Creating a Navigational and Interpretive Sign Design Manual for the Sendero Pacífico Trail System in Costa Rica

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Abstract

The Sendero Pacífico trail network runs from the Cloud Forest in Monteverde to the Gulf of Nicoya in Costa Rica. We worked with the World Trails Network to establish a hierarchy of signs to standardize waymarking and directions along this 60-kilometer trail network. We interviewed people from the communities along the trail as well as World Trails Network ambassadors to learn more about trail sustainability, signage contents, and community involvement. Additionally, we utilized geographic information system software to mark points along the trail where a sign is needed. We created example signs as well as a manual to aid in the construction and placement of signs along the trail.

Executive Summary

The World Trails Network is an international organization responsible for the creation, maintenance and education of trail development and sustainability across the world. The current problem they are facing is the lack of a standardized and sustainable signage system for the Sendero Pacífico Trail Network. The Sendero Pacífico, also known as the Pacific Slope Trail, is a 60 km trail network that runs from the Cloud Forest in Monteverde to the Gulf of Nicoya. To tackle this problem, we created a comprehensive manual that outlines a system of signage creation. This includes a defined hierarchy of signage, the information the signs should contain, how to locally source materials, and where to place them along the trail. Information for the development and implementation of signs were found through a series of exploratory interviews and on the ground and remote mapping systems. These signs are meant to highlight not only the environment but also the local businesses along the trail network which helps in strengthening the community representation and involvement with the physical trail itself.

Background

Costa Rica relies on tourism and has put time and money into creating various opportunities for ecotourism in its parks, reserves, and protected land. There is a lot of community involvement on ecotourism projects to ensure sustainability, and members of the communities typically feel that ecotourism does more good than harm. Trails specifically need to be conserved and managed by both community members and outside signage experts. Effective navigational and interpretive signage systems are standardized and consider the resources and customs in the area around where the trail is located. The objective of navigational signage is to ensure hikers can safely get from the trailhead to their destination. The objective of interpretive signage is to highlight local information that will enhance the hiker's experience on the trail. Another key aspect of signage systems is safety. It is important to include safety concerns on signs and design signs so that they are effectively relaying the safety concerns. To understand how a hiker will interpret these signs, there needs to be knowledge of their behaviors. After researching this, it was clear to see that hikers are distinguished by a couple characteristics. One difference is day vs overnight hikers and another is local vs visiting hikers. These groups show similar tendencies to what they look for on the trail and how they treat the trail. However one main point that stuck out was that visiting hikers look for a standard way of signage since they aren't as familiar with the trail.

Goal and Project Objectives

The goal of our project was to effectively mark the Sendero Pacífico trail network in order to highlight local businesses and trail etiquette in a durable and sustainable manner. We carried out the following objectives to complete our goal.

1. Collected qualitative data about signage, sustainability, and materials along the Sendero Pacífico through exploratory interviews.
2. Collected qualitative data about the communities and businesses along the Sendero Pacífico through exploratory interviews.
3. Evaluated current status of signage and indicated positions of signs through Geographic Information Systems (GIS).

Methods

We addressed these objectives through a series of exploratory interviews and through GIS mapping both on the ground and online. We then analyzed this information through the use of thematic coding.

We conducted a series of exploratory interviews to gather more information on the content for the signage in addition to the physical signage itself. These were semi-structured interviews with three main groups of respondents: Monteverde Community Ambassadors, World Trails Network - Trails and Sustainability Task Team, and Monteverde Community and Business Leaders. These are people defined as the most knowledgeable about the Sendero Pacífico, signage standards, and the community needs along the trail. We used the information from these interviews to understand how to best service the communities along the trail through our signage, specifically content and materials.

We decided to use a map to plot our recommended sign locations. In order to create our map, we first had to map the routes for each hike. We used the hiking software Wikiloc in conjunction with ArcGIS online in order to plot the trails, then, to add the sign locations to the landscape. This map will be added to in the future and serve as a recommendation for future sign locations.

Findings

Based on the data we collected during the interviews, we found that the most common themes were trail conservation and sustainability, signage contents, and community involvement and interaction. We concluded that locally sourced and sustainable materials are the most effective as it does not harm the environment and take away from the experience of the trail. In addition, having signs to treat the trail with respect and how to take care of it can increase the longevity of the trail.We found that signs need to have color and illustrations and are most impactful when they are hand painted. It is also important to have a local logo on signs to create a sense of identity throughout the communities where the trail is located. The materials used for signs should be wood or recycled material from the surrounding communities. We identified that the most productive way to create a signage system is through community involvement and interaction. Signage systems can have a positive impact on these communities by advertising local businesses and increasing the amount of travelers exposed to the communities.

After collecting data about hazards and and other notable issues during our hikes using a GIS application on our phones (Wikiloc), we imported those data into ArcGIS online so that it could be better analyzed and compiled with other sections of the trail. The three main issues that we found while hiking were gates, intersections, and natural hazards. These issues continued to appear on each section of trail that we were on, so we paid close attention to them when doing our analysis. We then uploaded the points to our map in ArcGIS online. From this, we were able to note the recommended sign type, and directions and distances to nearby districts. This information, once put on signs, will provide crucial information to hikers that may not be familiar with the Sendero Pacífico.

Recommendations

From all of our findings and research, we found it best to present our recommendations through a manual for the World Trails Network, that will be translated in both English and Spanish. This is a comprehensive manual on signage creation based on what we gathered from interviews, literature review, and personal observations while hiking the trails. The first half of

the manual focuses on the construction of signs, including the four main types of signs, what information is presented on each, and what materials are to be used to construct them.

Implementation is the final and most important step of our process, because if we cannot successfully implement our signs then they will serve no purpose. It is important that all of our recommendations are communicated clearly and in Spanish through the manual, so that the local people are able to create an effective signage system. Once the signs are in place, we recommend a trail maintenance program involving the community members to improve the safety of the trail. Moving forward, it would also be beneficial to promote the Sendero Pacífico on different platforms where both local hikers and foreign travelers can learn about it.

Conclusion

Throughout all of the stages our project went through, from research all the way to making recommendations to local communities with the help of a bilingual manual, our project ultimately accomplished our three main objectives. By using all of this information this manual will help to improve the use, longevity, and conservation of the Sendero Pacífico. Overall, we hope that the example signs and manual that we produced will bring this trail to the next level so that more and more visitors can experience it.

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1.0 Chapter 1: Project Introduction and Background

The main problem that the World Trails Network is facing is that there are not enough signs on the Costa Rican Sendero Pacífico Trail network that mark the trails and allow hikers to safely navigate the trail system. The World Trails Network is a non-profit association that works to develop the quality and sustainability of trails around the world. In Costa Rica, the World Trails Network is trying to ensure that the Sendero Pacífico trail system is designed and managed well while using sustainable building and maintenance practices. The Sendero Pacífico, or the Pacific Slope Trail, is a trail network that stretches from the Cloud Forest in Monteverde to the Gulf of Nicoya. Our main goal is to develop a manual that outlines a standard procedure on how to construct and install signs. These signs must effectively relay the current location of the hiker, where they can go, and the distance to each destination. We aim to use durable and sustainable sign materials in order to create weatherproof signs that are also easily accessible in each area. Another element of the manual will be a procedure for planning and using an effective sign placement map. Overall, the purpose of these signs is to properly guide hikers through each section of the trail by taking into account appropriate design, location, and material.

1.1 Tourism in Costa Rica

It is imperative to add navigational signage to the Sendero Pacífico trail system with the current influx of tourists to ensure hikers are safely getting to their destination. Costa Rica is known for its beautiful rural areas and parks filled with a multitude of activities that people from all around the world come to enjoy. The country relies heavily on tourism for its economic stability and has felt the impact of the COVID-19 pandemic. The Costa Rican tourism industry had been expanding and approximately 3 million people were visiting each year until 2020, when the pandemic hit, and the country lost 2 million tourists worth of economic support (Costa Rican Tourism Institute). In 2021, there was an increase in tourism, but the experience of Covid left the country with high rates of poverty and unemployment. Tourism makes up approximately 8 percent of Costa Rica's GDP and 13 percent of its total employment. and is essential to the country's growth and development (Costa Rican Tourism Institute).

1.1.1 Eco-Tourism

Costa Rica relies on tourism and has put time and money into creating various opportunities for ecotourism in its parks, reserves, and protected land. There are several strengths and weaknesses of Costa Rican ecotourism that are important to list to understand the impact that it can have on the people and environment. A strength of ecotourism in Costa Rica is that the money made is often used toward community projects and the economic growth was working hand in hand with the conservation efforts. Another strength is that there is a lot of community involvement in ecotourism to ensure sustainability, and members of the communities typically feel that ecotourism does more good than harm (Bricker 2013). The biggest weakness that ecotourism has is the disconnect between the various aspects of ecotourism such as food, transportation, and hotels. For example, a hotel will follow sustainable practices while a restaurant will not because there are not general principles of ecotourism. Overall, the greatest strength of Costa Rica's ecotourism is conservation and there are fewer significant weaknesses elsewhere. It is also important to remember that the management of ecotourism in specific communities is key. Management needs to have a strong vision and scope of the project so that the outcome of the ecotourism efforts is positive (Mckeone, 2011).

Ecotourism emerged in the 1980s as a subcategory of tourism that aims to increase the number and availability of options to visit a country in natural areas. These natural areas

conserve the environment and provide activities such as hiking, biking, or kayaking rather than going to a resort. Ecotourism focuses on minimizing the negative effect tourists will have on the landscape and local towns. Local economies, cultures, environments, and socio-economic progress can all be affected by tourism, and ecotourism is an effort to avoid those negative impacts while still receiving the economic benefits that tourism brings (İlhan, 2017).

Ecotourism is a growing tool for Latin American countries that are facing economic issues that can be resolved by expanding their tourism industries. Communities work to attract tourists by changing their social and environmental practices to become more sustainable, which increases the economic profit in their area. However, this behavior can affect the overall development of a country because it can cause large economic and social inequality between communities. Also, changing practices to attract tourists can be harmful to natives' identities and cause stereotypes to be formed and encouraged about the people living in the communities (Dürr, 2016).

1.1.2 Sustainable Trails

Costa Rican ecotourism centers largely on trails, and with an influx of people going on the trails, it is important to consider what will make the trails sustainable. Trails need to be managed so that they remain ecologically resilient and economically possible as more hikers use them. For example, reminders to stay on the trail, keep water off trails, follow the natural path and contours, and watch the slope of the trail are all ways the trail can be ecologically resilient (Widawski & Oleśniewicz, 2019). Trails also need to have building and maintenance protocols that are financially possible for local communities to take charge of. There must be partnerships between local people, the public, and the private industry for collective support. There also must be an awareness of the environment and education on what is a sustainable system. All factors are important to consider when creating signs and deciding a sustainable location with local community members and industries (McCartney, 2021).

1.2 Signage Overview

The California State Parks mentions "see the trail as your visitor would," in their article titled *Educating Trail Users.* This is a good piece of advice because it allows signage creators to step away from what they know and helps them see what they would like others to know. Looking at things from a different perspective is a good way to translate information to others since it gets them out of their own heads and helps drive the design in the true direction they want it to be. The main types of signage that will be used for the Sendero Pacífico are navigational, interpretive, and directional. Each has a key piece in the signage hierarchy that allows for effective trail marking.

1.3 Navigational Signage

Navigational signage is used on trail systems around the world to keep hikers safe by guiding them to their destination. Effective signage systems are standardized and consider the resources and customs in the area around where the trail is located. The objectives of signage are to educate trail users about the trail, reassure hikers they are on the correct trail, increase visitor understanding of and interest in the area, and create a sense of the environment by branding the trail. These objectives can be met by following a set of basic trail marking principles. Once the process and general criteria to meet the objectives are written, the signs can be constructed and installed on the trail by hikers who are familiar with the trail.

1.3.1 Principles of Signage

Hikers depend on signage for their own safety, so it is a serious responsibility that protects them from getting into dangerous situations. It is important to remember that signage systems can be very complex and creating them takes long-term management. To achieve the signage objectives there are many principles of marking trails that are important to take into account when creating a signage system for a new area. The first main principle is that all marks should be visible to hikers walking in the direction that the route is and can be seen from a distance that will prevent a hiker from passing without seeing it. The route should be marked from both sides and the markers should be at an angle where the hiker will be able to see it. Secondly, when marking junctions, all paths must be marked so that the hiker can make no mistake in which way to go. There must be an additional guidance marker within 10 meters after the junction and a confirmation marker later on the trail so that the path switch is abundantly clear to the hiker. Finally, long trails without junctions should contain reassurance markers at a maximum of every 250 meters and are dependent on if the area of the trail goes through towns, has a significant change in terrain, and the distance in hours is significantly different from the change in kilometers. After these three principles, there are many more to follow, but these three make the most difference when considering hiker safety (Harnochova, 2017).

1.3.2 Waymarking

Waymarking is a method of marking trails that considers the hierarchy of signs along the trail and is used in several countries. Waymarking follows the general principles of marking trails but is meant to be adaptable depending on the area where the trail is. To create a standard procedure for marking trails it is best to use the general waymarking principles and add certain steps depending on what the surrounding communities are doing. A hierarchy of signs in the signage procedure defines which kind of signs go at which location. The hierarchy consists of kiosks, signposts, and blazes that need to be assigned to trailheads, junctions, mid-trail points, and the trail ends. There are many complexities in waymarking that need to be considered when making decisions when creating a signage system procedure in a new area (Harnochova, 2017).

1.4 Interpretive Signage

Interpretive signage acts as the main form of information exchange on trails or natural tourism sites as a way to educate and entice visitors during their experience. These signs effectively combine words and pictures to relay messages determined by whoever runs the site. Messages include information about proper behavior at the site, education facts about the site whether that be history or the environment/community, and an overall mode of communication for key factors. Signs can also be used to sway behavior in a way that doesn't disrupt the environment, especially in a site with a lot of wildlife. In addition, interpretive signs that use pictures and languages (single or multiple) end up being the most effective way to relay information to visitors, regardless of the site (Zhu et al., 2021).

1.4.1 Creation of Interpretive Signage

When planning interpretive signs, organizers must consider how they want their information to be relayed and interpreted. An effective sign is one that "offers stories that are designed to stimulate trail visitors' interest while challenging their imaginations and perhaps present new perspectives on familiar topics," according to the California State Parks system in their opening paragraph of their report titled *Educating Trail Users*. Engaging visitors allows for a more pleasant user experience, which translates to more knowledge transfer as well. California State Parks collected a list of top tips for the creation of interpretive signs and this has been used

as a “how-to” guide for making effective signs. Main tips include avoiding sensory overload, which means keep things straightforward but easy to understand in a way that doesn’t bombard people with information. In addition to text, graphics and illustrations can be used in place of words to avoid any confusion and take away the language barrier.

1.4.2 Text and Pictures in Interpretive Signage

There are two types of signs that are typically displayed, ontological and teleological. In a study done in Iceland on the effectiveness of signs on visitor behavior when seal watching, different signs were used, with the two different signs being teleological and ontological. Ontological signs are signs that provide instructions without explanation, such as how visitors should act but not explaining why they should act this way (Marschall et al., 2016). Teleological signs are signs that provide explanations along with instructions, explaining the “why” portion of the information. This study found that the signs with teleological text resulted in a more positive impact when analyzing visitor behavior than the ontological signs. This highlights the importance of having explicit text and reasoning behind the words put on the signs. When people understand what is being asked of them, they are more likely to do it rather than just given a command without instructions. Making signs more personable with explanations allows for the visitors to establish deeper meaning during their visit and makes it more likely they will come back.

Pictures are another important part in making an interpretive sign impactful. Pictures, graphics, and illustrations can bridge the language barrier that comes when natural tourism sites are very popular with speakers of different languages. A study done at Xixi National Wetland Park in China shows that high resolution image quality not only impacted the amount of information retained but showed that a clear graphic can overcome the language barrier. Their signs had a balance between clear and informative photos that enticed the visitor to read it and then had straightforward language as well (Zhu et al., 2021). Combining high resolution photos along with simplified graphics had a high impact on the visitors as they were able to learn a lot of information on their trip and improved their user experiences.

1.4.3 Impacts of Interpretive Signage

Interpretive signs often use a balance between pictures and text, finding the middle ground between them that best fits the location is the key to making a successful sign. Being able to balance information and enticement in signs allows for an overall pleasant user experience and encourages hikers to come back again and again, boosting the overall natural tourism of the region (Zhu et al., 2021). A site manager can decide what is the most effective information for the trail, whether that be safety, educational, or entertainment facts.

1.5 Safety Signs

Safety signs play a crucial role in ensuring the safety of their target audience. These signs have a wide variety of applications from roadways, construction sites, and any other high traffic area where safety concerns are present. In Costa Rica, trail safety is a topic of concern for hikers and the World Trails Network. Because the term “Safety Signs” is such a general term, three separate aspects of safety signs were explored: research, design, and human interpretation.

Safety sign research has blossomed exponentially over the past three decades, especially internationally. In order to conduct strong research on the topic of safety signs, it must first be understood where to look for information pertaining to safety signs. A group of scientists in China compiled over 3000 articles in which they analyzed and read about safety sign research to obtain and present data on the growing amount of research done on safety signs. The data were

represented with knowledge maps, which show the countries that have been doing research in these areas. From the study, we see that "based on the general features analysis of safety signs published research, safety signs research was in the stage of rapid development" (Gao, J., et al., 2021). The study also showed that safety sign research has been strongly emerging in Europe, which allowed us to interview European hiking experts as well, in order to see what active sign conventions work there. Additionally, we conducted extensive research focused in Southern Central America, because of our target demographic. From this research, it is possible to gain a much wider perspective on this critical safety topic, which provides valuable insight as to what the most effective safety signs are.

1.5.1 Safety Sign Design

When designing safety signs, it is important to consider which designs will be the most effective at relaying their intended message. Some aspects to consider are color scheme, font, layout, and complexity. In the work of Chen, Zhao, Gao, and Zhao (2020), the authors explore how different color schemes alter the effectiveness of safety signs. They mention how "safety signs are green in China while safety signs may be red or green in the USA" (Chen, et al., 2020). This observation demonstrates that there is no international standard when it comes to safety sign colors. Their study concluded that although a green and black sign was most effective, there was not a huge difference between this and other color combinations. From this, all the design factors (color scheme, font, layout, and complexity), color scheme seems to have no definitive influence on the effectiveness of safety signs.

1.5.2 Sign Efficacy

The most important aspect of safety signs is their ability to convey the intended message to the readers. In order to do this effectively, people must be able to quickly and accurately draw the information contained in the sign. Kim, Nam, Hwang, Choi & Shin (2013) look specifically at how construction workers understand the signs they deal with on a day to day basis. Although trail safety is a concern, it can be inferred that roughly a third of our target audience will not have sufficient knowledge on our signs. Taking this into consideration, signs need to concisely expound the safety hazards which the signs are in place to highlight. Although one-third of the audience is expected to not have a sufficient understanding of signs, the study concluded that in general, construction workers believe that safety signs and the ability to understand them is critically important to safety. In general, it is understood that although almost everybody recognizes the importance of safety signs, there is a significant number of people who will not understand signs that don't explicitly warn against the danger they are intended to prevent. Overall, the ability of the reader to understand safety signs is the most critical part of creating an effective safety sign.

1.6 Hiker's Behavior

Another main factor that plays a big role in any product or sign that is made is the targeted audience that will be utilizing the product or sign. In the case concerning signage on a trail, the main audience is hikers. This large overarching category of "hikers" can be broken down into day and overnight hikers. These subcategories of the average hiker have been shown to generally represent most of all hikers that explore trails. One other division of the hiking population is the area that the hiker is from relative to the location of the trail. This distinction of whether the hiker is local, or a visitor can prove to play a role in how they act and treat the trail. There is evidence in articles written by Taff, et al. (2014) and Byle and Halpenny (2012) that shows some different behaviors between these 4 different categories; overnight or day hiker and

local or tourist. There are crossovers in these categories, however. For example, a local tourist can also be an overnight hiker as well. These kinds of hikers tend to show a blend of habits from both categories, but these differences are mainly exemplified in the way that these hikers react to the leave no trace (LNT) program.

1.6.1 Day versus Overnight Hikers

A day hiker is mainly someone who goes out and explores a trail during the day. This can be for an hour or multiple hours at a time. An overnight hiker is almost the opposite in that they aim to hike during the day and then sleep either on the trail or in a campsite or lodge along the trail. These two groups are similar in how they conduct themselves in that when hiking a trail both groups of people tend to be very respectful of the trails themselves as well as the LNT program. Taff, et al. (2014) found this to be true in two different surveys they conducted. In this study these authors created a survey that was taken by hikers in both Washington state and Colorado. By analyzing the responses from two different states, the study has a diverse population that it polled. This diversity showed that the day and overnight hikers don't behave too differently from one another when exploring a new trail or returning to the same trial multiple times. Overall, these two distinct groups of hikers act similar to one another when exploring trails.

1.6.2 Local versus Visitors

The second common difference between hikers is whether or not they are local to the trail, or they are visiting the trail. Byle and Halpenny (2012) explore this difference in their study conducted in Canada. This study provides an example of how different groups of people, both locals and travelers, react to the LNT program within a foreign country. It is clear to see that the different groups treat the trails differently in respect to the LNT program. The local hikers that hike the trail expressed more experience and knowledge of the LNT program. When thinking about how local hikers treat a trail that they frequently visit, it is easy to imagine that they will keep that trail clean and healthy so that they can continue to go back for years to come. The visitors/ tourists were found to have less experience and knowledge of the LNT program, but they weren't oblivious to the fact that it existed or what it stands for. Overall, both groups treat trails a little differently but there is not a substantial difference (Byle and Halpenny, 2012).

1.7 Relation to Methods

By researching tourism in Costa Rica, directional signage, interpretive signage, safety signs, and hiker behavior, we obtained a lot of information that we used in our approach to accomplish our project objectives. By looking into tourism, we had a good idea of what questions to ask the community leaders during the interviews to accurately represent their community. After looking deeply into kinds of signs, we had an understanding of the fundamentals of signage. By looking into hiker behavior, we found what information was helpful when making signs and what information was helpful when using the GIS to map out specific points along the trail that hikers want to know about. In the end, the information found when looking into tourism in Costa Rica, directional signage, interpretive signage, safety signs, and hiker behavior, helped us greatly while accomplishing our project objectives.

2.0 Chapter 2: Methodology

In this chapter, we explain how we achieved our goal of developing navigational signage that allows hikers to navigate the trail without a guide safely and ethically. We completed the following main objectives to achieve our goal:

1. Collected qualitative data about signage, sustainability, and materials along the Sendero Pacífico through exploratory interviews.
2. Collected qualitative data about the communities and businesses along the Sendero Pacífico through exploratory interviews.
3. Evaluated current status of signage and indicated positions of signs through Geographic Information Systems (GIS).

2.1 Objectives 1 and 2

The first two objectives of our methodology were to gather information about the communities, signage, sustainability, materials, and businesses along the Sendero Pacífico by conducting exploratory interviews. This helped us understand the experience and motivations of hikers while immersing ourselves in the environment. We have a greater understanding of the importance of the Sendero Pacífico in each community and gained insight about the current state of the trail that shows us where navigational signage is needed most.

To conduct these interviews, our team had to seek approval from the Institutional Review Board (IRB). This is done to review our research protocols to ensure they conform to all ethical guidelines involving human subjects. To gain approval, we submitted an IRB application that outlined all of our methods, who we were interviewing, and how the interviews were going to be conducted, which can be found in the following section. In addition to how the interviews would be conducted, a consent script was drafted to inform the participant that their participation was voluntary, they could cease at any time, and everything would be kept confidential. This consent script can be found in Appendix A. After our entire process was reviewed, we gained IRB approval on January 18th, 2022 (see Appendix E). From that date, we were able to follow our protocol and conducted our exploratory interviews with three main groups of participants.

2.1.1 Exploratory Interviews

The Monteverde community is full of different groups of people that have a strong understanding of the community's wants and needs. To gain a better understanding of how to service these communities through our signage system, we conducted a series of exploratory interviews with different groups within the community. This gave us an insight into how the trail and the signage impacted the different communities along the Sendero Pacífico trail network. We interviewed three main groups identified as the most knowledgeable ones along the trail network: Monteverde community ambassadors, World Trails Network - Trails and Sustainability Task Team, and the Monteverde community and business leaders. These groups have different perspectives of the community's desires and gave us information about how they view the trail system and what they want to see come out of this project.

We conducted semi-structured interviews, meaning that each group was asked a specific set of questions but still leaving room for questions to be thought of and asked during the interview as they came up (Kallio, 2016). This was done to allow for specifics to be answered while having the opportunity to explore different avenues in conversation as they came up. At the beginning of the interview, we read a verbal consent script to the respondent, (see Appendix A). Each interview had two interviewers and one respondent at a time.

These interviews were recorded and then transcribed using transcription software built into Microsoft Word and Google Translate to translate the ones from Spanish to English. We did this so we could conduct thematic analysis across all the respondents' answers. Thematic coding, also known as thematic analysis, is a type of qualitative analysis where text is analyzed to find common themes across multiple inputs by going line for line through responses and seeing which themes pop up most frequently (Vaughn & Turner, 2015). This gave us a sense of common themes across the communities and leaders as to best serve them. Thematic coding was done on each of the three groups individually and then one big analysis across all interviews at the end. This form of analysis helped us identify common desires of the community members to help identify content for the signs.

2.1.2 Monteverde Community Ambassadors Interviews

The Monteverde community ambassadors are a group of people identified by WPI students in *Empowering Community Trail Development Along the Sendero Pacífico* in 2019 that have stepped up and taken leadership of the trail in their community. The community ambassadors meet every month via zoom to talk through issues within their communities and along the trail. This is done to promote communication along the trail network within the communities to identify and address problems they may have. Using a contact distribution list from our sponsor, we reached out to these community ambassadors to ask for their participation in this interview. When they agreed, we proceeded with scheduling the interview.

This was a semi-structured interview, where we asked specific questions but still leaving time for open ended follow up questions that came up as the interview progressed. Questions for this specific group can be found in Appendix B. We began the interview with questions related to the respondent, such as demographics and their roles within the community. This gave us an idea as to their position and responsibilities at the time. The next set of questions we asked involved the community's views and interactions with the Sendero Pacífico. It gave us an understanding of how the community viewed the trail network as it is right now. We also asked questions about what the community ambassadors see as the most important parts of their community and what they would like to be highlighted. This gave us insight into specific content for the signage along the trails.

2.1.3 World Trails Network - Trails and Sustainability Task Team Interviews

The World Trails Network has different task teams within the organization that help take care of different objectives. Specifically, this task team is in charge of working on trail sustainability and establishment of trail systems that are underdeveloped and working on becoming finalized and maintained. Some members of this team have worked directly with the Sendero Pacífico, but not all of them. Using a contact distribution list from our sponsor, we reached out to these community ambassadors to ask for their participation in this interview. When they agreed, we proceeded with scheduling the interview.

This was a semi-structured interview, with us asking specific questions but still leaving time for open ended follow up questions that came up as the interview progressed. Questions for this specific group can be found in Appendix C. We began the interview with questions related to the respondent, such as demographics and their roles within the World Trails Network. This gave us an idea as to their position and responsibilities at the time. The next set of questions was about the Trails and Sustainability Task team. It helped us gain a better understanding of how widespread this task team is, their objectives, and the impacts they have made internationally. We asked specifics about trail signage that helped us learn about what has already been established in terms of signage across the world and what parts of that to bring to the Sendero

Pacífico signage network. This gives us a direction to pursue when we are on sight and gives us more insight into the needs related to the trail and physical signage. This gave us a direction to pursue when we were on sight and gave us insight into specific trail related needs.

2.1.4 Monteverde Community and Business Leaders Interviews

In addition to community ambassadors, there are community leaders within Monteverde. This is a group of leaders within the communities along the Sendero Pacífico who promote rural businesses. Within the larger communities of Monteverde and San Luis, these community leaders are also business owners but in the smaller communities along the trail, they promote rural businesses such as soap makers and farmers. These community leaders speak for the underrepresented members of their community. Our goal from interviewing this group was to identify how the locals and business owners view the Sendero Pacífico in their community and the impact it has made. Using a contact distribution list from our sponsor, we reached out to these community ambassadors to ask for their participation in this interview. When they agreed, we proceeded with scheduling the interview.

Questions for this specific group can be found in Appendix D. We began the interview with questions related to the respondent, such as demographics and their roles within the community that runs along the Sendero Pacífico. This gave us a bit of background about the respondent and to see their roles and responsibilities to their community. We proceeded by asking about their leadership role such as how they got to this position and asking specifics into what it entails. We gained a better understanding of how they serve their community so we can effectively bring awareness to what they want highlighted. We also asked questions specific to businesses, whether or not they are a business owner, which gave us a better idea of what businesses are within these communities. The most important question we asked was “how do you view the Sendero Pacífico in your community?” This is the most important question because it gave us a direct insight into how the trail network is impacting the community, especially in terms of tourism.

These exploratory interviews with the three groups shed light onto how to best serve the communities along the Sendero Pacífico. Talking to the Monteverde community ambassadors, World Trails Network - Trails and Sustainability Task Team, and the Monteverde community and business leaders allowed us to dive deeper into the communities and develop a better understanding of what information would be useful for effective signage. In addition to these interviews and the information gathered for the signage, we used GIS as a method of locating where to put signage and where along the communities they will be most effective.

2.2 Objective 3

The third phase of our methodology was to take the previously gathered information and data and get that entered into one easily shareable location. For this, we used Geographic Information Systems, more specifically ArcGIS online. By inputting our data into ArcGIS online, we were able to view the whole trail and each section individually. In addition, we were able to virtually look through points of interest identified in the hikes, which ultimately allowed us to create a map of locations where signs are necessary, as well as allowed us to specify which type of sign was needed at each location.

2.2.1 Geographic Information System (GIS)

A Geographic Information System, or GIS, is a system of layering maps and data in order to present the two harmoniously. Our goal was to produce a manual that would allow locals to develop a standardized marking system for the Sendero Pacífico so that hikers could safely get to

their destination. In order to do so, we used the spatial data to orient ourselves on sections of the trail and used electronic pins to mark areas of interest. This was significant because we needed a map to both navigate our way on the trails, but more importantly to mark the coordinates of certain areas on the trail. On our map, we listed two types of data that are shown below.

Spatial Data	Attribute Data
Trail start/end points *We noted the location of the start and end points of the trail in order to link attribute data to these points.*	Sign conditions *We recorded what the signs say and their condition to determine if replacement was necessary.*
Location of existing signs *We accounted for all existing signs and marked their location in order to easily relocate them in the future.*	Condition of points of interest (Safety, Navigation) *We noted the condition of the trailheads to ensure hikers start at the correct point, and that the trailheads are conspicuous and easy to access. We also noted points at intersections where either trail leads in order to direct hikers in the future.*
Intersections in the trail *We noted which direction we took on our hike as well as the locations of the intersections where signs are needed.*	Noteworthy observations made during our hike *We will mark any other unexpected or noteworthy observation that will help us create more effective signs and were made at our discretion.*

Table 1. A visual tool used to depict the differences between spatial and attribute data.

The layering of the data allowed for easy analysis and thus a unified compilation of data from which we could create a manual. To layer the data, we used ArcGIS software which license is provided to us through WPI. In tandem with this software, we used smartphones running WikiLoc in the field to record the data we needed. Wikiloc is an app that tracks the hiking route and allows the user to create points at any given location. These points included the type of point as well as a photo. We then compiled our data on the ArcGIS software using a laptop. Reception was not an issue for smartphones because we pre-downloaded maps and offline notes to collect our data. Once we regained reception, we transferred this data to ArcGIS. ArcGIS can be a challenging software to learn, but online help and tutorials from Esri Canada have helped us become knowledgeable enough on the topic in order to effectively use it as we need. Being able to use GIS was critical in organizing our data, so it was important for us to become familiar with it.

Since the Sendero Pacífico is so long, we were not able to trek the entirety of the trail. However, we were able to obtain and plot the trail based on maps compiled and sent to us by our sponsor. We hiked various sections of the trail as day hikes to get an idea of the status of the trail. Ideally, the Sendero Pacífico is one 5-day hike that follows the route as shown in the flowchart below.

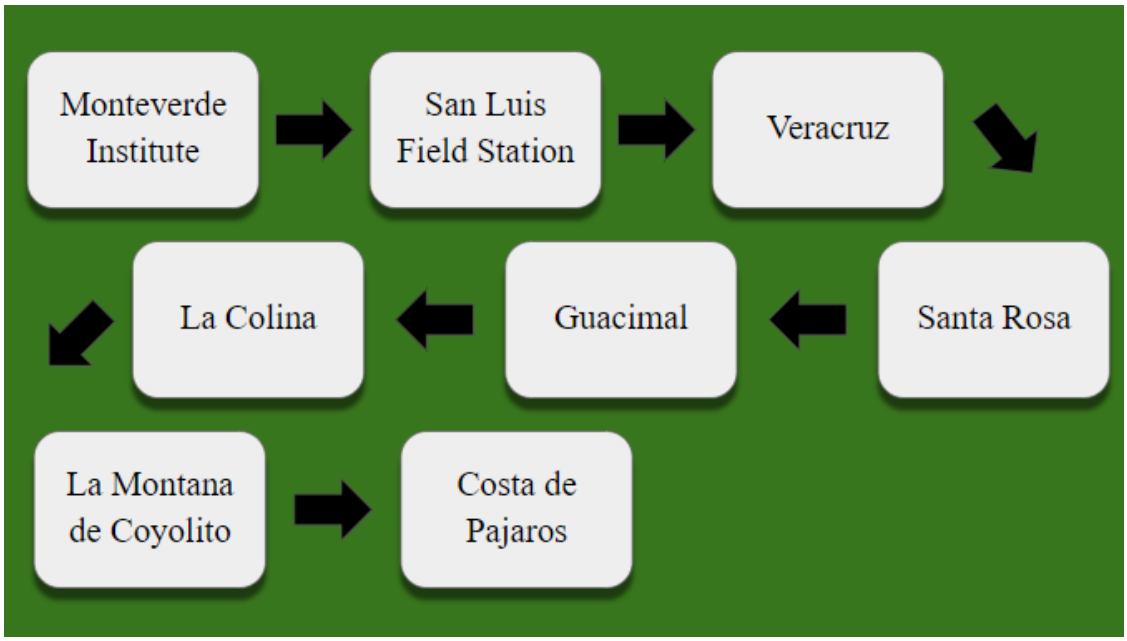

Figure 1. A visualization tool that describes the intended hiking route.

Instead of hiking this route in one go, we hiked from San Luis to Veracruz, Guacimal to La Colina, La Colina to La Montana de Coyolito and visited La Costa de Pajaros as separate trips on different days. Our ability to hike depended on COVID-19 factors, as well as the feedback we received over the first 2 weeks during the interview process. Another factor we needed to consider was the weather. During the time we were there, it was the middle of what is known as the dry season or summer which spans from December to April. Since we were there during January and February, we needed to be cautious about the temperature and ensure it was not too hot to hike. However, these months were ideal for visibility and safety as we do not have a huge concern of getting rained on which could make the trails treacherous and hurt our electronic equipment.

By completing our hike and collecting data using the methods described above, we were able to effectively generate a manual by which signs on the Sendero Pacífico trail will be created and employed. Upon collection of all of this data, we needed to meet our timeline of analyzing the data and completing our deliverables.

2.3 Timeline of Events

Our time on IQP was split into three main phases: pre arrival in Costa Rica, present in Costa Rica, and post travel. During the first phase we learned some critical Spanish to aid in our interview process, set up interviews for later in the term, and made travel plans so that we were able to hike as much of the trail as we could. During the second phase we focused on our data collection by conducting all of our interviews and physically hiking the trail. We also had on ground data collection for our GIS objective during this time. All of this data was then used in our last phase as we finalized our deliverables and final paper. This entire timeline is represented below in more detail in a Gantt chart.

PROJECT TITLE	Creating a Navigational and Interpretive Sign Design Manual for the Sendero Pacifico Trail System in Monteverde, Costa Rica	ORGANIZATION	WPI
TEAM MEMBERS	Michael Sposato, Malyssa Deranian, Nick Pellegrini, Abby Maynard	TIME	1/10/22-3/3/22

					PHASE ONE										PHASE TWO																PHASE THREE									
					WEEK 1					WEEK 2					WEEK 3					WEEK 4					WEEK 5					WEEK 6					WEEK 7					WEEK 8				
WBS NUMBER	TASK TITLE	START DATE	DUE DATE	DURATION	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
1	Pre-Arrival to Costa Rica																																									
1.1	Take Spanish Classes	1/10/22	1/20/22	10																																						
1.2	Set Up Zoom Meetings	1/12/22	2/4/22	22																																						
1.3	Create Travel Plans	1/10/22	1/22/22	12																																						
1.4	Fly to Costa Rica	1/22/22	1/22/22	0																																						
2	Present in Costa Rica																																									
2.1	Conduct Zoom Interviews	1/26/22	2/4/22	8																																						
2.2	Hike and Interview People at Alberques	1/25/22	2/3/22	8																																						
2.3	Transcribe and Analyze Interviews	1/25/22	2/16/22	21																																						
2.4	Organize Deliverables	2/3/22	2/16/22	13																																						
	Map all hikes using wiki loc and Arc GIS	1/26/22	2/16/22	20																																						
2.50	Fly back to the US	2/18/22	2/22/22	4																																						
3	Post Travel in Massachusetts																																									
	Utilize Arc GIS to give better sign recomendations	2/10/22	2/25/22	15																																						
3.1	Finalize Deliverables	2/16/22	2/25/22	9																																						
3.1.1	Translate Deliverables into Spanish	2/25/22	2/26/22	1																																						
3.2	Final Report	2/25/22	3/3/22	8																																						

Figure 2: Gantt Chart Outlining Team's Sequence of Events

3.0 Chapter 3: Findings and Discussion

3.1 Interview Findings

The first step in the methodology was to conduct exploratory interviews on members of different groups related to the Sendero Pacífico. We visited four towns, three of which we hiked to, and were able to get to know the trail surrounding where our interviews took place. The objective of these interviews was to collect data from community members and discover community relationships to the trail system that would inform us on how to best proceed with marking the trail. After completing our interviews with the community members, we found that they greatly appreciate the Sendero Pacífico and see it as a positive aspect within their communities. By learning about the possibilities that the Sendero Pacífico could create for small communities and getting to know local businesses and cultures, we were able to learn how to create a functional and sustainable signage system.

In addition to visiting the local communities along the Sendero Pacífico, remote zoom interviews were conducted with people across the world. We spoke to experts within the World Trails Network and beyond about how to best standardize a system of signage, starting from creation and working our way up to implementation. Talking with these experts gave us an insight into what methods of signage work best for different audiences and their collective experience showed us how we can best service the Sendero Pacífico with our signage and handbook. The biggest takeaways included that the signage should not take anything away from the experience of the trail but rather add to it, whether that be in terms of content or materials. Also, signage should be effective in transmitting messages, whether that be through colors, pictures, or language.

3.1.1 Trail Sustainability and Conservation

An overarching theme that came up while analyzing all of the interviews was conservation and sustainability of the trail and the materials used for signage. When asked why conservation is important, Adriana, a young woman from the family who runs the albergue in Veracruz who we met in Costa de Pajaros responded, “As humans we must leave a positive mark and reforest them or highlight those spaces, it is a way of doing… and also thinking about future generations and visitors.” Climate change is a big problem for these communities along the Sendero Pacífico. It was brought up over and over again. “It would be very sad if I do not know in 30 years, you visit us again and this area is over,” she said. Being able to save the environment is important because these local communities depend on the ecotourism sites to be successful. Ecotourism is dependent on the conservation of these local resources in addition to actively being a part of it (Mckeone, 2011). Since these small communities that run along the Sendero Pacífico are interwoven into the trails, being able to conserve it for years to come is important.

In addition to the physical trail itself, their signage and construction is just as important, Julien Gray, the director of the South West Coast Path Association, which looks after England’s longest trail in addition to being the vice chair of the World Trails Network, touched upon making sure the signs fit in with the local environment. “So sustainability obviously comes into it using signage which and that's why using local materials is always the best option because it number one helps in if you don't have a local furniture in terms of design styles, and you can actually create a local vernacular using local materials, which is really helpful and that can also help create a sense of place.” These materials can add to the trail instead of taking away from it when it looks unnatural, making the user experience more positive along the trail (Zhu et al.,

2021). This shows us that being able to integrate local materials strengthens the relationship between the communities and the trails can allow for a lasting impact on both.

To construct the signs, materials from the local environment should also be used. Since there is very little signage on the trail, one of our main interview questions was what changes could be made to the Sendero Pacífico and the signage systems in these communities? One response was in Veracruz from Dylan, the son of Rojelio and Ana, the family whose property spans a portion of the trail and also co-owners of the albergue. When asked if he had ideas for the Sendero Pacífico, he responded "...there is still a long way to go because improving the area is very beautiful and has a lot of potential, but we as humans must work more on this and also improve the ecological systems that exist here…" He gave us ideas on what materials we should use in signs. He and his family drove home the fact that conservation is important and "here the easiest thing would be wood because trying to find trees that are already dead and use the wood and if not with a little more creativity to use things that rather one can recycle…" which allows for us to not take anything away from the environment. These materials allow for us to integrate the environment with the trails to have an immersive experience along the trail.

Trail development goes hand in hand with trail sustainability. Dionicio, a co-owner of the Veracruz albergue, has lived here all of his life and sees the trail as a big part of his community. "I feel that it may be that we need more advice where people with more knowledge about trials come to give us ideas and accompany us on what the logical part of how to build a trail… but we would need people with capacity and we give advice where they have worked on trails that they have and at the same time for what it is to improve you from all that." He wants the trail to be developed but his local knowledge can only take him so far. Being able to integrate materials from the community, community members for conservation, and general sustainability practices can help develop the trail for years to come.

3.1.2 Signage Contents

A way to bring more awareness to the trail and to integrate the local community more is to have a defined symbol for the trail. This symbol becomes the "face" of the trail network. Beebe Bahrami, a published author and freelance writer with a PhD in anthropology specializing in the depth of humans and the natural experience, told us "you don't really need too much, but you need that one symbol that everyone is looking for that says they're still on the trail." She told us that El Camino de Santiago, a trail she specialized on by writing *Moon Guide: Camino de Santiago*, uses a yellow seashell with a blue background as the symbol of the trail and everyone knows that is the trail. "When you pick a symbol that represents that trail, it becomes the icon for the trail, and it's a really powerful tool to create a sense of identity with it and throughout the communities everyone will start replicating it and it will wind up on T-shirts and hats and patches and you name it." This is a powerful piece of advice that will help us with the creation of our signage. Having the symbol of the Sendero Pacífico on all the signs will help reassure people they are on the path but also bring a sense of community to the path itself. Bringing a symbol in to encompass the entire trail network allows for a sense of community to grow and build to give people a strong sense of identity and pride within the trail network. Symbols are often an effective way of communicating ideas through signage as well (Marschall et al., 2016). Using the Sendero Pacífico trail symbol truly brings a proud sense of community to the trail that will allow the locals to have something they are proud of representing them.

Figure 3: Sendero Pacífico Trail Symbol

That sense of community can also be used in the upkeep of the trail. Julien gave us the suggestion to use local materials and have local community members paint the signs. “Going back to visit and maintain the upkeep will help strengthen the community involvement with the trail. Think, actually, it's a great way of getting the local community engaged in the trail. If they go out and they paint it up and they walk at the same time, even if it's not the people who wouldn't be trail leaders, they would then understand what that section of the trail is. So get each community to paint its section or to waymark that section of the trail.” Hand painted signs are very popular in these communities as they are easy to create and maintain. This advice about signage creation has given us a lot of insight into what guidelines to give to the community about the new to develop signage system of the Sendero Pacífico.

At a women’s organization, Jenny discusses what signs she has seen in her community. She recognized the lack of signage on the section of the trail to El Coyolito and discussed a few ideas she noticed worked best and kept that sense of community. We found that like most of our interview subjects, Jenny felt strongly about using wood that has already fallen from the farm nearby. It is necessary to have as little impact on the environment as possible when creating the signs to uphold the principles of ecotourism, especially when the signs will result in an increase in tourists coming to the communities (Bricker 2013). We have found that it would be the best option economically to use wood for the signs but also the most accessible and sustainable material. When wood is not accessible, recycled material such as can covers or plastic plates is also a good option for constructing signs. Jenny also noticed yellow labels on rocks as signals and suggested using black, red, or yellow colors that make the signs eye-catching.

As well as learning about the colors and materials of signs, we also found some recurring themes on what a sign should contain. We interviewed Katy Van Dusen, climate change activist who has hiked the Sendero Pacífico, and inquired about what elements a sign should contain. Katy describes how signs should be “Helping people know where they are and how long distances are from point A to point B. Topography…knowing where there's water… It might be good for people to know how far you are from Wi-Fi …if people need help they know and they can communicate.” Distance to hiker destination, steepness, nearest water source, and nearest service, are all factors that are very important to hiker safety. These additional elements will be accounted for in our waymarking methods while following the principles of signage (Harnochova, 2017). If these elements are all displayed and the signs follow the general principles of signage, hiker safety will significantly improve along the trail.

Signage systems need to be able to convey information communities deem as important. Costa de Pajaros is a coastal town focused on responsible fishing; this is the last stop on the Sendero Pacífico trail system. To best service these communities, we asked for what elements they look for in signs. “Illustrations, not necessarily numbers or so many letters but easier illustrations,” one of the local fishermen said. This allows for the language barrier to be bridged while still getting the point across (Zhu et al., 2021). Especially in a community that is so dependent on nature, being able to share ideas to tourists and visitors allows for the balance between man and nature to be maintained.

To use the information gathered on what exactly a sign should look like, we then learned about the process of how they should be made. In an interview conducted with World Trails Network member, András József, we learned about the various types of signage systems and found that each system is largely dependent on the environment and surrounding community. András shared his expertise on European waymarking systems and styles of signs that he has used and the methods he finds work best. We found that in Europe, metal signs are used much more often than in Costa Rica, and there are specific color coding systems that they follow. After a series of interviews with community members, we feel that an investment in metal signs may not be a financially smart decision. We also found that having one standardized system on each section of the trail, especially when reassurance markers are needed, is a good solution that informs hikers where they are at all times. These markers will have the same color, or the same logo, which is often used in European waymarking methods (Harnochova, 2017). We learned how different areas of the world are marking their trails and used this information to make decisions about the signage system in Costa Rica.

3.1.3 Community Involvement and Interaction

Waymarking along Sendero Pacífico is going to need a lot of hands to help with this trail. Again, when talking to Beebe, we asked her about trail marking and received a lot of feedback as making the trail really takes a village. “Look at if you're trying to get you know better marking and safer trail practices and it really does take every community involved on the trail to be organized.” This shows us that it can’t just rely on one person at one time, community involvement in the trail is fundamental to its success and population as time goes on.

The data from the interviews shows that community interaction is important when creating a signage system on a trail with surrounding communities. The Sendero Pacífico is an opportunity to educate. In our interview with World Trails Network Member, András Molnar, he informed us of the importance of community workshops when making signs. He hiked the Sendero Pacífico in 2019 and had organized workshops when he visited the communities. He stated how “engaging the local people and also sharing knowledge and experience from the outside” during these workshops was a successful method, however, the pandemic broke out right after which slowed down this process. Trail management that ensures collaboration between the community and outside experts is key to making an effective and environmentally friendly system (Mckeone, 2011). We have found evidence that the most productive method for creating a signage system involves both local people and trail experts in workshops or focus group-style meetings.

Communities are also interested in interacting with hikers to learn about different cultures, as well as teach others about their own. A woman who has lived in La Colina for the past 33 years shared her thoughts on the way the trail has and could continue bringing together people of different backgrounds: “It is good way to meet people from another country to know their culture their customs and as they say that everything enters through the eyes so when you see the person in the eyes you know more or less what they are like more than this one and you feel happy that you did it since you can't go to your country.” The woman expresses the importance of bringing new people to the community because some people have never left the country and had the opportunity to learn about different cultures. We found that the people residing in La Colina are not so familiar with the trail, however, they see it as a tool for raising cultural awareness within their community.

During our interviews we learned that several community members and leaders hope to see more hikers on the Sendero who will be attracted to their businesses. A standardized signage

system will increase the number of hikers that can find the communities and creates an opportunity to advertise businesses along the trail. The first interview in La Colina was with two working women who had a positive view on how the Sendero could impact local businesses. During the interview, a woman who works in handicrafts stated: “I see it as an opportunity to meet people, to attract tourists to here,” when asked how she saw the trail in her community. She felt the trail could help attract tourists to her business as well as other businesses/activities in La Colina such as horseback riding, a bakery, and a butterfly garden. It is important to support these local businesses because it will strengthen the community economies and create more job opportunities to improve their standard of living. Creating a signage system on the trail will allow tourists to safely navigate to La Colina, as well as develop the economy by advertising and bringing customers to local businesses.

3.2 On the Ground GIS Findings

While hiking the three trail sections between San Luis and Veracruz, Guacimal and La Colina, and La Colina and El Coyolito, we utilized Wikiloc to record many findings along the trail. Prior to arriving in Costa Rica, our project mainly focused on interpretive signage and information on kiosks at trailheads. But, while hiking we found that it is much more important to focus on directional signage as the trail is not always clearly marked or blazed. So as we continued to hike throughout the backcountry, public roads, and farms, we began marking more and more gates, natural hazards, and intersections. While hiking it was easily noted by the group that there is a significant lack of directional signage.

3.2.1 Gates

While hiking the Sendero Pacífico there were many gates at the edges of cattle pastures, horse farms, and other properties that we passed through. These gates were common throughout the trail but were most prevalent between San Luis and Veracruz. We found it unusual to be walking through barbed wire gates that surrounded private cattle farms since it is unusual to enter a stranger’s land through their gates and proceed to walk through their farm. Introducing a signage system in these locations would help alleviate the feeling of illegally trespassing that most hikers experience. A directional sign pointing upwards, a simple blaze system, or a logo would help with clearing the confusion as well. The lack of signs at gate entrances makes the path very unclear and is a safety hazard for anyone hiking without a guide.

Figure 4: Gate near El Coyolito

3.2.2 Natural Hazards

While hiking from La Colina to El Coyolito, there were multiple natural hazards that we encountered along the route. The first hazard was crossing and walking along the intercontinental highway. While hiking we found no signs that helped provide directions to cross, continue down the road for a couple of hundred meters, and then turn off onto another dirt road. Without our guide who had hiked this section of the trail, it would have been very difficult to figure out where to go. Cell service was also scarce so there was nothing to help us locate where we were in relation to the trailhead or our destination. Additionally, another natural hazard that we encountered were rivers between Guacimal and La Colina, and again between La Colina and

Figure 5: River near Guacimal

El Coyolito. Each time the thought process and course of action for crossing were the same. We tried to find the shallowest part of the river or a series of rocks to step on to avoid getting wet. Similar to the crossing of the intercontinental highway, we had to walk along the river to then continue onto the trail. A directional sign here would have been very helpful to communicate where to go and when to turn.

3.2.3 Intersections

The third major issue that we focused on were the intersections that we came across while hiking. We ran into these intersections on every hike many times. We again had a guide to help us on our way but there were times with no cell reception that we had to knock on doors and ask local people for directions. Seeing this happen multiple times truly showed us the importance of signs along the trail. Additionally, while on the roads between La Colina and El Coyolito, there was an intersection where one way led back to Guacimal, and the other continued down the Sendero Pacífico. This intersection could have caused us to go "backwards" on our hike, and if we had reservations down the trail at another community, we would not have gotten there in time or in the daylight.

Figure 6: Intersection Near La Colina

3.3 Application of GIS Findings

Using Wikiloc as described in section 2.2.1, proved to be very helpful for our mapping and research. Once we compiled the data described in section 3.3, we then uploaded these Wikiloc files to the internet. We then downloaded these Wikiloc maps and uploaded them to ArcGIS online. This GIS software allows us to interpret and organize this data by creating detailed maps with a variety of layers noting spatial and attribute data. We plotted our routes on top of an already existing trail map given to us by our sponsor. The data on the maps we created is broken down into four categories or layers: route, intersections, existing infrastructure, and trail hazards.

3.3.1 Our Use of ArcGIS

Beginning this project, our group had no prior experience using ArcGIS. Having a remote team member allowed us to have one person putting more focus into the learning and use of ArcGIS, which gave us the time to create a more detailed GIS map for our final deliverable. From the beginning, we knew that we wanted to create a GIS map of our future sign locations. However, we did not know the details of how we were going to make it happen. So, the first step was to learn exactly what we are capable of doing with ArcGIS. In order to do so, we spent a lot of time experimenting with the software as well as talking it through as a group. We were able to decide on at least four distinct layers to include in our maps.

The route portion of our map was the most straightforward part. Our first priority was finding a software to use on a smartphone in conjunction with ArcGIS online. We used Wikiloc because our sponsor recommended it to us. It drew a line to denote the route as the hike was conducted. This route was then uploaded to ArcGIS online and was established as the first layer. The route from each hike we took can be toggled on and off on the map.

Upon arrival in Costa Rica, we realized that the existing sign infrastructure was different than we had originally thought. There were virtually no hiking signs already in existence, aside from a few empty or close to empty wooden kiosks. Instead, we found a lot of old directional signs for motocross racing. This is an issue because the motocross track passed over and through

the hiking trail, yet it did not exactly follow the trail. And since the signs were just arrows, these could easily confuse hikers. On our ArcGIS map, we marked the location of these signs in order to allow them to be removed to mitigate confusion for hikers.

On the hike, we came across a plethora of potential trail hazards. We noted river crossings, gates, fences, and shortcuts that our guides took us through. We are also working alongside another group focused on safety and ethics, so the safety hazards were not our main concern. That said, it was still important for us to shed some light on these areas in order to ensure proper signage gets installed at these points.

3.3.2 Sendero Pacífico Map

One portion of our deliverable is an online map with our recommended sign locations marked and sign type specified. To do so, we plotted our sponsor's map in ArcGIS. We then took our routes and points described in the previous section and layered them on top of the sponsor map. Shown below, is a picture of our map. The trails are highlighted in different colors as specified by the legend found in ArcGIS.

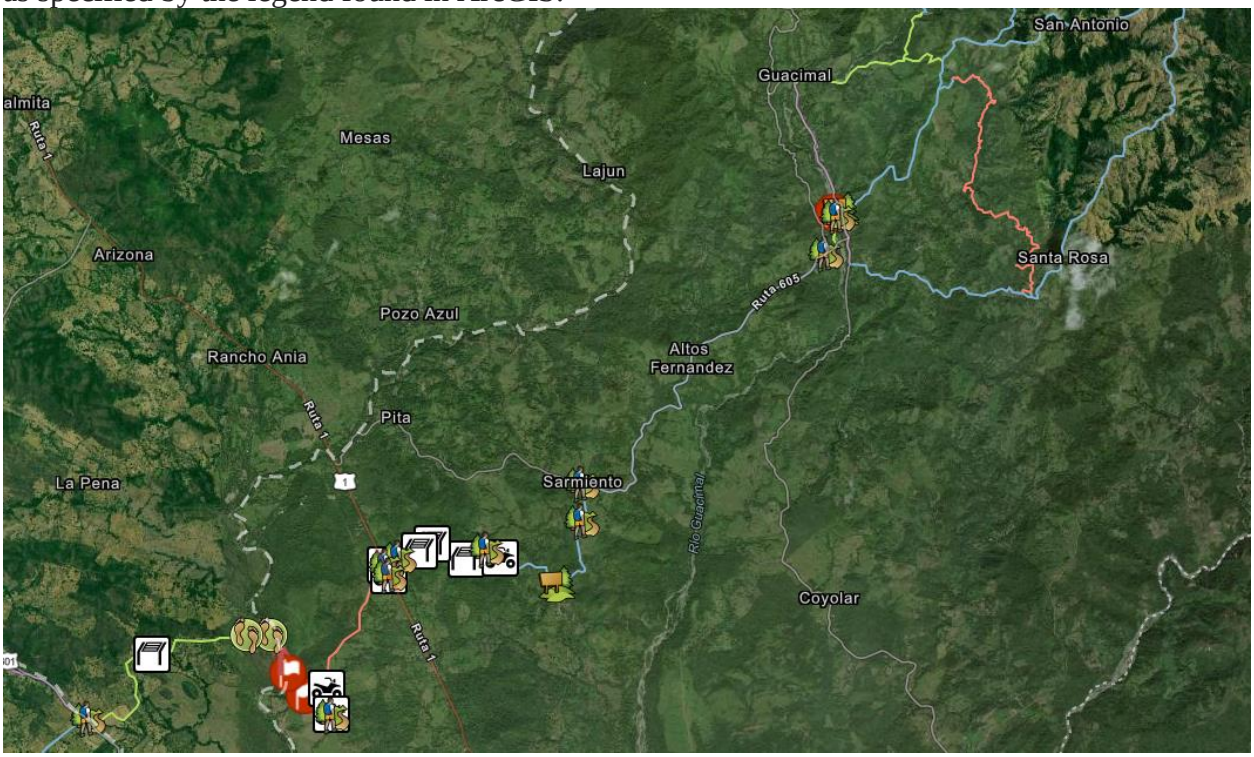

Figure 7: Still image of our Interactive Map of the Sendero Pacífico

.

In this map, you can also see different icons relating to different sections of trail. When viewing this map in ArcGIS online, we can click on each of these logos and an information box will pop up. An example of one of these boxes is shown to the right. At the top of the box is the reason we are concerned with this particular location. In this instance, there is a gate at this location which could potentially confuse or disrupt hikers on the trail. Next, the box has a category for sign type and has

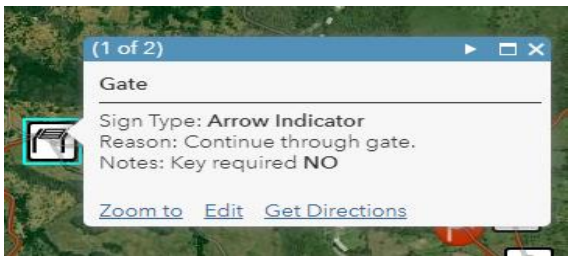

Figure 8: Example of an Information Box Under One of our Map Icons.

a bolded category next to it. Every icon box that calls for a sign will also note the type of sign necessary at this point. Since there is only one path around this particular gate, an arrow to indicate the hiker is still on the trail will suffice. The reason box briefly notes the reason for which we are recommending a sign at this point. This box also contains an additional note specific to this location. By adding all these icons to the map, we are hopeful that this will just be the beginning of this map and that eventually the sections we did not hike will also be done this same way. Ultimately, this map will appear in our manual, which will be a compilation of all our sign recommendations. This map will play a key role in the application of our research on the trail.

4.0 Chapter 4: Recommendations and Conclusion

4.1 Utilizing the manual

From all of our findings and research, we found it best to present our recommendations through a manual for the World Trails Network, that will be translated in both English and Spanish. This is a comprehensive manual on signage creation based on what we gathered from interviews, literature review, and personal observations while hiking the trails. Our manual contains two main sections: the construction and the implementation signs. The construction of signs includes the types of signs, what information is presented, and what materials are used to construct them. The implementation of signs includes the location of signs, why they were chosen, and how to attach the signs. These two aspects come together as our final deliverable for this project.

4.1.1 Construction of Signs

There are four main types of signs that we recommend constructing for the Sendero Pacífico: blazes, directional, sign posts, and kiosks. Each builds off the next to create a hierarchy of signage, which is a structure that starts with the fundamentals of signage and builds to the most complex. The types of signs were defined by the needs defined from the interviews conducted. The biggest response when asking the question "what are some changes you would like to see along the Sendero Pacífico" was improvement in signage. The trail is drastically undermarked in a lot of areas so being able to waymark the trail allows for users to independently hike the trail and travel through the communities using the three types of signage.

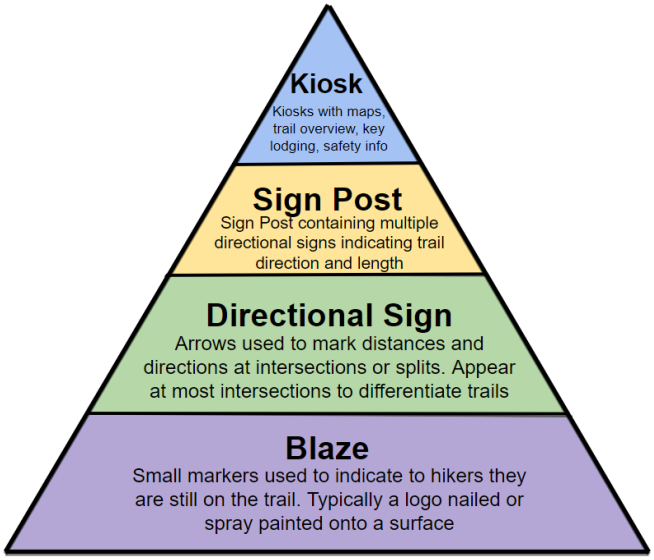

Figure 9: Diagram of Hierarchy of Signage

In addition to the types of signage, each has specific information that goes on it. Blazes are quintessential for waymarking as they reassure you are continuing on the right path (Harnochova, 2017). These help people traverse the different terrains of the trail as they go along. Second up on the signage hierarchy is directional signs, which are signs that provide the route when approaching a junction. These typically have directions at a junction in addition to distance markers to show people the next point of interest. This is important because it can highlight important distances to turns and stopping points. The final tier on the signage hierarchy is the informational signage. These are typically found at trailheads and include a plethora of information, such as safety notes, maps, and key locations such as hostels and restaurants. Informational signage showcases not just the trail but the local businesses along it, a key aspect local communities wanted highlighted along the trail. These signs are examples of interpretive signs that effectively combine pictures and words to convey information (Zhu et al., 2021). All of these signs put together along a hiking trail allow for a comprehensive overview as to what to expect before, during, and after hiking.

We have defined a certain set of materials to be used to create the signs, in addition to what the signs should contain and what types they are. A big theme across all of our interviews was sustainability and being able to use recyclable materials in the most effective manner to not destroy the natural environment. All of our signs will be made out of wood, specifically wood

that comes from a dead tree or that is already shaped and can be reformatted into something else. The blazes will be made out of latex paint using a stencil to be able to mark the trail with the specific logo, that way it brings a sense of community and recognition to the trail you are on. All of these should be subject to routine maintenance by the local community members.

4.1.2 Implementation of Signs

Once the signs are constructed, the final step is to apply the signs to the trail and have them serve their intended purpose. In order to apply the completed signs, we must first know where to place them, and then decide how to hang them.

In order to map the sign placement, we have created a detailed ArcGIS map, as described in section 3.4.2. We marked all the locations we thought were confusing or could potentially be confusing to hikers hiking without a guide. Typically, these were intersections or turns on the trail where somebody could accidentally stray from the trail. Overall, this map is critically important to ensure that we maximize the effectiveness of our signs. If they are not placed in an effective spot, they will not serve their intended purpose. This is why the hanging of these signs is also important, because the signs must be conspicuous and eye level to hikers, easy to access for repairs, and must not damage the environment they are placed in. Since we are relying on locals to hang these signs, we needed to provide clear instructions on how to properly hang the signs.

As specified in the manual, our blazes are to be hung on a tree with a single aluminum nail at eye level and facing the trail. These will be our most common sign type, so it is efficient and sustainable to only use one nail each. Directional signs will be placed at smaller intersections or confusing points on the trail. These will be a bit bigger than blazes, but one nail will still suffice for these as well. Some instances may require two nails depending on what type of surface the sign is being hung on as each sign is unique to each location. Sign posts will be placed at some larger intersections and will be pounded into the ground. These are larger and contain more information than the previous sign types, so they need a sturdier base. Lastly, we will have kiosks at some larger trail heads. These require rather more difficult construction compared to the others, so these will not appear very often. However, there are still some locations currently on the map for these. As the project evolves, more and more locations will be added to the map, and what we have now is just a start.

4.2 Next Steps

The next step is to follow the manual to construct the signs. There will need to be some time spent on finding affordable and environmentally friendly paint and tool suppliers in the country. A timeline will need to be created to plan the construction and installation of the signs, and the project will need to be delegated to different communities/task teams. Once the navigational signs are placed and hikers can safely walk the trail without a guide, interpretive signage can be added along the trail to promote local businesses. We found that parts of the trail are treacherous and less maintained, so we suggest a yearly maintenance program. This can be done by local community members who travel on the trail often and are familiar with each area and the surrounding natural scenery.

Since the Sendero is a newer trail that is less popular because it cannot be hiked without a guide, it has few visitors. Once there is a signage system in place hikers will be able to travel along the Sendero and spread the news of its accessibility. However, it will be important to increase the attention the trail gets from travelers coming into the country who have not heard of the trail before. We recommend advertising the trail in a place hikers will be able to see while

making their travel plans and before coming to the country. Additionally, we recommend that the Sendero Pacífico be added to common hike discovery navigation sites such as AllTrails and the Monteverde information website. Travelers who are planning their trips in and looking for a hike to do once in Monteverde will be informed of the Sendero and be able to map out their trips.

4.3 Conclusion

Our project delivered example signs along with a manual to help improve signage on the Sendero Pacífico Trail network. By creating example signs in conjunction with a manual with steps detailing the construction, placement, and information of each sign, our group aimed to make it as seamless as possible to replicate these signs. Additionally, our manual was also produced in Spanish, so that local communities can also read it and utilize it to improve their local sections of the trail. The production of this manual has taken into consideration all our previous chapters, interviews, and firsthand hiking experience. By using all of this information this manual will help to improve the use, longevity, and conservation of the Sendero Pacífico. Overall, we hope that the example signs and manual that we produced will bring this trail to the next level so that more and more visitors can experience it.

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Appendices

Appendix A. Script for Oral Consent

Purpose: To conduct interviews with local community members and leaders to obtain an idea and discuss their opinions on signage along the Sendero Pacífico trail system. We are seeking to increase our understanding of the directional signage that is currently in place on each section of the trail. In addition to creating the best way to develop and improve ease of navigation in other areas of the trail.

Welcome to our interview! We are a team of students from Worcester Polytechnic Institute (WPI) in Massachusetts working with the World Trails Network to help them create a standardized signage system along the Sendero Pacífico trail network that will highlight local businesses, trail markers, and other highlights.

Bienvenidos a nuestra entrevista! Somos un equipo de estudiantes del Instituto Politécnico de Worcester (WPI) en Massachusetts que trabaja con World Trails Network para ayudarlos a crear un sistema de sistema de señalización a lo largo de la red de senderos de Sendero Pacífico que destacarán los negocios locales, los marcadores de senderos y otros aspectos destacados.

Before we begin, we want you to know that while we would love for you to answer all of the questions being asked in the interview, you are not obligated to answer any question; if you do not want to answer a question, please let the interviewer know and we will move on. This is mostly an open discussion with a few guided questions so there is a lot of room for open ended responses. This interview will be around 30-45 minutes. With your permission, we will record this conversation but names will be kept completely confidential. Do you grant us permission to record you during this interview?

Antes de comenzar, queremos que sepa que, si bien nos encantaría que responda todas las preguntas que se le hacen en la entrevista, no está obligado a responder ninguna pregunta; si no desea responder una pregunta, infórmese al entrevistador y continuamos. Esta es principalmente una discusión abierta con algunas preguntas principales, por lo que hay mucho espacio para respuestas abiertas. Esta entrevista durará alrededor de 30-45 minutos. Con su permiso, grabaremos esta conversación pero los nombres se mantendrán completamente confidenciales. ¿Nos das permiso para grabarse durante esta entrevista?

Once the information from the interview is transcribed, the recordings will be destroyed. The purpose of this interview is to get your feedback on current signage along the Sendero Pacífico and see what you would like highlighted in your communities overall. This is a collaborative project between the World Trails Network and WPI, and your participation is greatly appreciated. The research will be published in the archives of WPI and all personal information will be redacted. Please feel free to ask any questions prior, during, or after the interview has finished. Thank you for your participation!

Una vez transcrita la información de la entrevista, las grabaciones serán destruidas. El propósito de esta entrevista es obtener su opinión sobre la señalización actual a lo largo del Sendero Pacífico y ver qué le gustaría resaltar en sus comunidades en general. Este es un proyecto

colaborativo entre World Trails Network y WPI, y su participación es muy apreciada. La investigación se publicará en los archivos de WPI y se redactará toda la información personal. Siéntase libre de hacer cualquier pregunta antes, durante o después de que termine la entrevista. ¡Gracias por tu participación!

[If consented to be recorded: turn on recording device and state “So you have just given consent for us to record this interview, is this correct?”] "Entonces, acaba de dar su consentimiento para que grabemos esta entrevista, ¿es correcto?"

Team contact: gr-WTNS@wpi.edu

Project Advisor: Sarah Strauss sstrauss@wpi.edu

Appendix B. Interview Protocol and Monteverde Community Ambassadors Interview Questions

The purpose of these interview questions is to learn about the desires of the community members for the content of signs along the Sendero Pacífico, including improvement of the navigational signs, the highlighting of businesses, and to best understand the areas surrounding the trail.

Interviewer Introduction:

***Note: there will only be two interviewers per interview.

Comenzaremos con algunas presentaciones personales.

- Abigail Maynard is a junior Biomedical Engineering major from Concord, NH and specializes in bioinstrumentation. At school she is involved in mentoring high school robotics teams and some of her interests outside of school include art, hiking, and going on road trips.
    - Me llamo Abby Maynard y soy estudiante de ingeniería biomédica de Concord, NH y me especializo en bioinstrumentación. En la escuela, participo como mentor de equipos de robótica de la escuela secundaria y algunos de mis intereses fuera de la escuela incluyen el arte, el senderismo y los viajes por carretera.
- Malyssa Deranian is a junior Industrial Engineering major from Windham, NH. At school she is involved in Varsity Rowing and Armenian club, and loves to hike and travel in her free time.
    - Me llamo Malyssa Deranian y soy estudiante de ingeniería industrial de Windham, NH. En la escuela participo en Varsity Rowing y el club armenio, y me encanta caminar y viajar en mi tiempo libre.
- Michael Sposato is a junior Mechanical Engineering major with a double minor in Manufacturing and Fire Protection from Flemington, NJ. At WPI he is involved in Varsity Football, Greek life, Tour guides, and some religious organizations.
    - Me llamo Mike Sposato y me especialicé en Ingeniería Mecánica con una doble especialización en Manufactura y Protección contra Incendios de Flemington, NJ. En WPI estoy involucrado en Varsity Football, la vida griega, guías turísticos y algunas organizaciones religiosas.
- Nickolas Pellegrini is a junior Aerospace Engineering major from Southampton, Massachusetts. Additionally, is a member of the Varsity Football team as well as involved in Greek life on campus. Has spent a lot of time outdoors and in the woods in western Massachusetts.
    - Me llamo Nick Pellegrini y soy estudiante de ingeniería aeroespacial de Southampton, Massachusetts. Además, soy miembro del equipo Varsity Football y participo en la vida griega en el campus. He pasado mucho tiempo al aire libre y en los bosques del oeste de Massachusetts.

Refer to Appendix A for script for the oral consent before conducting the interview.

1. Could you tell us a little about yourself? ¿Podrías contarnos un poco sobre usted?
    a. Where in Costa Rica are you from? ¿De qué parte de Costa Rica eres?
        i. If so, how long have you lived here? Si es así, ¿cuánto tiempo ha vivido aquí?

        ii. If not, where are you from originally? Si no, ¿de dónde eres originalmente?

2. What community do you represent along the Sendero Pacífico? ¿A qué comunidad representa a lo largo del Sendero Pacífico?
    a. How long have you been involved in the community? ¿Cuánto tiempo ha estado involucrado en la comunidad?
    b. Where is it located relative to the trail? ¿En dónde se encuentra en relación con el sendero?
3. What undermarked parts of the trails are most frequently used? ¿Qué partes de los senderos que no están marcados se usan con más frecuencia?
    a. What parts would you like to see more developed? ¿Qué partes te gustaría ver más desarrolladas?
    b. What parts of the trail are adequately marked? ¿Qué partes del sendero están adecuadamente señalizadas?
4. What elements do you look for in signs? ¿Qué elementos buscas en los signos?
    a. Is there a sign format that you have noticed people respond to best? ¿Hay algún formato de letrero del cual haya notado que la gente responde mejor?
5. What kind of materials are easily accessible? ¿Qué tipo de materiales son fácilmente accesibles?
    a. Which kinds are commonly used here? ¿Qué tipo de materiales son comunes en Costa Rica?
6. Is there anything having to do with the current signage you would like to be improved upon?
   ¿Tiene alguna sugerencia sobre cómo mejorar los letreros?

Appendix C. World Trails Network - Trails and Sustainability Task Team Interview Questions

1. Could you tell us a little about yourself? ¿Podrías contarnos un poco sobre usted?
    a. Where in Costa Rica are you from? ¿De qué parte de Costa Rica eres?
        i. If so, how long have you lived here? Si es así, ¿cuánto tiempo ha vivido aquí?
        ii. If not, where are you from originally? Si no, ¿de dónde eres originalmente?
2. What is your role within the WTN organization? ¿Cuál es su papel dentro de la organización WTN?
    a. Are you a part of any other task teams within the organization? ¿Es usted parte de otros equipos de trabajo dentro de la organización?
3. How did you become a part of the Trails and Sustainability Task team? ¿Cómo se convirtió en parte del grupo de trabajo de Trails and Sustainability?
    a. What are the objectives of this team? ¿Cuáles son los objetivos de este equipo?
    b. What specific trails have you worked on? ¿En qué senderos específicos has trabajado?
    c. What has this experience been like, working with this task team? ¿Cómo ha sido esta experiencia, trabajando con este equipo de trabajo?
    d. What impact do you think this team has made on trails across the world? ¿Qué impacto crees que ha tenido este equipo en los senderos de todo el mundo?
4. What is your level of involvement with the trails networks in Costa Rica? ¿Qué tan involucrado está con las redes de senderos en Costa Rica?
    a. Specifically, what is your experience with navigating the Sendero Pacífico, if any? Específicamente, ¿cuál es su experiencia con la navegación del Sendero Pacífico, si alguna?
5. What undermarked parts of the trails are most frequently used? ¿Qué partes de los senderos que no están marcados se usan con más frecuencia?
    a. What parts would you like to see more developed? ¿Qué partes te gustaría ver más desarrolladas?
    b. What parts of the trail are adequately marked? ¿Qué partes del sendero están adecuadamente señalizadas?
6. What are the most important things you think signage should contain? ¿Cuáles son las cosas más importantes que cree que debe contener la señalización?
    a. What international signage systems do you think are effective and why? ¿Qué sistemas de señalización internacional cree que son efectivos y por qué?
    b. Do you think these could easily apply to the Sendero Pacífico? ¿Crees que estos podrían aplicarse fácilmente al Sendero Pacífico?
7. What kind of materials are easily accessible? ¿Qué tipo de materiales son fácilmente accesibles?
    a. Which kinds are commonly used here? ¿Qué tipo de materiales son comunes en Costa Rica?
8. What are some things along the Sendero Pacífico you would like to be improved upon? ¿Cuáles son algunas cosas a lo largo del Sendero Pacífico que le gustaría mejorar?
    a. What do you think of the current trail network? ¿Qué opinas de la red de senderos actual?

b. What do you think about the current signage of the trail network? ¿Qué opinas de la señalización actual de la red de senderos?

Appendix D. Monteverde Community & Business Leaders Interview Questions

1. Could you tell us a little about yourself?
    a. Are you from the Monteverde area or Costa Rica?
        i. If so, how long have you lived here?
        ii. If not, where are you from originally
2. What community do you represent along the Sendero Pacífico?
    a. How long have you been involved in the community?
    b. Where is it located relative to the trail?
3. How did you come into a leadership role within your community?
    a. How long have you been in this leadership role?
    b. What has it been like taking on responsibility in the community?
4. If you are involved with a business, can you please describe the business?
    a. How long has it been around for?
    b. What is your role in this business?
    c. What about the business would you like to showcase?
5. If you are not specific to a business, what businesses would you like to mention or highlight?
    a. What is the business?
    b. How long has it been around for?
    c. What about the business would you like to showcase?
6. How do you view the Sendero Pacífico in your community?
    a. What are some positives about the trail network within your community?
    b. What are some changes you would make with the relationship between the Sendero Pacífico and your community?
7. What things would you like to see highlighted about the community along the Sendero Pacífico?
    a. Any specifics about businesses or local culture?

Appendix E. IRB Approval Letter

The following figure is a copy of the Institutional Review Board (IRB) approval letter for the conduction of our methods.

WORCESTER POLYTECHNIC INSTITUTE

100 INSTITUTE ROAD, WORCESTER MA 01609 USA

Institutional Review Board

FWA #00030698 - HHS #00007374

Notification of IRB Approval

Date:	18-Jan-2022
PI:	Sarah Strauss
Protocol Number:	IRB-22-0302
Protocol Title:	Sendero Pacifico Trail Signs
Approved Study Personnel:	Maynard, Abigail~Strauss, Sarah~Sposato, Michael~Deranian, Malyssa~Pellegrini, Nickolas D~
Effective Date:	18-Jan-2022
Exemption Category:	2
Sponsor*:	

The WPI Institutional Review Board (IRB) has reviewed the materials submitted with regard to the above-mentioned protocol.We have determined that this research is exempt from further IRB review under 45 CFR § 46.104 (d). For a detailed description of the categories of exempt research, please refer to the IRB website.

The study is approved indefinitely unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific approval must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue. You are also required to report any adverse events with regard to your study subjects or their data.

Changes to the research which might affect its exempt status must be submitted to the WPI IRB for review and approval before such changes are put into practice. A full IRB application may be required in order for the research to continue.

Please contact the IRB at irb@wpi.edu if you have any questions.