6)
All PAs	99 (9.9)	384 (38.4)	895 (89.5)	530 (8.9)	2,108 (35.4)	4,273 (71.7)	1802 (6.8)	7,36 (27.8)	12,867 (48.6)	8,850 (2.0)	34,651 (7.7)	76,086 (17.0)
Total Buffer Area	1,001 (100%)			5,958 (100%)			26,475 (100%)			447,239 (100%)		
Average increase (km2/year)	1918-1968	1968-2018		1918-1968	1968-2018		1918-1968	1968-2018		1918-1968	1968-2018	
	5.7	17.8		31.6	84.8		111.2	255.1		516.0	1511.4	

Areas in km^2; Proportional coverage in %.

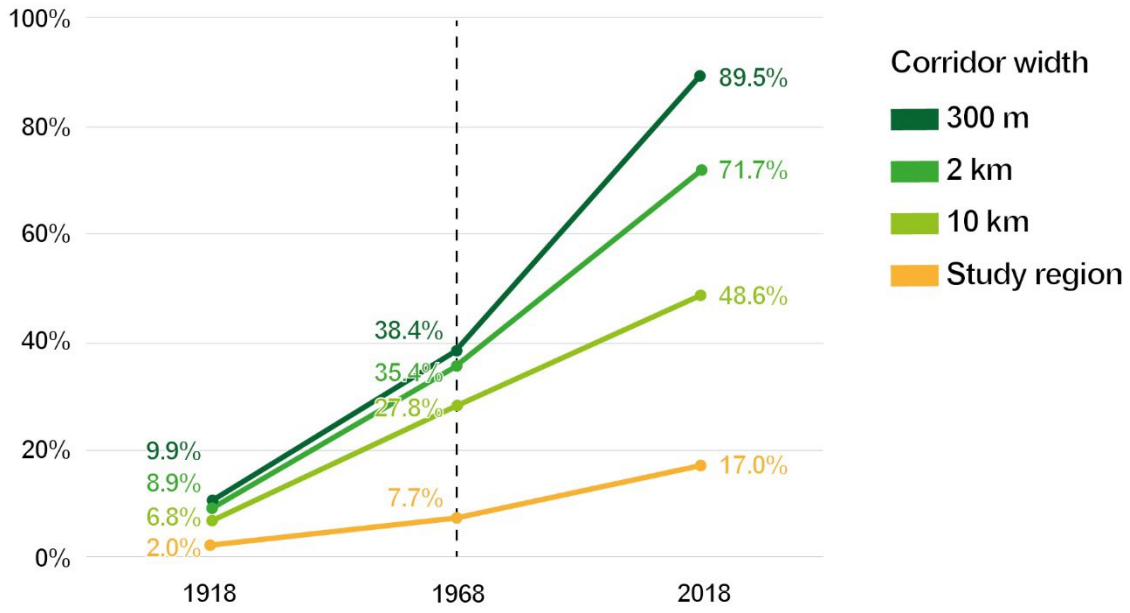


Figure 5-3. Protected area coverage (%) considering different corridor widths along the Appalachian Trail (300m, 2km, and 10km) and in the whole study region (200 km) at three moments in time (1918, 1968, and 2018).

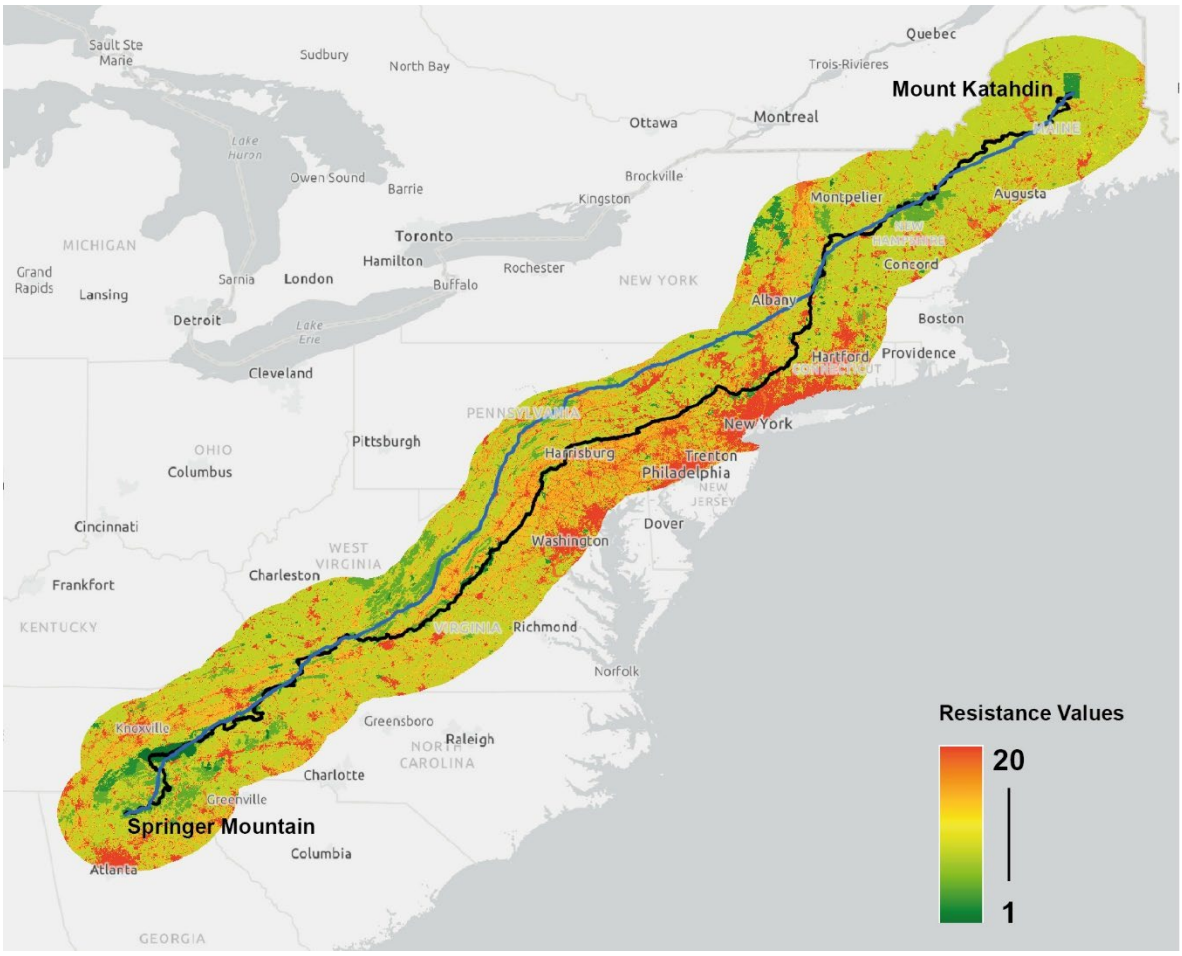


Figure 5-4. Appalachian Trail (black line) and Least-Cost Path (blue line) over the Resistance map for *before* scenario, showing proximity between them in the South and North parts and the distance in the Central part.

Table 5-3. Cumulative costs along the Appalachian Trail and the Least-Cost Path in *before* and *after* scenarios

	Appalachian Trail	Least-cost Path	Differences*** (LCP/AT)
Length	3,416 km	1,984 km	58.1%
Resistance maps*			
Cumulative cost *before*	210,693	119,458	56.7%
Cumulative cost *after*	154,802	119,185	77.0%
Variation in time	-26.5%	-0.2%	
Land use resistance maps**			
Cumulative cost *before*	66,158	32,495	49.1%
Cumulative cost *after*	73,910	49,174	66.5%
Variation	11.7%	51.3%	

* Resistance maps built from three layers (land use, distance from roads, and protected areas, with value per cell ranging from 1 to 20); ** Land use resistance maps built from land use layer only (value per cell ranging from 1 to 13); *** Difference refers to the ratio between LCP and AT; Variation refers to the difference between the resistance values in the before and after scenarios.

Table 5-4. Average resistances over time, and paired t-test results for resistance changes at different corridor widths along the Appalachian Trail (AT) and in control areas

Corridor	AT points			Control Areas			t*	p
Width	Before	After	Variation	Before	After	Variation		
300 m	4.41	3.33	-24.5%	5.48	5.96	8.8%	-6.639	<.001
2 km	4.50	3.91	-13.0%	5.49	6.08	10.8%	-5.513	<.001
10 km	4.83	4.74	-1.9%	5.71	6.23	9.2%	-4.075	<.001

* T-tests using 95% Confidence Interval; 99 Degrees of Freedom.

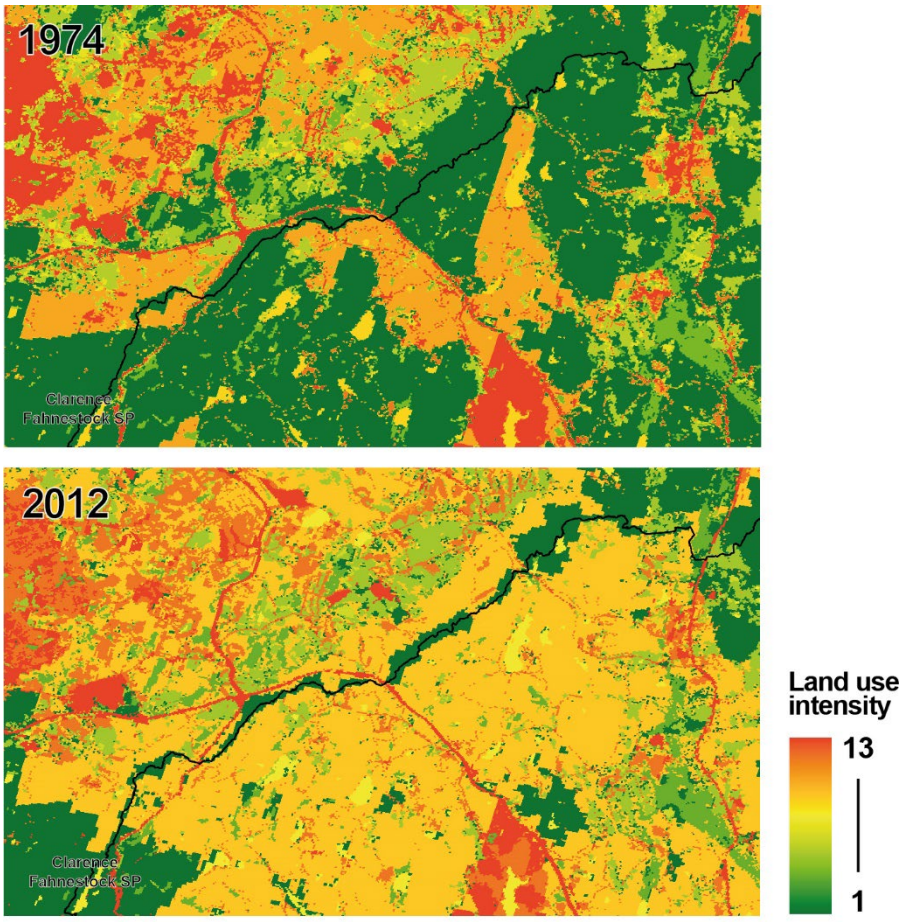


Figure 5-5.Change in land use along the Appalachian Trail (black line) in eastern New York from 1974 to 2012 showing that very low-use areas only remain along a narrow AT corridor. Land use intensity ranges from 1 to 13, following the land use classes from Table 1.

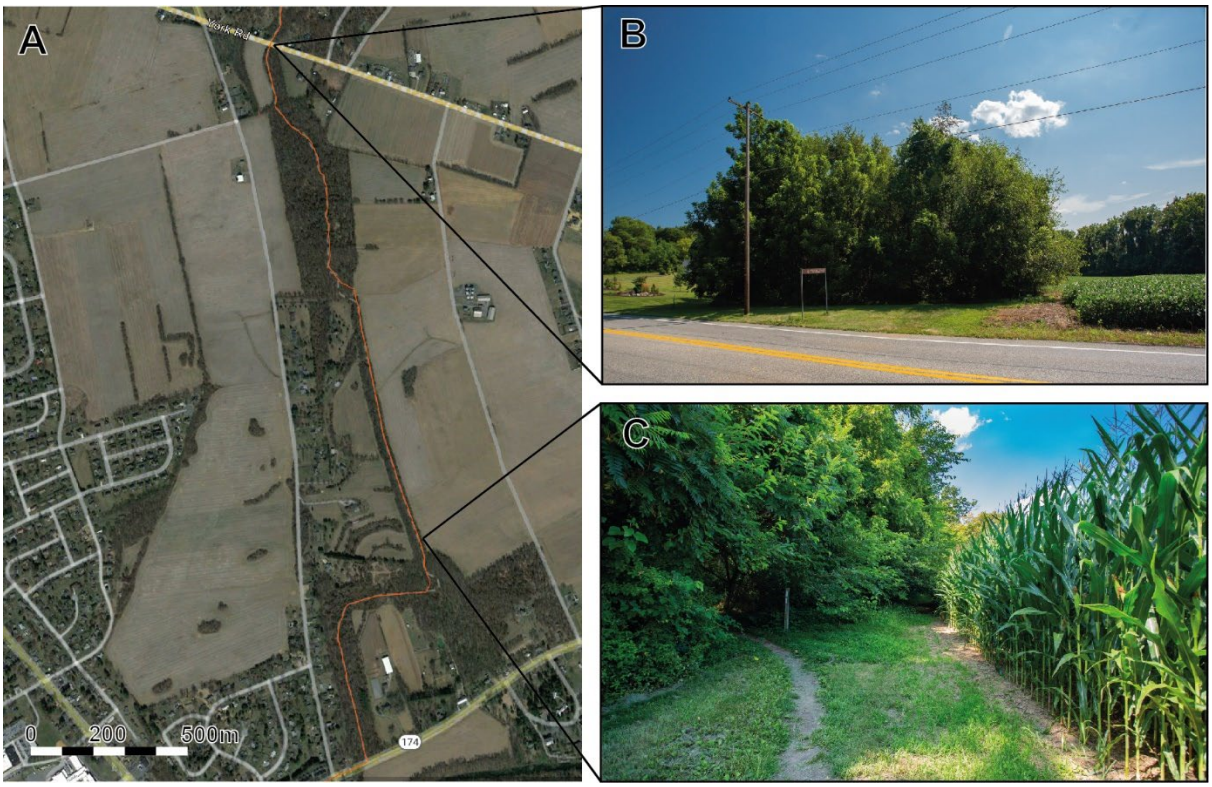


Figure 5-6. The narrow AT corridor in the Cumberland Valley and adjacent croplands. A: aerial image of *Google Earth Pro* on 8/14/2022; B: AT crossing York Road; and C: AT entering the tree corridor and corn fields (B and C photos by Ernesto V. Castro on 5/8/2021).

CHAPTER 6
CONCLUSION

By adopting a multidisciplinary approach, this study provides a comprehensive view of the contribution of mega trails to nature conservation. The evaluation of the effects of these trails on hikers, communities, and landscape showed that they could play a role as conservation tools, contributing to aspects as diverse as people and community awareness and engagement, sustainable economic development, land protection, and landscape conservation. By comparing research findings on the three trails that form the US Triple Crown of Hiking, we can identify limitations and difficulties, but also actions that could enhance their benefits, generating guidelines for implementing mega trails as conservation tools worldwide.

After a brief introduction (Chapter 1) presenting the conceptual framework and the three main elements related to mega trail explored in this dissertation - hikers, communities, and natural environments - I explored the sense of place presented by hikers (Chapter 2). The findings on the relationship between hiking duration and sense of place and its spatial scale suggest that mega trails can create meaningful places (Gustafson, 2001) at the landscape level. By finding that even day hikers have a stronger and broader sense of place if motivated by mega trails, we conclude that the positive effect of mega trails goes far beyond the few thousand people who endure long-distance hikes annually and that the sense of place can go beyond the specific sites visited. The perception that there is a brand effect (Swait & Erdem, 2007) is reinforced by interviews in gateway communities, which showed that these long-distance hikers give concreteness to the idea of the mega trail beyond the trail audience (Cerveny et al., 2022).

The trail brands seem to bring these large landscapes into the perceptible realm of people, which is one of the biggest challenges in gaining support for large-scale conservation actions (Gobster et al., 2007). Despite some controversy about the difficulty of incorporating knowledge

about sense of place into management decisions (Farnum et al 2005; Kaltenborn and Bjerke, Williams, 2008), harnessing the beneficial effects of sense of place in favor of conservation projects seems promising. Implementing mega trails as backbones of conservation projects in priority landscapes and geographic features, such as mountain ranges, ecoregions, biodiversity hotspots, or climate corridors can help reinforce the meaning of these places and strengthen conservation actions in these territories. If trail systems and networks contribute to integrated planning and connectivity, they should not overshadow trail brands directly related to geographic features and priority areas for conservation. These trail brands can be more effective in communicating the importance of these areas for conservation to society.

The mega trails studied pass through some of the most famous natural attractions in the U.S., such as the Old Faithful Geyser in Yellowstone National Park (CDT) or Clingmans Dome, in the Great Smoky Mountains NP (AT). However, there is little or no mention of the trail in some of these places. Intensive outreach and signage in these popular sections and road crossings could strengthen the trail brands. The trails studied adopt different strategies concerning major tourist attractions. While the CDT and AT pass through many major attractions, the PCT seems to prioritize a more wilderness experience, avoiding places such as the Yosemite Valley and the Crater Lake Rim Trail, the most popular of the respective national parks. However, 85% of PCT thru-hikers take the rim trail as an alternate route in Crater Lake NP (Halfway Anywhere, 2023), showing their interest in major attractions. Locating the trail to provide experiences at major attractions and reaching a wider audience while having alternate routes for those who prefer to avoid crowded areas, seems like a balanced strategy to broaden audiences and ensure enjoyable experiences for all.

In Chapter 3, I found that sense of place alone is not enough to generate civic actions and pro-environmental behaviors, being necessary to forge a connection to nature as a whole for that. A better understanding of the relationships and processes that lead from outdoor experience to support for conservation is essential to improve planning and experiences offered in natural environments, and this study represents another step in this direction. Despite some controversy about the relationships between these constructs and their subdimensions (Jorgensen & Stedman, 2001; Tam, 2013), putting together the findings of chapters 2 and 3, it is possible to state that hiking experiences on mega trails are related to sense of place, connection to nature, and pro-environmental behaviors.

Regarding local communities, as my conceptual framework highlighted, they are also a key element in the dynamics of mega trails, whether as users, direct beneficiaries, or actors in conservation actions, as seen in Chapter 4. The finding that positive perceptions about the trail are not always based on facts, such as the importance of the trail in the local economy, suggests that trails play a role in community identities, going beyond the effects of this and other tangible benefits (Stewart et al., 2004). Reinforcing these linkages through initiatives such as trail town programs appears to result in more positive perceptions and attitudes toward trail protection.

Despite the relatively low economic importance, the overall positive perception of the trails and hikers is justified by the even lower perception of the eventual trail's negative impacts on communities (Frauman & Banks, 2012; Harrill, 2004). This finding reinforces that mega trails divide the economic benefits among many gateway communities but also their negative impacts. Maintaining tourist activity on a limited scale is essential for mega trails initiatives to minimize negative impacts on communities and promote sustainable tourism, which is proposed to be economically viable, environmentally appropriate, and socially acceptable (McCool, 2016).

The third element of my conceptual framework is the natural environment. Chapter 5 demonstrated that civic action involving hikers, local communities, and public managers results in greater landscape connectivity. This chapter focused only on the Appalachian Trail, and the generalizability of the findings needs to be tested. Nevertheless, based on the AT example, we can say that public-private partnerships with the engagement of hikers and organizations and long-term presence in the territory (Mittlefehldt, 2010) have created a favorable scenario for conservation. By joining the authority and structure of the government, with the flexibility and engagement of non-profit organizations, AT has seen the protected area coverage and landscape connectivity grow. The legal basis for protecting the trail corridor and the growing focus on the landscape perspective gave impetus to conservation actions, positively influencing connectivity beyond the narrow trail corridor.

On the other hand, in many sections, the trail corridor seems too narrow to represent an alternative to many species' movements (Beier, 2019). This problem mainly occurs in flatter areas more suitable for agriculture and other human activities. Trails planned as conservation tools should seek to protect wider corridors or add to their strategies other actions to increase connectivity, such as easements and agreements with landholders to adopt production practices that increase the matrix permeability (Baum et al., 2004) even in places where it is not viable to establish a wide forest corridor. Planning the trail location in the corridor can also result in a greater effective corridor width (Ford et al., 2020). In places where the corridor width is critical, the trail can be located on the edge or even in adjacent open areas.

Mega trails can be backbones for many large-scale conservation actions, including the designation of protected areas, protection or restoration of corridors, and engagement with landholders and local communities to promote more sustainable land uses. These measures are

among the most frequently cited as important to promote landscape conservation and climate change adaptation (Gregory et al., 2021; Heller & Zavaleta, 2009). Overall, a dollar invested in mega trails or related local trails seems to give a greater return to society than a dollar invested in isolated local trails.

This study explored the relationship between mega trails and nature conservation through different approaches and opened several possibilities for future investigation. Further research may help to understand whether the sense of place and connection to nature results from trail experiences or at what level hikers choose this activity influenced by a previous connection to nature and places. I concluded that mega trails could keep tourism at sustainable levels but estimating the economic impact of hikers in gateway communities, especially small towns without other significant attractions, would help to understand the extent to which mega trails could sustain the economy of rural communities that suffer with the decline of extractive industries. Regarding the landscape, I concluded that the AT influences corridor protection and connectivity at a large scale, but further research can answer the role of the trail in connectivity at a local scale. Empirical studies with species more vulnerable to fragmentation can answer if they effectively use the narrow corridors restored in critical areas or indicate other necessary actions for the mega trails to provide connectivity also on a local scale.

Based on my findings so far, I can conclude that the pioneer Benton Mackaye (1921) was right when he proposed the first mega trail as a strategy to promote contact with nature for the people, enable sustainable rural communities, and landscape-scale planning. Mega trails can play an important role as conservation tools, but how they are planned, managed, and marketed is essential to create a high level of success. Considering a wider audience than long-distance hikers in communication strategies, involving local communities, and taking environmental

criteria into account when planning routes and ecological corridors could make a big difference in the level of success of these initiatives.

APPENDIX A
SURVEY APPLIED TO HIKERS (CHAPTERS 2 AND 3)

Research Informed Consent:

Hello. My name is Ernesto Viveiros de Castro, I am a PhD student at the School of Natural Resources and Environments at the University of Florida. I would like to invite you to participate on a research about long distance trails. Before you decide, I would like to let you know a few things about this study.

First, this survey is part of a study looking at how hikers and local people think about these trails and their environments. I'll ask you questions about your opinions on trail management and environmental issues. There are no right or wrong answers. We're really just interested in your opinion on these topics.

Second, It will take around 15 minutes of your time to address my questions

Finally, This study is anonymous, answering these questions will not affect you either for better or for worse. Please understand your participation is voluntary and that there is no payment or compensation for your participation. There is no anticipated risk or direct benefit to participants. You have the right to withdraw your consent or discontinue participation at any time without penalty. You have the right to refuse to answer any particular question.

If you have any questions about this research protocol, with number IRB 202100413, please contact Dr. Taylor Stein, at +1 (650) 204¬1052 o tstein@ufl.edu. Questions or concerns about your rights as a research participant may be directed to the IRB02 office at University of Florida by telephone at +1 (352) 392-0433.

I am 18 years old or older, I understand the information above and I provide my consent to participate in this study.

1. I am 18 years old or older, I have read the information above and I provide my consent to participate in this study.

Yes _____

No _____

Section 1: Trail use

2. How many times have you used this trail?

[ ] First time [ ] 6 to 10 times

[ ] 2 to 5 times [ ] More than 10 times

3. If you were coming here and someone asked you to which trail you were going, what would you say? [PROMPT: How would you refer to this trail? (a given name)]

_____

4. Did you know that this trail is part of the [mega trail]**?**

[ ] Yes [ ] No

5. Have you ever referred to this trail as part of the xxxxxxx Trail? [PROMPT: that is, when talking about this trail to someone, you have used the term [mega trail] instead of another name]

[ ] Yes [ ] No

6. About your reasons for choosing this trail to hike during this visit, can you tell

me how important was each of these reasons? [PROMPT: using a five point scale from not at all important to extremely important]

	1	2	3	4	5
6.1. Hike in any natural trail close to home/accommodation					
6.2. Visit [local attraction]					
6.3. Hike in the [local protected area]					
6.4. Hike in the [mega trail]					

1- Not important at all; 2- slightly important; 3- moderately important; 4- very important; 5- Extremely important

7. **About how long did you spend (or are spending) on the trail during this visit?**

[ ] Up to 2 hours

[ ] Half-day hiking (or less)

[ ] Day hiking

[ ] Multiple-day hiking (How many days?_____)

[ ] [mega trail] Section hiking [PROMPT: meaning a plan to complete the [mega trail] in multiple trips] (How many days?)

[ ] [mega trail] Thru hiking

8. **Did you visited or will visit other places for outdoor activities during this trip?**

[ ] No (SKIP TO QUESTION #13)

[ ] Yes (Please specify: _____)

9. **Have you ever hiked other** [mega trail] **section?**

[ ] Yes [ ] No [IF NO, SKIP THE NEXT TWO QUESTIONS]

10. **How many days have you hiked in the** [mega trail] **before?** [PROMPT: It can be an approximate number…]

[ ] Days [INSERT THE NUMBER OF ESTIMATED DAYS]

[ ] Thru hiking [MARK IF S/HE IS/WAS A THRU HIKER]

11. **Do you consider that you collect sections of the** [mega trail]**? [**PROMPT: in this sense collecting means looking for hiking opportunities in as many [mega trail] sections as possible, whether you're thinking of completing the trail one day or not]

[ ] Yes [ ] No

12. **Have you ever hiked on another long-distance trail?**

[ ] No [IF NO, SKIP THE NEXT QUESTION]

[ ] Appalachian Trail

[ ] Continental Divide Trail

[ ] Other (Please specify: _____)

13. **Except for the** [mega trail], **how many days have you hiked in long-distance trails before? [PROMPT: It can be an approximate number… If you are/were a thru hiker only check this option and inform the trail name]**

[ ] Days

[ ] Thru hiking

Section 2: Sense of Place

14. **Now, I'm going to ask you some questions about what you think and feel about these places. For the following statements please indicate your agreement or disagreement according to the scale.**

	SD	D	N	A	SA
a. I feel like these places are part of me.	1	2	3	4	5
b. These places are the best place for what I like to do	1	2	3	4	5
c. I identify strongly with these places.	1	2	3	4	5
d. I get more satisfaction out of being here than anywhere else.	1	2	3	4	5
e. I am very attached to these places.	1	2	3	4	5
f. Coming or being here says a lot about who I am.	1	2	3	4	5
g. The things I do here, I would enjoy doing just as much somewhere else.	1	2	3	4	5
h. Because of my lifestyle, these places are important to me	1	2	3	4	5
i. Most of my family/friends are, in some way, connected with these places.	1	2	3	4	5
j. I identify with the physical landscape of these places.	1	2	3	4	5
k. I am interested in the plants and animals that live in these places.	1	2	3	4	5

1- Strongly disagree; 2- Disagree; 3- Neither agree nor disagree; 4- Agree; 5- Strongly agree

15. **When you've been talking about how you feel about these places, are you thinking more of these places as being…?** [PROMPT: MARK ALL THAT APPLY]

[ ] [Local Trail/Attraction]

[ ] [Local protected area]

[ ] [Local Mountains/geographic features]

[ ] [The State]

[ ] [The Mega Trail]

[ ] Nature as a whole

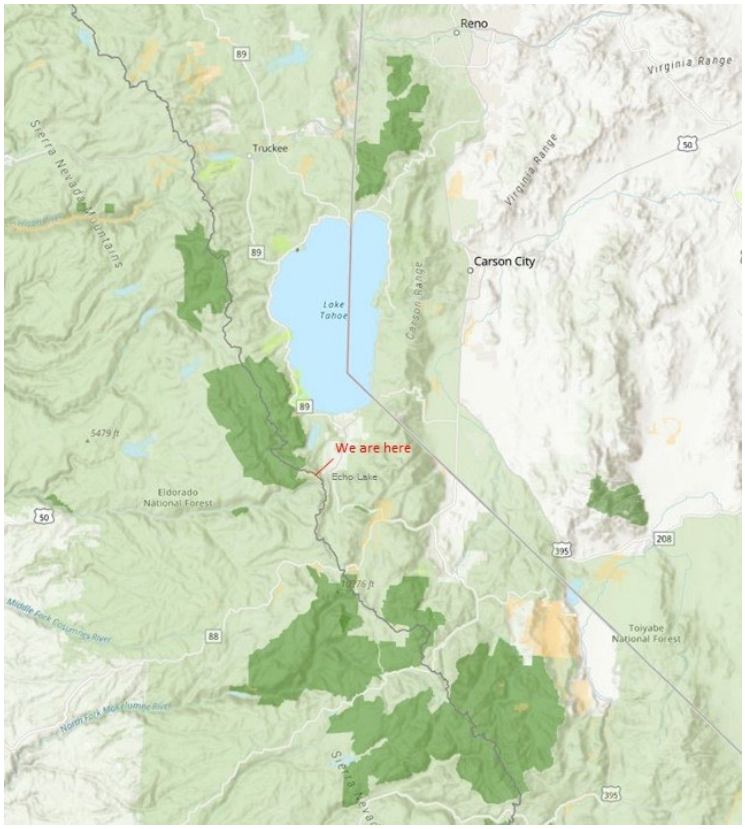
16. **In a scale from 1 to 5, tell me how connected you feel with each of these following places** [PROMPT: Please answer by responding: not connected at all; disconnected; neither connected nor disconnected; connected; and strongly connected]

	NC	D	N	C	SC
a. [Local attraction Local Trail/Attraction]	1	2	3	4	5
b. [Local protected area]	1	2	3	4	5
c. [Local Mountains/geographic features]	1	2	3	4	5
d. [The State]	1	2	3	4	5
e. [The Long-distance Trail]	1	2	3	4	5
f. Nature as a whole	1	2	3	4	5

1- Strongly connected; 2- Somewhat connected; 3- Neither connected nor disconnected; 5- Not connected at all

Section 3: Scale of Sense of Place

17. **Based on your previous responses and thinking about the places that matter to you, please touch the map to indicate the areas the areas you deem important to protect or keep protected. [PROMPT: You can use up to 3 touches. So, you can use more than one touch to mark a large area]**



*** Example of local map**

18. **Now, considering a broader scale, are there other places that matter to you? Please touch**

the map to indicate the areas you deem important to protect or keep protected. [PROMPT: You can use up to 10 touches. So, you can use more than one touch to mark a large area]

*Example of large map

19. **Again, thinking in your connection with these places, please tell me which of these places is more important for you, ranking in order of importance.** [PROMPT: Please rank marking 1 for the most important, 2, 3 etc. subsequently. You can leave some options blank]

    a. [Local attraction Local Trail/Attraction]
    b. [Local protected area]
    c. [Local Mountains/geographic features]
    d. [The State]
    e. [The Mega Trail]

20. **Aside from these places, is there another natural place that you feel connected to?**

[ ] Yes [ ] No [If no, skip next question]

21. **Why that place is special for you?** [PROMPT: Open ended question. Please mark that best fit]

[ ] Where I spent my childhood

[ ] Where I had my first experience in nature

[ ] The closest natural environment to my home

[ ] A place I've never been (e.g. I've known it through reports, books, documentaries, etc.)

[ ]Other reason (Please specify)

Section 4: Connection to nature and pro-environmental behavior

22. **Now, I'm going to ask you some questions about your feelings about nature as a whole. For the following statements please indicate your agreement or disagreement according to the scale.: strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree.**

	SD	D	N	A	SA
a. I think of the natural world as a community to which I belong	1	2	3	4	5
b. When I think of my life, I imagine myself to be part of a larger cyclical process of living.	1	2	3	4	5
c. I often feel a kinship with animals and plants.	1	2	3	4	5
d. I feel as though I belong to the Earth as equally as it belongs to me.	1	2	3	4	5
e. I often feel part of the web of life.	1	2	3	4	5
f. I feel that all inhabitants of Earth, human, and nonhuman, share a common "life force."	1	2	3	4	5
g. Like a tree can be part of a forest, I feel embedded within the broader natural world.	1	2	3	4	5

1- Strongly disagree; 2- Disagree; 3- Neither agree nor disagree; 4- Agree; 5- Strongly agree.

23. If something threatened to change the landscape or environment of this place, such as permanent clear cuts for commercial purposes, how willing would you be to to take each of the following actions? [PROMPT: Please answer on a scale of 1 to 5, from not willing at all to definitely would].

	1	2	3	4	5
a. Talk to family/friends/community about it					
b. Use online tools (e.g. post on internet/social media) to gather attention					
c. Sign a petition					
d. Written to authorities (e.g. congress people)					
e. Attend a protest/rally					
f. Take this issue in account when voting					
g. Stop consuming products from companies that threaten the landscape					
h. Donate money to ensure the protection of the land					

1- Not willing at all; 2- Slightly willing; 3- Moderately willing; 4- Very willing; 5- Definitely would.

24. How much would you be willing to donate in a year to ensure the protection of the land? [PROMPT: For example for an NGO to buy the land and allocate it for conservation. ONLY ASK IF IF THE PREVIOUS ANSWER IS THAT S/HE IS WILLING TO DONATE]

_____

25. Would you consider being a volunteer to work to protect or keep this place in good conditions? If so, how many days would you work in a year? [PROMPT: Do not take into account the distance from home. IF NO, SKIP NEXT QUESTION]**]**

[ ] Not willing at all

[ ] Slightly willing

[ ] Moderately willing

[ ] Very willing

[ ] Definitely would

26. How many days in a year? _____

27. Now, thinking about your everyday actions, please tell me how frequently you adopt these behaviors. Please answer using the scale: never, rarely (once a year), occasionally (once a month), frequently (once a week), always

	1	2	3	4	5
a. I try to eat local food as much as possible.					
b. I try to adapt my diet to reduce my impact on nature (e.g. reducing meat consumption or being vegetarian)					
c. I try to reduce my energy consumption (e.g. using bikes or public transport, turning off air conditioning)					
d. I try to reduce my carbon footprint.					
e. I take steps to improve habitat for wildlife near my home					
f. I do volunteer work to care for a natural area near my home					

1- Never; 2- Rarely (once a year); 3- Occasionally (once a month); 4- Frequently (once a week); 5- Always

Section 6: Demography and economy

We would like to ask a few questions about you, your background, and your past experiences. This information will be used for statistical analysis only, and all information will remain anonymous and strictly confidential.

28. What is your main address Zip Code? [If you prefer, inform city and neighborhood]

_____

29. Do you own a secondary home in this area? [In this case, area include this county and neighbor counties]

[ ] Yes

[ ] No

30. Which gender do you identify with? [OPEN ENDED QUESTION. MARK THE OPTION THAT BEST APPLY]

[ ] Female [ ] Transgender Female [ ] Non-binary

[ ] Male [ ] Transgender Male [ ] Other

[ ] Prefer not to say

31. Which of the following best describes your status?

[ ] Married [ ] Divorced

[ ] Single [ ] Widowed

[ ] Prefer not to say

32. What is the highest level of education you have completed?

[ ] Eighth grade or less [ ] Some College [ ] Graduate Degree or beyond

[ ] Some High School [ ] College Complete

[ ] High School Graduate or GED[ ] Some Graduate School

33. What is your profession or occupation? _____

34. Are you presently… [Please mark all that apply]

[ ] Employed Full Time [ ] Retired

[ ] Employed Part Time [ ] Part Time Student

[ ] Unemployed looking for work [ ] Full Time Student

[ ] Unemployed not looking for work [ ] Disabled

35. **What year were you born?** _____

36. **What race or ethnic group(s) would you place yourself in?** [Please mark all that apply]

[ ] Black [ ] Hispanic or Latino [ ] Asian American

[ ] Native Hawaiian or Pacific Islander [ ] American Indian or Alaskan Native

[ ] White [ ] Other, Mixed…

37. **What was your approximate total household income, before taxes this past year?**

[ ] Less than $15,000 [ ] $40,001 to $50,000 [ ] $100,001 to $150,000

[ ] $15,001 to $30,000 [ ] $50,001 to $70,000 [ ] $150,001 to $200,000

[ ] $30,001 to $40,000 [ ] $70,001 to $100,000 [ ] More than $200,000

[ ] Prefer not to say

38. **How many people are included in your household?**

____ People

39. **How many days in your trip and how many people are included in your expenses?**

____ Days ____ People

40. **Can you tell me how much money you spent in this trip?** [PROMPT: considering transportation, accommodation, food, groceries, equipments for this trip and other expenses, including the whole group]

Total expenses _____

41. **Is there anything else you'd like to add on this topic about, which I haven't asked you specifically?**

_____

APPENDIX B
SEMI-STRUCTURED INTERVIEWS GUIDE – LOCAL KEY ACTORS

Research Informed Consent:

Hello. My name is Ernesto Viveiros de Castro, I am a PhD student at the School of Natural Resources and Environments at the University of Florida. I would like to invite you to participate on a research on long distance trails. Before you decide, I would like to let you know a few things about this study.

First, this interview is part of a study regarding how hikers and local residents think about these trails. Most of this research is based on anonymous surveys, but you were invited as a local stakeholder and should be identified. I will ask for your name, workplace, and contact information, but all of your responses will be held in confidence. Your name and institution will be kept confidential and only the sector where your institution works will be mentioned in the final work.

Second, It will take around 30 minutes of your time to address my questions I'll ask you questions about your opinions. There are no right or wrong answers. We're really just interested in your opinion on these topics as a local stakeholder.

Finally, answering these questions will not affect you either for better or for worse. Please understand your participation is voluntary and that there is no payment or compensation for your participation. There is no anticipated risk or direct benefit to participants. You have the right to withdraw your consent or discontinue participation at any time without penalty. You have the right to refuse to answer any particular question.

If you have any questions about this research protocol, with number IRB 202100413, please contact Dr. Taylor Stein, at +1 (650) 204¬1052 o tstein@ufl.edu. Questions or concerns about your rights as a research participant may be directed to the IRB02 office at University of Florida by telephone at +1 (352) 392-0433.

I'd like to ask for your permission to record the interview

I am 18 years old or older, I understand the information above and I provide my consent to participate in this study.

____

[PROMPT: Identify the name of interviewee, town, date and time]

1- **Could you introduce yourself and tell me if you are involved in any way with the [Mega Trail]?** [PROMPT: If the person answers yes, ask: **how and how long?]**

2- **How long have you lived here?** [Only for people coming from other regions] **What influenced your decision to move here?**

3- **Do you feel there is value in having the trail located close to your community? [PROMPT: If the person answers yes, ask: what are the most significant benefits?**]

4- **In your opinion, what is the role played by the [Mega Trail] in the local economy?** [PROMPT: If the answer is too laconic, encourage with something like; "**Tell me more about it. Do you think she is relevant or not? And why?**]

5- [Only for business owners/managers] **How important is the [Mega Trail] in your income?**

6- [Only for business owners/managers] **Do you seek to adopt practices to minimize the impact of your activity?** [PROMPT: If the person answers only yes, ask: **Which ones?**]

7- **In your opinion, what is the role played by the [Mega Trail] in the local identity?** [PROMPT: If the answer is too laconic, encourage with something like; **"Tell me more about it. Do you think she is relevant or not? And why?**]

8- **Could you estimate the proportion of residents who know about the existence of the [Mega Trail]?**

9- **In your opinion, does the trail somehow influence the local people relationship with nature?**

10- **Do you think local people view the [Mega Trail] positively, negatively, or neutrally? Why?**

11- **How do you think local people seem the long-distance hikers: positively, negatively, or neutrally? Why?**

12- **Do you think that people who works with activities not related to the trail, like agriculture, seem the trail in a different way?**

13- **On the other side, do you feel that there are negative impacts of having the trail near your community? [**PROMPT: If the person answers only yes, ask: **what are the most significant negative impacts?]**

14- **Is there anything else you'd like to add on this topic, which I haven't asked you specifically?**

To finish, please fill this short questionnaire with some data. I reinforce that all of your responses will be held in confidence (self-administered in Qualtrics):

Name:

Town:

Institution/company:

Time involved in present economic activity/profession:

What year were you born?

Which gender do you identify with?

If you are interested in receive info about the results of this research, please inform your e-mail.

APPENDIX C
UF INSTITUTIONAL REVIEW BOARD EXEMPT APPROVALS

UF | Institutional Review Board
UNIVERSITY of FLORIDA

Behavioral/NonMedical Institutional Review Board
FWA00005790

PO Box 112250
Gainesville FL 32611-2250
Telephone: (352) 392-0433
Facsimile: (352)392-9234
Email: irb@ufl.edu

DATE: 4/29/2021
TO: Ernesto Castro
308 Reed Lab, PO Box 110565
Gainesville, Florida 32611
FROM: Ira Fischler, Ph.D., Professor Emeritus
Chair IRB-02

IRB#: **IRB202100413**
TITLE: A Pathway to Nature Conservation: the Role of Long-Distance Trails in Connecting Hikers, Communities, and Landscapes.

Approved as Exempt

You have received IRB approval to conduct the above-listed research project. Approval of this project was granted on 4/29/2021 by IRB-02. This study is approved as exempt because it poses minimal risk and is approved under the following exempt category/categories:

> (2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or (iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by §46.111(a)(7).

Special Note(s) to Investigator:

Exempt approved studies will not have an approval stamp on the consents, fliers, emails, etc.

However, the documents reviewed are the ones to be used. If you need to modify the document(s) in any manner then you'd need to submit to our office for review and approval prior to implementation.

> Effective immediately, UF Research will adopt the UF Campus COVID-19 Guidelines found at https://coronavirus.ufl.edu/resources/health-guidance/ as the requirements for UF research activities, with the exception of certain human subject research.

Principal Investigator Responsibilities:

The PI is responsible for the conduct of the study.

- Using currently approved consent form to enroll subjects (if applicable)
- Obtaining approval for revisions before implementation
- Reporting Adverse Events
- Retention of Research Records
- Obtaining approval to conduct research at the VA
- Notifying other parties about this project's approval status

Should the nature of the study change or you need to revise the protocol in any manner please contact this office prior to implementation at 352-392-0433 or via email at irb@ufl.edu.

Study Team:

Angelica Almeyda Zambrano Co-Investigator

The Foundation for The Gator Nation
An Equal Opportunity Institution
Confidentiality Notice: This e-mail message, including any attachments, is for the sole use of the intended recipient(s), and may contain legally privileged or confidential information. Any other distribution, copying, or disclosure is strictly prohibited. If you are not the intended recipient, please notify the sender and destroy this message immediately. Unauthorized access to confidential information is subject to federal and state laws and could result in personal liability, fines, and imprisonment. Thank you.

UF | Institutional Review Board
UNIVERSITY *of* FLORIDA

Behavioral/NonMedical Institutional Review Board
FWA00005790

PO Box 112250
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DATE: 5/5/2022

TO: Ernesto Castro
308 REED LAB PO Box 110565
Gainesville, Florida 32611

FROM: Ira Fischler, Ph.D., Professor Emeritus
Chair IRB-02

IRB#: **Revision 1 for IRB Study #IRB202100413**

TITLE: A pathway to nature conservation: the role of long-distance trails in connecting hikers, communities, and landscapes.

Revision Approved - Exempt

On 5/3/2022, the IRB reviewed and approved your revision:

Revision 1 for IRB Study #IRB202100413

Approval Includes, but is not limited to:

- Updated study staff
- Updated study description
- Updated subject description
- Updated subjects/records/specimens reviewed
- Updated data collection forms/questionnaires

Thank you for keeping the IRB informed about your research project, thereby allowing us to keep accurate files. If the IRB staff can be of any further assistance, please feel free to call.

Study Team:

Taylor	Stein	Co-Investigator

The Foundation for The Gator Nation
An Equal Opportunity Institution
Confidentiality Notice: This e-mail message, including any attachments, is for the sole use of the intended recipient(s), and may contain legally privileged or confidential information. Any other distribution, copying, or disclosure is strictly prohibited. If you are not the intended recipient, please notify the sender and destroy this message immediately. Unauthorized access to confidential information is subject to federal and state laws and could result in personal liability, fines, and imprisonment. Thank you.

APPENDIX D
NATIONAL PARK SERVICE RESEARCH PERMITS

Great Smoky Mountains National Park

SCIENTIFIC RESEARCH AND COLLECTING PERMIT Grants permission in accordance with the attached general and special conditions **United States Department of the Interior** **National Park Service** **Great Smoky Mountains**	**Study#: GRSM-02147** **Permit#: GRSM-2021-SCI-2147** **Start Date: Jul 10, 2021** **Expiration Date: Aug 20, 2021** **Coop Agreement#:** **Optional Park Code:**

Name of principal investigator:

Name: Mr Ernesto Bastos Viveiros de Castro **Phone:**(352) 846-0850 **Email:**ernesto.castro@ufl.edu

Name of institution represented:

University of Florida

Additional investigators or key field assistants:

Name: Angélica Maria Almeyda Zambrano **Phone:** (352) 273-4734 **Email:** aalmeyda@ufl.edu

Study Title:

A Pathway to Nature Conservation: the Role of Long-Distance Trails in Connecting Hikers, Communities, and Landscapes.

Purpose of study:

THE NATIONAL PARK SERVICE HAS NOT BEEN INVOLVED IN THE DESIGN OR SELECTION OF ANY OF THE QUESTIONS USED FOR THIS STUDY

Since its origins, nature conservation efforts have been strongly related to experiences in natural environments. Seminal environmentalists like Henry Thoreau and John Muir and pioneering movements, such as the Sierra Club, have their roots in nature-based activities. Trails are the most basic element to provide opportunities of contact with natural environments and since the proposition of the Appalachian Trail by the forester Benton Mackaye in 1921, many long-distance trails (LDT), which cross very large territories, connecting different landscapes and protected areas, have been implemented worldwide as a large-scale nature conservation strategy.

The motivation for implementing LDTs is based on a tripod that includes: promote connection to nature and engagement of hikers in conservation behavior; generate income for local communities; and protect biodiversity corridors and connectivity among natural areas. Although LDTs have been proposed as conservation tools on a regional scale since its conception and were officially recognized as a conservation tool in the USA in 1968 by the National Trail System Act, few studies have actually evaluated their direct or indirect contribution to nature conservation and much of the accumulated knowledge is empirical and non-systematized. The proposed research aims to integrate ecological, economic and social approaches to fill this gap and understand at what level LDTs are a valid strategy for promoting nature conservation in different socioeconomic contexts and guide the implementation of the Atlantic Forest Trail.

Some of the main questions that we intend to answer with the proposed study are: Does the LDT brand influences people's interest in visiting natural areas? Do hikers develop a sense of place for LDT? If so, at what scale? Does the level of involvement of communities and people with the LDT influence their environmental concern? Is the tourism income enough to influence the land-use decision-making by landholders and prevent deforestation? And finally, the trail use and management contribute to landscape conservation, influencing the amount of habitat conserved and the landscape structural connectivity?

To address these research questions, a case studies design will be used, and two long-distance trails were chosen to compare different countries, historical, and socioeconomic contexts. The Appalachian Trail (USA), with 3,500 km from Georgia to Maine, completed for the first time in 1937, will be used as a success case. As a case still in the early stages of implementation in a developing country, I will study the Atlantic Forest Trail (Brazil), a 4,000 km long that started being implemented in 2014 in the most populated and devastated region of Brazil.

Understanding and quantifying the role of LDTs as conservation tools is key to conciliate conservation of natural resources and tourism activities, guiding conservation planning of multi-purpose landscapes. This is especially important in the COVID-19 pandemic and post-pandemic context that has greatly changed the relationship of people with outdoor activities, which could have great impact in future conservation strategies.

Subject/Discipline:

Social Science

Locations authorized:
In order to preserve the wilderness experience of the visitor, you are limited to working at one of four trailheads:
>Newfound Gap Parking Lot area (preferred for high visitation site)
>Clingmans Dome Parking Lot area
>Fontana Trailhead at edge of Park (preferred for low visitation site)
>Davenport Gap Trailhead at edge of Park

Transportation method to research site(s):
The sites where apply the survey will be accessed by car, using the park roads.

Collection of the following specimens or materials, quantities, and any limitations on collecting:

Name of repository for specimens or sample materials if applicable:

NPS General Conditions for Scientific Research and Collecting Permit (available at the RPRS HELP page) apply to this permit. The following specific conditions or restrictions, and any attached conditions, also apply to this permit:
READ AND ABIDE BY NPS GENERAL CONDITIONS #1-18, A-I (enclosed).

For any actions involving the Eastern Band of Cherokee Indians, you must be in compliance with EBCI research policy. This permit does not convey any waver of EBCI policy, rules, or law.

ALL RESEARCH MUST BE CONDUCTED WITH MINIMAL IMPACT TO THE PARK'S RESOURCES. In no case should the continued survival of a population of any native species be jeopardized by your activities.

Check for current park conditions on-line before traveling to the park to insure the roads and trails you wish to use are accessible: https://twitter.com/smokiesroadsnps and https://www.nps.gov/grsm/planyourvisit/conditions.htm

THE PRINCIPAL INVESTIGATOR AND ALL CO-INVESTIGATORS MUST CARRY A COPY OF THE SIGNED RESEARCH PERMIT WITH THEM AT ALL TIMES WHILE WORKING IN THE PARK AND PRESENT IT TO ANY PARK EMPLOYEE WHO ASKS TO SEE IT.

THIS PERMIT DOES NOT AUTHORIZE YOU TO PARK OUTSIDE OF DESIGNATED PARKING AREAS…PLEASE PLAN YOUR FIELD SCHEDULE TO ARRIVE AT POPULAR DESTINATIONS EARLY IN THE MORNING TO INSURE ACCESS TO A DESIGNATED PARKING PLACE. Please be respectful of park visitors, employees, and neighbors; a permit to conduct research within the park does not convey or imply permission to conduct research on private land surrounding the park.

PROVIDE THE RESEARCH COORDINATOR WITH THE DATES OF YOUR WORK IN THE PARK AS SOON AS YOU KNOW THEM (it is acceptable to provide a range of dates if you are working both inside and outside the park over a period of time).

This permit is made upon the express condition that the United States, its agents and employees shall be free from all liabilities and claims for damages and/or suits for or by reason of any injury, injuries, or death to any person or persons or property of any kind whatsoever, whether to the person or property of the Permittee, its agents or employees, or third parties, from any cause or causes whatsoever while in or upon said premises or any part thereof during the term of this permit or occasioned by any occupancy or use of said premises or any activity carried on by the Permittee in connection herewith, and the Permittee hereby covenants and agrees to indemnify, defend, save and hold harmless the United States, its agents, and employees from all liabilities, charges, expenses and costs on account of or by reason of any such injuries, deaths, liabilities, claims, suits or losses however occurring or damages growing out of the same. Permittee promises to cooperate with the NPS in the investigation and defense of any claims that may be filed with the NPS arising out of the activities of the cooperator, its agents, and employees.

YOU ARE REQUIRED TO SUBMIT AN ONLINE REPORT OF YOUR RESEARCH ACTIVITIES EACH YEAR, and you must mail two copies of your final research report to our office upon completion of your project. Even if you did no work in the park during a calendar year, you must go online and say so. The report can be submitted at the end of your year's work at any time with your research account password that you used to submit your permit. A reminder to submit your Investigator's Annual Report will be distributed electronically to permit holders at the end of the calendar year by Washington. We also request copies (paper and/or electronic) for our library of any publications, dissertations, etc. that use data collected in Great Smoky Mountains National Park.

Breach of any of the terms of this permit or for violation of park regulations will be grounds for revocation of this permit and denial of future permits.

Summary of permitted field methods and activities:
This study includes social, economic, and ecological approaches. For the first two surveys will be applied with hikers and local residents. When approached, each respondent will be presented to a statement of informed consent and explanation on the purpose of the study. In addition to specific questions, demographic information will be collected for further analyses in the future (see the questionnaires attached).

The first survey has the goal to assess the sense of place developed by hikers and its scale according to the hike extension and the hiker's profile; the trail influence on their environmental awareness and engagement, and the economic impact of hiking in local economies. In a confirmatory approach, the survey aims to answer research questions and test hypothesis formulated for LDTs based on the literature and empirical observation. This survey will be carried out with about 480 trail users (240 in each trail) using a systematic random sampling. The interviews will take place in three trail sections classified as 'popular' (which have a high frequency of users and give access to outstanding attractions) and three classifieds as 'isolated' or 'less popular' (which have low frequency, without outstanding attractions). The three pairs of trail sections will be distributed in the South, Central, and North parts, trying to cover the diversity of environments and contexts. Along the AT the preliminary proposal include AT trailheads close to Newfound Gap and Fontana Dam (in the Great Somke Mountains NP); McAfee Knob and Dragon's Tooth Trail (close to Jefferson NF), and Killington Peak and Gifford Woods (in the Green Mountains NF). The questionnaires will be developed in Qualtrics software and applied by the PI and trained volunteers using tablets to directly feed the spreadsheets with the results. One person of each three on the trail will be addressed, whenever possible in moments of rest. If a group has more than 3 people only one will be interviewed. It is expected that each application last approximately 15 minutes.

Another survey will be applied with people from local communities to assess the level of environmental concern and whether it varies among people and communities with different levels of involvement with the trail, and whether tourism around the trail influences landowners' decision to maintain their areas preserved or not. This survey will be applied using a cluster sampling design with local residents in 6 towns along each trail, being three considered tourist places, and three not so related to tourism activities. Along the Appalachian Trail the comparison will include three towns of the AT Community Program and three towns that are close to that AT Communities. The survey includes questions about sources of income and the revised New Environmental Paradigm Scale (Dunlap et al., 2000), besides demographic information (see the attached questionnaire). In each community, at least of 30 people involved and 30 non-involved in tourism activities will be interviewed, summing 360 questionnaires in each trail and 720 in total.

The ecological approach will be based on GIS historical analysis based on aerial and satellite images. Thirty pairs of points in each trail with similar environmental conditions (one along the trail and one at least 10 km away) will have the land use classified at the moment of the trail implementation and presently using paired T-tests to compare landscape ecology trying to assess the trail's influence on the amount of conserved habitat and structural connectivity.

Recommended by park staff(name and title):

Reviewed by Collections Manager:

Yes ____ No ____ NA

Approved by park official:

Date Approved:

20 May, 2021

Title:

Biologist / Research Coordinator

I Agree To All Conditions And Restrictions Of this Permit As Specified
(Not valid unless signed and dated by the principal investigator)

(Principal investigator's signature)

May 20, 2021
(Date)

THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)

GENERAL CONDITIONS
For
SCIENTIFIC RESEARCH AND COLLECTING PERMIT

United States Department of the Interior
National Park Service

1. **Authority** - The permittee is granted privileges covered under this permit subject to the supervision of the superintendent or a designee, and shall comply with all applicable laws and regulations of the National Park System area and other federal and state laws. A National Park Service (NPS) representative may accompany the permittee in the field to ensure compliance with regulations.

2. **Responsibility** - The permittee is responsible for ensuring that all persons working on the project adhere to permit conditions and applicable NPS regulations.

3. **False information** - The permittee is prohibited from giving false information that is used to issue this permit. To do so will be considered a breach of conditions and be grounds for revocation of this permit and other applicable penalties.

4. **Assignment** - This permit may not be transferred or assigned. Additional investigators and field assistants are to be coordinated by the person(s) named in the permit and should carry a copy of the permit while they are working in the park. The principal investigator shall notify the park's Research and Collecting Permit Office when there are desired changes in the approved study protocols or methods, changes in the affiliation or status of the principal investigator, or modification of the name of any project member.

5. **Revocation** - This permit may be terminated for breach of any condition. The permittee may consult with the appropriate NPS Regional Science Advisor to clarify issues resulting in a revoked permit and the potential for reinstatement by the park superintendent or a designee.

6. **Collection of specimens (including materials)** - No specimens (including materials) may be collected unless authorized on the Scientific Research and Collecting permit.

The general conditions for specimen collections are:

- Collection of archeological materials without a valid Federal Archeology Permit is prohibited.

- Collection of federally listed threatened or endangered species without a valid U.S. Fish and Wildlife Service endangered species permit is prohibited.

- Collection methods shall not attract undue attention or cause unapproved damage, depletion, or disturbance to the environment and other park resources, such as historic sites.

- New specimens must be reported to the NPS annually or more frequently if required by the park issuing the permit.Minimum information for annual reporting includes specimen classification, number of specimens collected, location collected, specimen status(e.g., herbarium sheet, preserved in alcohol / formalin, tanned and mounted, dried and boxed, etc.), and current location.

- Collected specimens that are not consumed in analysis or discarded after scientific analysis remain federal property.The NPS reserves the right to designate the repositories of all specimens removed from the park and to approve or restrict reassignment of specimens from one repository to another. Because specimens are Federal property, they shall not be destroyed or discarded without prior NPS authorization.
- Each specimen (or groups of specimens labeled as a group) that is retained permanently must bear NPS labels and must be accessioned and cataloged in the NPS National Catalog.Unless exempted by additional park - specific stipulations, the permittee will complete the labels and catalog records and will provide accession information.It is the permittee's responsibility to contact the park for cataloging instructions and specimen labels as well as instructions on repository designation for the specimens.

- Collected specimens may be used for scientific or educational purposes only, and shall be dedicated to public benefit and be accessible to the public in accordance with NPS policies and procedures.

- Any specimens collected under this permit, any components of any specimens (including but not limited to natural organisms, enzymes or other bioactive molecules, genetic materials, or seeds), and research results derived from collected specimens are to be used for

scientific or educational purposes only, and may not be used for commercial or other revenue - generating purposes unless the permittee has entered into a Cooperative Research And Development Agreement(CRADA) or other approved benefit - sharing agreement with the NPS.The sale of collected research specimens or other unauthorized transfers to third parties is prohibited.Furthermore, if the permittee sells or otherwise transfers collected specimens, any components thereof, or any products or research results developed from such specimens or their components without a CRADA or other approved benefit-sharing agreement with NPS, permittee will pay the NPS a royalty rate of twenty percent(20 %) of gross revenue from such sales or other revenues. In addition to such royalty, the NPS may seek other damages to which the NPS may be entitled including but not limited to injunctive relief against the permittee.

7. **Reports** - - The permittee is required to submit an Investigator's Annual Report and copies of final reports, publications, and other materials resulting from the study. Instructions for how and when to submit an annual report will be provided by NPS staff.Park research coordinators will analyze study proposals to determine whether copies of field notes, databases, maps, photos, and / or other materials may also be requested.The permittee is responsible for the content of reports and data provided to the National Park Service

8. **Confidentiality** - - The permittee agrees to keep the specific location of sensitive park resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

9. **Methods of travel** - Travel within the park is restricted to only those methods that are available to the general public unless otherwise specified in additional stipulations associated with this permit.

10. **Other permits** - The permittee must obtain all other required permit(s) to conduct the specified project.

11. **Insurance** - If liability insurance is required by the NPS for this project, then documentation must be provided that it has been obtained and is current in all respects before this permit is considered valid.

12. **Mechanized equipment** - No use of mechanized equipment in designated, proposed, or potential wilderness areas is allowed unless authorized by the superintendent or a designee in additional specific conditions associated with this permit.

13. **NPS participation** - The permittee should not anticipate assistance from the NPS unless specific arrangements are made and documented in either an additional stipulation attached to this permit or in other separate written agreements.

14. **Permanent markers and field equipment** - The permittee is required to remove all markers or equipment from the field after the completion of the study or prior to the expiration date of this permit. The superintendent or a designee may modify this requirement through additional park specific conditions that may be attached to this permit. Additional conditions regarding the positioning and identification of markers and field equipment may be issued by staff at individual parks.

15. **Access to park and restricted areas** - Approval for any activity is contingent on the park being open and staffed for required operations. No entry into restricted areas is allowed unless authorized in additional park specific stipulations attached to this permit.

16. **Notification** - The permittee is required to contact the park's Research and Collecting Permit Office (or other offices if indicated in the stipulations associated with this permit) prior to initiating any fieldwork authorized by this permit.Ideally this contact should occur at least one week prior to the initial visit to the park.

17. **Expiration date** - Permits expire on the date listed. Nothing in this permit shall be construed as granting any exclusive research privileges or automatic right to continue, extend, or renew this or any other line of research under new permit(s).

18. **Other stipulations** - This permit includes by reference all stipulations listed in the application materials or in additional attachments to this permit provided by the superintendent or a designee. Breach of any of the terms of this permit will be grounds for revocation of this permit and denial of future permits.

Crater Lake National Park

SCIENTIFIC RESEARCH AND COLLECTING PERMIT	
Grants permission in accordance with the attached general and special conditions **United States Department of the Interior** **National Park Service** **Crater Lake**	**Study#: CRLA-00170** **Permit#: CRLA-2022-SCI-0019** **Start Date: Jun 19, 2022** **Expiration Date: Jul 31, 2022** **Coop Agreement#:** **Optional Park Code:**

Name of principal investigator:

Name: Mr Ernesto Bastos Viveiros de Castro **Phone:** (352) 846-0850 **Email:** ernesto.castro@ufl.edu

Name of institution represented:

University of Florida

Additional investigators or key field assistants:

Name: Taylor Stein **Phone:** (352) 846.0860 **Email:** tstein@ufl.edu

Study Title:

A pathway to nature conservation: the role of long-distance trails in connecting hikers, communities, and landscapes

Purpose of study:

Since its origins, nature conservation efforts have been strongly related to experiences in natural environments. Seminal environmentalists like Henry Thoreau and John Muir and pioneering movements, such as the Sierra Club, have their roots in nature-based activities. Trails are the most basic element to provide opportunities of contact with natural environments and since the proposition of the Appalachian Trail by the forester Benton Mackaye in 1921, many long-distance trails (LDT), which cross extensive territories, connecting different landscapes and protected areas, have been implemented worldwide as a large-scale nature conservation strategy.

The motivation for implementing LDTs is based on a tripod that includes: promoting connection to nature and engagement of hikers in conservation behavior; generate income for local communities, and protect biodiversity corridors and connectivity among natural areas. Although LDTs have been proposed as conservation tools on a regional scale since its conception and were officially recognized as a conservation tool in the USA in 1968 by the National Trail System Act, few studies have actually evaluated their direct or indirect contribution to nature conservation and much of the accumulated knowledge is empirical and non-systematized. The proposed research aims to integrate ecological, economic and social approaches to fill this gap and understand at what level LDTs are a valid strategy for promoting nature conservation in different socioeconomic contexts.

Some of the main questions that we intend to answer with the proposed study are: How are the experiences on LDT related to sense of place and its spatial scale? How are sense of place, connection to nature, and pro-environmental behavior related? What is the impact of trail-related outdoor activities (triple crown) on the US economy? Is the tourism income enough to influence the land-use decision-making by landholders and prevent deforestation? Does the interaction with the trails influence the environmental concern of local residents? Do these trails contribute to connectivity on extensive landscapes or at a local scale?

To address these research questions, a multiple case studies design will be used, and the three long-distance trails which form the American Triple Crown were chosen to compare the LDT effects in different contexts. Understanding and quantifying the role of LDTs as conservation tools is key to conciliate conservation of natural resources and tourism activities, guiding conservation planning of multi-purpose landscapes.

Subject/Discipline:

Social Science

Locations authorized:

The only research activity inside the Crater Lake NP will be the hikers' survey. The hikers will be approached at two PCT sections, being one in a popular trail section and the other in a more isolated trail section. The preliminary proposal is to include the Watchman trailhead or the Discovery Point as the popular place and other section moderately used. These points were proposed following suggestions of Heidi Barker, the park Backcountry Manager and Office Supervisor. Any suggestion of moderately used sections would be appreciated.

Transportation method to research site(s):

The sites where apply the survey will be accessed by car and foot, using the official park roads and trails.

Collection of the following specimens or materials, quantities, and any limitations on collecting:

Name of repository for specimens or sample materials if applicable:

NPS General Conditions for Scientific Research and Collecting Permit (available at the RPRS HELP page) apply to this permit.

The following specific conditions or restrictions, and any attached conditions, also apply to this permit:

CRATER LAKE NATIONAL PARK
Park-Specific Conditions
Ensure everything (e.g., equipment, vehicles, tools, supplies, etc.) and everyone (e.g., boots, laces, packs, etc.) are clean and free of off-site soil and/or organic debris.

Data and Publications
A minimum of one copy of all publications and/or reports shall be sent to the park curator for retention in the accession file for each permit. Additionally, for electronic data or information available on the internet, please send the URL where these data can be accessed.

Conditions for Collection of Specimens
Permittee shall review and adhere to the NPS General Conditions for Scientific Research and Collecting Permit, Section 6, Collection of Specimens, which can be found at http://science.nature.nps.gov/research/ac/html/AppFAQ#03.
Contact Information for Collections:
Mary Merryman, Park Curator
Telephone: 541-594-1132
Email: mary_merryman@nps.gov

Summary of permitted field methods and activities:

Recommended by park staff(name and title):

Reviewed by Collections Manager:

Yes____ No____

Approved by park official:

Digitally signed by CRAIG ACKERMAN
Date: 2022.06.21 15:59:47 -07'00'

Date Approved:

Title:

Superintendent

I Agree To All Conditions And Restrictions Of this Permit As Specified
(Not valid unless signed and dated by the principal investigator)

(Principal investigator's signature)

June, 16th, 2022
(Date)

THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)

GENERAL CONDITIONS
For
SCIENTIFIC RESEARCH AND COLLECTING PERMIT

United States Department of the Interior
National Park Service

1. **Authority** - The permittee is granted privileges covered under this permit subject to the supervision of the superintendent or a designee, and shall comply with all applicable laws and regulations of the National Park System area and other federal and state laws. A National Park Service (NPS) representative may accompany the permittee in the field to ensure compliance with regulations.

2. **Responsibility** - The permittee is responsible for ensuring that all persons working on the project adhere to permit conditions and applicable NPS regulations.

3. **False information** - The permittee is prohibited from giving false information that is used to issue this permit. To do so will be considered a breach of conditions and be grounds for revocation of this permit and other applicable penalties.

4. **Assignment** - This permit may not be transferred or assigned. Additional investigators and field assistants are to be coordinated by the person(s) named in the permit and should carry a copy of the permit while they are working in the park. The principal investigator shall notify the park's Research and Collecting Permit Office when there are desired changes in the approved study protocols or methods, changes in the affiliation or status of the principal investigator, or modification of the name of any project member.

5. **Revocation** - This permit may be terminated for breach of any condition. The permittee may consult with the appropriate NPS Regional Science Advisor to clarify issues resulting in a revoked permit and the potential for reinstatement by the park superintendent or a designee.

6. **Collection of specimens (including materials)** - No specimens (including materials) may be collected unless authorized on the Scientific Research and Collecting permit.

The general conditions for specimen collections are:

- Collection of archeological materials without a valid Federal Archeology Permit is prohibited.
- Collection of federally listed threatened or endangered species without a valid U.S. Fish and Wildlife Service endangered species permit is prohibited.
- Collection methods shall not attract undue attention or cause unapproved damage, depletion, or disturbance to the environment and other park resources, such as historic sites.
- New specimens must be reported to the NPS annually or more frequently if required by the park issuing the permit. Minimum information for annual reporting includes specimen classification, number of specimens collected, location collected, specimen status (e.g., herbarium sheet, preserved in alcohol / formalin, tanned and mounted, dried and boxed, etc.), and current location.
- Collected specimens that are not consumed in analysis or discarded after scientific analysis remain federal property. The NPS reserves the right to designate the repositories of all specimens removed from the park and to approve or restrict reassignment of specimens from one repository to another. Because specimens are Federal property, they shall not be destroyed or discarded without prior NPS authorization.
- Each specimen (or groups of specimens labeled as a group) that is retained permanently must bear NPS labels and must be accessioned and cataloged in the NPS National Catalog. Unless exempted by additional park-specific stipulations, the permittee will complete the labels and catalog records and will provide accession information. It is the permittee's responsibility to contact the park for cataloging instructions and specimen labels as well as instructions on repository designation for the specimens.
- Collected specimens may be used for scientific or educational purposes only, and shall be dedicated to public benefit and be accessible to the public in accordance with NPS policies and procedures.
- Any specimens collected under this permit, any components of any specimens (including but not limited to natural organisms, enzymes or other bioactive molecules, genetic materials, or seeds), and research results derived from collected specimens are to be used for

scientific or educational purposes only, and may not be used for commercial or other revenue - generating purposes unless the permittee has entered into a Cooperative Research And Development Agreement(CRADA) or other approved benefit - sharing agreement with the NPS.The sale of collected research specimens or other unauthorized transfers to third parties is prohibited.Furthermore, if the permittee sells or otherwise transfers collected specimens, any components thereof, or any products or research results developed from such specimens or their components without a CRADA or other approved benefit-sharing agreement with NPS, permittee will pay the NPS a royalty rate of twenty percent(20 %) of gross revenue from such sales or other revenues. In addition to such royalty, the NPS may seek other damages to which the NPS may be entitled including but not limited to injunctive relief against the permittee.

7. **Reports** - - The permittee is required to submit an Investigator's Annual Report and copies of final reports, publications, and other materials resulting from the study. Instructions for how and when to submit an annual report will be provided by NPS staff.Park research coordinators will analyze study proposals to determine whether copies of field notes, databases, maps, photos, and / or other materials may also be requested.The permittee is responsible for the content of reports and data provided to the National Park Service

8. **Confidentiality** - - The permittee agrees to keep the specific location of sensitive park resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

9. **Methods of travel** - Travel within the park is restricted to only those methods that are available to the general public unless otherwise specified in additional stipulations associated with this permit.

10. **Other permits** - The permittee must obtain all other required permit(s) to conduct the specified project.

11. **Insurance** - If liability insurance is required by the NPS for this project, then documentation must be provided that it has been obtained and is current in all respects before this permit is considered valid.

12. **Mechanized equipment** - No use of mechanized equipment in designated, proposed, or potential wilderness areas is allowed unless authorized by the superintendent or a designee in additional specific conditions associated with this permit.

13. **NPS participation** - The permittee should not anticipate assistance from the NPS unless specific arrangements are made and documented in either an additional stipulation attached to this permit or in other separate written agreements.

14. **Permanent markers and field equipment** - The permittee is required to remove all markers or equipment from the field after the completion of the study or prior to the expiration date of this permit. The superintendent or a designee may modify this requirement through additional park specific conditions that may be attached to this permit. Additional conditions regarding the positioning and identification of markers and field equipment may be issued by staff at individual parks.

15. **Access to park and restricted areas** - Approval for any activity is contingent on the park being open and staffed for required operations. No entry into restricted areas is allowed unless authorized in additional park specific stipulations attached to this permit.

16. **Notification** - The permittee is required to contact the park's Research and Collecting Permit Office (or other offices if indicated in the stipulations associated with this permit) prior to initiating any fieldwork authorized by this permit.Ideally this contact should occur at least one week prior to the initial visit to the park.

17. **Expiration date** - Permits expire on the date listed. Nothing in this permit shall be construed as granting any exclusive research privileges or automatic right to continue, extend, or renew this or any other line of research under new permit(s).

18. **Other stipulations** - This permit includes by reference all stipulations listed in the application materials or in additional attachments to this permit provided by the superintendent or a designee. Breach of any of the terms of this permit will be grounds for revocation of this permit and denial of future permits.

Glacier National Park

SCIENTIFIC RESEARCH AND COLLECTING PERMIT

Grants permission in accordance with the attached general and special conditions

United States Department of the Interior
National Park Service
Glacier

Study#: GLAC-00298
Permit#: GLAC-2022-SCI-0018
Start Date: Jul 15, 2022
Expiration Date: Dec 31, 2022
Coop Agreement#:
Optional Park Code:

Name of principal investigator:

Name: Mr Ernesto Bastos Viveiros de Castro **Phone:** (352) 846-0850 **Email:** ernesto.castro@ufl.edu

Name of institution represented:
University of Florida

Additional investigators or key field assistants:

Name: Taylor Stein **Phone:** (352) 846.0860 **Email:** tstein@ufl.edu

Study Title:
A pathway to nature conservation: the role of long-distance trails in connecting hikers, communities, and landscapes

Purpose of study:
Since its origins, nature conservation efforts have been strongly related to experiences in natural environments. Seminal environmentalists like Henry Thoreau and John Muir and pioneering movements, such as the Sierra Club, have their roots in nature-based activities. Trails are the most basic element to provide opportunities of contact with natural environments and since the proposition of the Appalachian Trail by the forester Benton Mackaye in 1921, many long-distance trails (LDT), which cross very large territories, connecting different landscapes and protected areas, have been implemented worldwide as a large-scale nature conservation strategy.
The motivation for implementing LDTs is based on a tripod that includes: promote connection to nature and engagement of hikers in conservation behavior; generate income for local communities; and protect biodiversity corridors and connectivity among natural areas. Although LDTs have been proposed as conservation tools on a regional scale since its conception and were officially recognized as a conservation tool in the USA in 1968 by the National Trail System Act, few studies have actually evaluated their direct or indirect contribution to nature conservation and much of the accumulated knowledge is empirical and non-systematized. The proposed research aims to integrate ecological, economic and social approaches to fill this gap and understand at what level LDTs are a valid strategy for promoting nature conservation in different socioeconomic contexts.
Some of the main questions that we intend to answer with the proposed study are: How are the experiences on LDT related to sense of place and its spatial scale? How are sense of place, connection to nature, and pro-environmental behavior related? What is the impact of trail-related outdoor activities (triple crown) on the US economy? Is the tourism income enough to influence the land-use decision-making by landholders and prevent deforestation? Does the interaction with the trails influence the environmental concern of local residents? Do these trails contribute to connectivity on extensive landscapes or at a local scale?
To address these research questions, a multiple case studies design will be used, and the three long-distance trails which form the American Triple Crown were chosen to compare the LDT effects in different contexts. Understanding and quantifying the role of LDTs as conservation tools is key to conciliate conservation of natural resources and tourism activities, guiding conservation planning of multi-purpose landscapes.

Subject/Discipline:
Social Science

Locations authorized:
The only research activity inside the Glacier NP will be the hikers' survey. The hikers will be approached at two CDT sections, being one in a popular trail section and the other in a more isolated trail section. The preliminary proposal is to include the St. Mary's Fall and other section moderately used. Any suggestion of moderately used sections or alternatives of popular attractions along the CDT would be appreciated and the can be changed following suggestions from the park staff.

May conduct surveys on trail near St. Mary Falls or nearby trail junction. Try to conduct surveys on hardened surfaces (e.g. rock or bare ground) to avoid trampling vegetation.
For moderate site, if Marias Pass area does not work out well, may conduct surveys between Appistoki Falls trailhead and the Proposed Wilderness boundary at about 1/2 a mile from the trailhead.

Transportation method to research site(s):
The sites where apply the survey will be accessed by car and foot, using the official park roads and trails.

Collection of the following specimens or materials, quantities, and any limitations on collecting:
Please contact the St. Mary or Two Medicine area rangers to let them know what days you will be conducting surveys in their district.

Name of repository for specimens or sample materials if applicable:

NPS General Conditions for Scientific Research and Collecting Permit (available at the RPRS HELP page) apply to this permit. The following specific conditions or restrictions, and any attached conditions, also apply to this permit:
In addition to attached general NPS and Glacier specific conditions:

Please coordinate with our Data Manager, Richard Menicke, (406-888-7918 or richard_menicke@nps.gov) to discuss data requirements.

Please contact a District or Area Ranger prior to commencing field work for information on current local conditions and possible closures and to inform them of your plans. Please see the attached Researcher Contact List for information on who to contact for each area you will be working in.

New field personnel must obtain a safety briefing before beginning work in the backcountry. Returning personnel must watch the backcountry safety video at least once every three years (or annually if backcountry camping). Contact a Backcountry Permit Office at glac_backcountry_permits@nps.gov to make an appointment or call: Apgar--406-888-7859; St. Mary--406-732-7751; or Many Glacier--406-732-7740.

Summary of permitted field methods and activities:
This study includes social, economic, and ecological approaches. For the first two surveys will be applied with hikers and local residents. When approached, each respondent will be presented to a statement of informed consent and explanation on the purpose of the study. In addition to specific questions, demographic information will be collected for further analyses in the future (see the questionnaires attached).
The first survey has the goal to assess the sense of place developed by hikers and its scale according to the hike extension and the hiker's profile; the trail influence on their connection to nature and pro-environmental behavior intentions, and the economic impact of hiking in local economies. In a confirmatory approach, the survey aims to answer research questions and test hypothesis formulated for LDTs based on the literature and empirical observation. This survey will be carried out with about 720 trail users (240 in each trail) using a stratified quota sampling. The interviews will take place in three trail sections classified as 'popular' (which have a high frequency of users and give access to outstanding attractions) and three classifieds as 'moderately used' (which have low frequency, without outstanding attractions). The three pairs of trail sections will be distributed in the South, Central, and North parts, trying to cover the diversity of environments and contexts. Along the CDT the preliminary proposal includes St. Mary's Fall (inside the Glacier NP, MT); Gray's Peak (inside Arapaho NF, CO), and Gila Hot Springs (inside Gila NF, NM) as popular sections. Moderately used section close to each popular will also be included in the research. The questionnaires will be developed in Qualtrics software and applied by the PI using tablets to directly feed the spreadsheets with the results. One person of each three on the trail will be addressed, whenever possible in moments of rest. If a group has more than 3 people only one will be interviewed. It is expected that each application last approximately 10 minutes.
Another survey will be applied with people from local communities to assess the level of environmental concern and whether it varies among people and communities with different levels of involvement with the trail, and whether tourism around the trail influences landowners' decision to maintain their areas preserved or not. This survey will be applied using a cluster sampling design with local residents in 6 towns along each trail, being three considered tourist places, and three not so related to tourism activities. Along the Continental Divide Trail the comparison will include three towns of the Gateway Communities Program and three towns that are close to that towns. The survey includes questions about sources of income and the revised New Environmental Paradigm Scale (Dunlap et al., 2000), besides demographic information (see the attached questionnaire). In each community, at least of 30 people will be interviewed, summing 180 questionnaires in each trail and 540 in total.
The ecological approach will be based on GIS historical analysis based on satellite images. Thirty pairs of points in each trail with similar environmental conditions (one along the trail and one at least 10 km away) will have the land use classified at the moment of the trail implementation and presently using paired T-tests to compare landscape ecology trying to assess the trail's influence on the amount of conserved habitat and structural connectivity.

Recommended by park staff(name and title): Director, CCRLC

TARA CAROLIN Digitally signed by TARA CAROLIN Date: 2022.07.14 16:54:27 -06'00'

Reviewed by Collections Manager:

Yes ____ No n/a

Approved by park official:

PETER WEBSTER Digitally signed by PETER WEBSTER Date: 2022.07.20 10:40:04 -06'00'

Date Approved:

Title:

Deputy Superintendent

I Agree To All Conditions And Restrictions Of this Permit As Specified
(Not valid unless signed and dated by the principal investigator)

Ernesto Bastos Viveiros de Castro Digitally signed by Ernesto Bastos Viveiros de Castro
Date: 2022.08.02 08:57:59 -07'00'

(Principal investigator's signature) (Date)

THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)

GENERAL CONDITIONS
For
SCIENTIFIC RESEARCH AND COLLECTING PERMIT

United States Department of the Interior
National Park Service

1. **Authority** - The permittee is granted privileges covered under this permit subject to the supervision of the superintendent or a designee, and shall comply with all applicable laws and regulations of the National Park System area and other federal and state laws. A National Park Service (NPS) representative may accompany the permittee in the field to ensure compliance with regulations.

2. **Responsibility** - The permittee is responsible for ensuring that all persons working on the project adhere to permit conditions and applicable NPS regulations.

3. **False information** - The permittee is prohibited from giving false information that is used to issue this permit. To do so will be considered a breach of conditions and be grounds for revocation of this permit and other applicable penalties.

4. **Assignment** - This permit may not be transferred or assigned. Additional investigators and field assistants are to be coordinated by the person(s) named in the permit and should carry a copy of the permit while they are working in the park. The principal investigator shall notify the park's Research and Collecting Permit Office when there are desired changes in the approved study protocols or methods, changes in the affiliation or status of the principal investigator, or modification of the name of any project member.

5. **Revocation** - This permit may be terminated for breach of any condition. The permittee may consult with the appropriate NPS Regional Science Advisor to clarify issues resulting in a revoked permit and the potential for reinstatement by the park superintendent or a designee.

6. **Collection of specimens (including materials)** - No specimens (including materials) may be collected unless authorized on the Scientific Research and Collecting permit.

The general conditions for specimen collections are:

- Collection of archeological materials without a valid Federal Archeology Permit is prohibited.
- Collection of federally listed threatened or endangered species without a valid U.S. Fish and Wildlife Service endangered species permit is prohibited.
- Collection methods shall not attract undue attention or cause unapproved damage, depletion, or disturbance to the environment and other park resources, such as historic sites.
- New specimens must be reported to the NPS annually or more frequently if required by the park issuing the permit. Minimum information for annual reporting includes specimen classification, number of specimens collected, location collected, specimen status (e.g., herbarium sheet, preserved in alcohol / formalin, tanned and mounted, dried and boxed, etc.), and current location.
- Collected specimens that are not consumed in analysis or discarded after scientific analysis remain federal property. The NPS reserves the right to designate the repositories of all specimens removed from the park and to approve or restrict reassignment of specimens from one repository to another. Because specimens are Federal property, they shall not be destroyed or discarded without prior NPS authorization.
- Each specimen (or groups of specimens labeled as a group) that is retained permanently must bear NPS labels and must be accessioned and cataloged in the NPS National Catalog. Unless exempted by additional park-specific stipulations, the permittee will complete the labels and catalog records and will provide accession information. It is the permittee's responsibility to contact the park for cataloging instructions and specimen labels as well as instructions on repository designation for the specimens.
- Collected specimens may be used for scientific or educational purposes only, and shall be dedicated to public benefit and be accessible to the public in accordance with NPS policies and procedures.
- Any specimens collected under this permit, any components of any specimens (including but not limited to natural organisms, enzymes or other bioactive molecules, genetic materials, or seeds), and research results derived from collected specimens are to be used for

scientific or educational purposes only, and may not be used for commercial or other revenue - generating purposes unless the permittee has entered into a Cooperative Research And Development Agreement(CRADA) or other approved benefit - sharing agreement with the NPS.The sale of collected research specimens or other unauthorized transfers to third parties is prohibited.Furthermore, if the permittee sells or otherwise transfers collected specimens, any components thereof, or any products or research results developed from such specimens or their components without a CRADA or other approved benefit-sharing agreement with NPS, permittee will pay the NPS a royalty rate of twenty percent(20 %) of gross revenue from such sales or other revenues. In addition to such royalty, the NPS may seek other damages to which the NPS may be entitled including but not limited to injunctive relief against the permittee.

7. **Reports** - - The permittee is required to submit an Investigator's Annual Report and copies of final reports, publications, and other materials resulting from the study. Instructions for how and when to submit an annual report will be provided by NPS staff.Park research coordinators will analyze study proposals to determine whether copies of field notes, databases, maps, photos, and / or other materials may also be requested.The permittee is responsible for the content of reports and data provided to the National Park Service

8. **Confidentiality** - - The permittee agrees to keep the specific location of sensitive park resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

9. **Methods of travel** - Travel within the park is restricted to only those methods that are available to the general public unless otherwise specified in additional stipulations associated with this permit.

10. **Other permits** - The permittee must obtain all other required permit(s) to conduct the specified project.

11. **Insurance** - If liability insurance is required by the NPS for this project, then documentation must be provided that it has been obtained and is current in all respects before this permit is considered valid.

12. **Mechanized equipment** - No use of mechanized equipment in designated, proposed, or potential wilderness areas is allowed unless authorized by the superintendent or a designee in additional specific conditions associated with this permit.

13. **NPS participation** - The permittee should not anticipate assistance from the NPS unless specific arrangements are made and documented in either an additional stipulation attached to this permit or in other separate written agreements.

14. **Permanent markers and field equipment** - The permittee is required to remove all markers or equipment from the field after the completion of the study or prior to the expiration date of this permit. The superintendent or a designee may modify this requirement through additional park specific conditions that may be attached to this permit. Additional conditions regarding the positioning and identification of markers and field equipment may be issued by staff at individual parks.

15. **Access to park and restricted areas** - Approval for any activity is contingent on the park being open and staffed for required operations. No entry into restricted areas is allowed unless authorized in additional park specific stipulations attached to this permit.

16. **Notification** - The permittee is required to contact the park's Research and Collecting Permit Office (or other offices if indicated in the stipulations associated with this permit) prior to initiating any fieldwork authorized by this permit.Ideally this contact should occur at least one week prior to the initial visit to the park.

17. **Expiration date** - Permits expire on the date listed. Nothing in this permit shall be construed as granting any exclusive research privileges or automatic right to continue, extend, or renew this or any other line of research under new permit(s).

18. **Other stipulations** - This permit includes by reference all stipulations listed in the application materials or in additional attachments to this permit provided by the superintendent or a designee. Breach of any of the terms of this permit will be grounds for revocation of this permit and denial of future permits.

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BIOGRAPHICAL SKETCH

Ernesto Bastos Viveiros de Castro received his Doctor of Philosophy degree in interdisciplinary ecology, with a concentration in tropical conservation and development, in the summer of 2023 from the University of Florida in the School of Natural Resources and Environments. His research interests lie in environmental management and conservation subjects, including protected areas, tourism and recreation, landscape management, and wildlife conservation. Before arriving at UF, he graduated with honors in biology with a bachelor's degree in Ecology at Rio de Janeiro Federal University (UFRJ, Brazil) in 1999. He got a Master of Science degree in ecology from the same university, with a concentration in biological conservation, in 2002, studying differential extinction vulnerabilities of mammals in a fragmented landscape in the Brazilian Atlantic Forest.

He has been working in the Brazilian federal agency for protected areas (ICMBio) for the last 20 years, as Superintendent of Serra dos Órgãos National Park (2004-2011), National Coordinator of Ecotourism (2011-2012) and Superintendent of Tijuca National Park (2012-2018). Ernesto is also a member of the World Commission on Protected Areas (WCPA-IUCN), the IUCN Tourism Specialists Group (TAPAS-IUCN), and the World Trails Network. In addition to his academic life and work in the agency, he is a nature photographer and the proposer of the Atlantic Forest Trail, a mega trail that is being implemented as a climate corridor strategy in Brazil.