

Samuel Barton

GEOG 78.01 Final Project

Professor Alvarez Leon

March 14, 2023

### Staying Grounded in the Outdoors: An Investigation of Geospatial Technologies while Hiking

Hiking is an activity which can fully immerse those who participate, connecting them to the ‘wild’ nature and physical beauty of the Earth. This connectivity between one’s mind and body with the natural world is shown to be therapeutic for both physical and mental health as shown by various studies (see Coble, 2003; Goldenberg, 2007; Hull, 1995; Niedermeier, 2017; Nordbø, 2015). In its rawest form hiking only requires comfortable, durable shoes, and a natural area, making it extremely accessible for anyone. There is some debate for what differentiates hiking from other activities such as walking and running, but Goldenberg (2007) asserts that hiking differs from walking and running in that one is usually on a natural trail with various obstacles such as uneven terrain, roots, and rocks rather than on a paved path. Because of these features, people hike slower than they typically walk/run on paved surfaces, and also there is a large sense of adventure in these wild, natural spaces. These wild areas are often distanced from civilization and if some man-made elements exist, they are often subtle and match the ‘rugged’ aesthetic which many hikers find beautiful (Hooker, 2007; Hull, 1995). Due to the remote nature of hiking spaces, safe navigation is a major priority for hikers as many discussed their fear of getting lost due to suboptimal navigational abilities in a study by Coble (2003). Therefore, most technology usage by hikers (but not all) is related to navigation or wayfinding. The technologies

explored in this study fall into four categories: static maps, GPS enabled devices, social media platforms, and physical features on-trail. In one response to my survey questions, a hiker stated, “different navigational techniques have a big effect on your perception of physical space (I. Jackson, Personal Communication, March 12, 2023). In his book *After the Map*, Rankin (2016) defines a term ‘geo-epistemology’ as the changes in the kind of geographic knowledge produced; geo-epistemology is “the difference between knowing your neighborhood through detailed stories, a pictorial guidebook, a map, aerial photographs, the coordinates of a GPS receiver, or simply walking around” (Rankin, 2016, p. 2). This study will explore the geo-epistemology of various technologies and how they enable different forms of spatial perception and wayfinding during hiking. Ultimately, this study discovered that hiking is best enjoyed with minimal digital technologies, preferring non-digital spatial representations which keep hikers grounded in the physical world they seek to enjoy.

## Maps

Although there seems to be a smaller emphasis on static maps in today’s digital society, maps, and specific hiking maps in particular, remain a key form of geospatial technology in hiking. Of the thirteen college students interviewed, nine mentioned using static maps either before hikes to plan, during hikes, or both. I define the term ‘static map’ to refer to maps which do not change; in practice, these could be paper maps or digital maps without a GPS tracking component (see Figures 1 and 2).

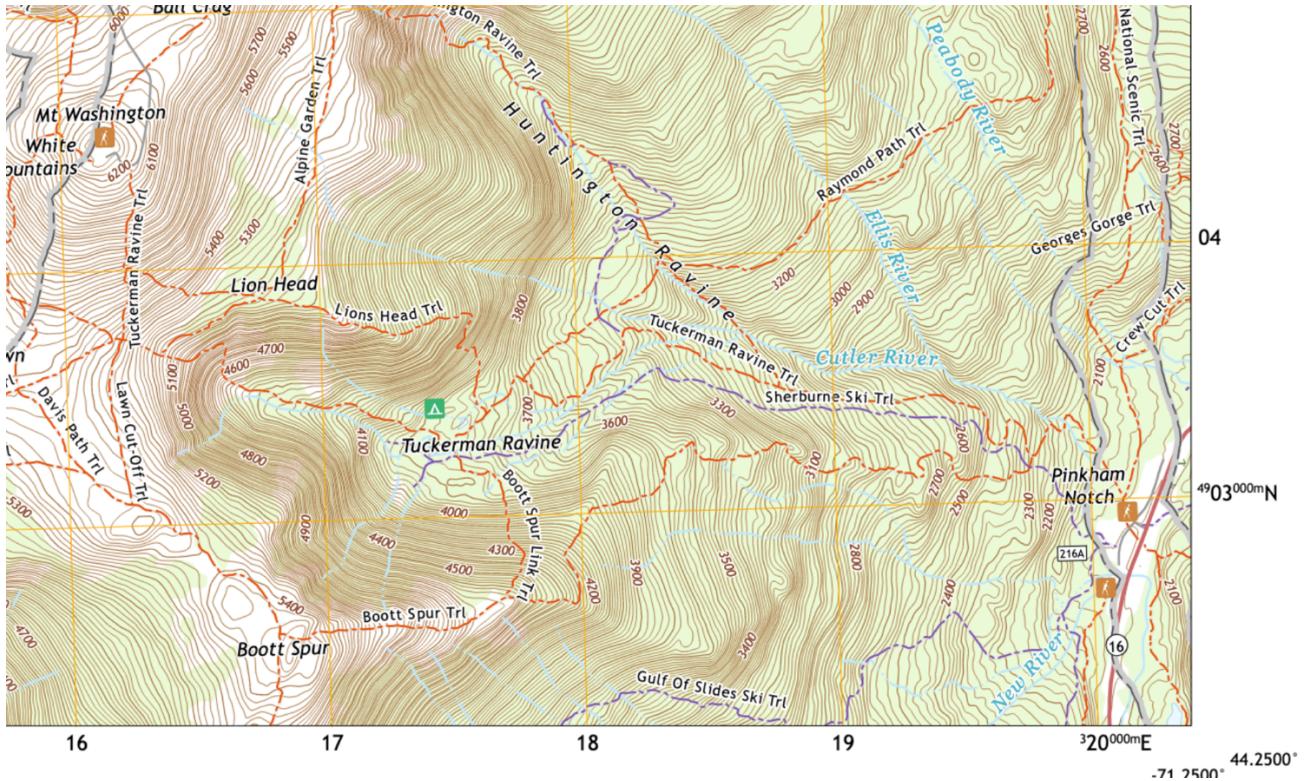


Figure 1 – Paper Map of Tuckerman Ravine Trail from the USGS (accessed digitally from USGS.gov)

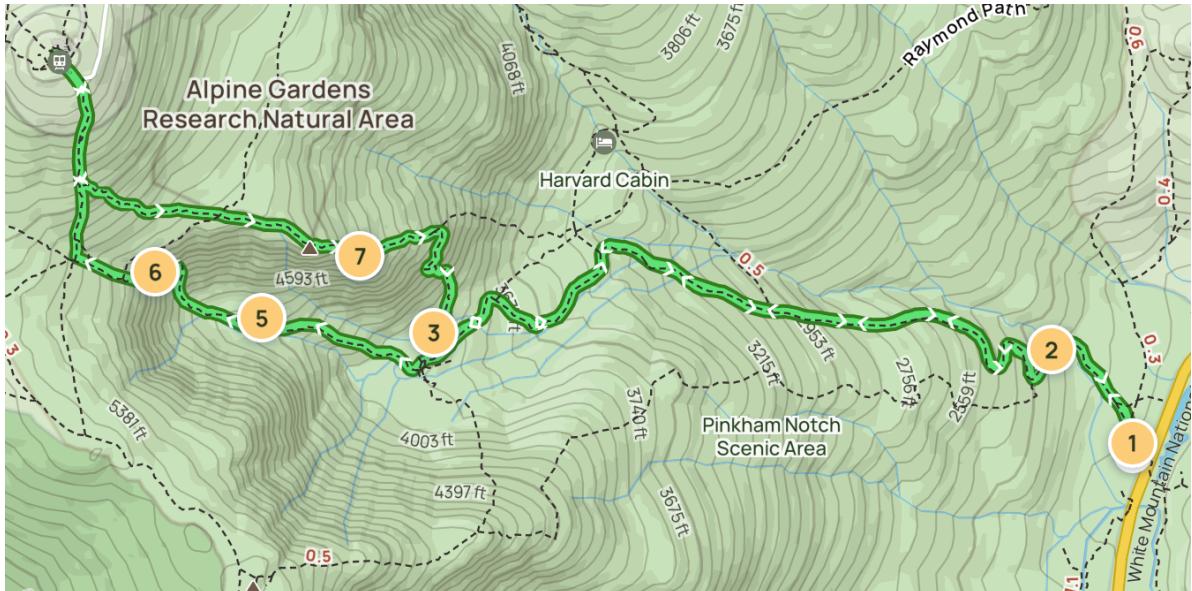


Figure 2 – Digital Map of Tuckerman Ravine Trail with Trail Overlaid (from AllTrails.com) This map is still interactive but is accessed from a desktop computer from afar.

Hikers use maps both in the planning phase of hikes and on for on-trail navigation. There is a learning curve to using maps as a tool for understand terrain and for navigation. Users must

comprehend the cartographic symbols such as topographical lines which signify elevation, dotted lines which denote trails, blue lines which indicate rivers or streams. (Pielot, 2009). However, once a hiker learns cartographic knowledge, instead of lines and colors, he or she will simply see rivers, mountains, cities, and boundaries. With skilled use of maps, Rankin (2016) claims “the world has come to you” (p. 3). On trail, another difficulty with maps is that hikers must orient them with the environment which requires the skill of aligning conspicuous physical features with corresponding cartographical features on the map or using a compass.

Geo-epistemologically, maps widen their focus over a region of interest for the user, and this attribute allows the hiker to identify which features are important, whether it be trails, rivers, or terrain contours. Maps can also shape expectations for hiking experiences. Trails communicate behavioral expectations and tensions by subtly showing hikers which way to travel (Senda-Cook, 2013). One respondent noted that since paper maps show more terrain detail (contour lines, elevations, shading) than GPS apps, he is more thoughtful of the risks attached to the terrain – he is able to assess the entire region, rather than simply the trail he takes (C. Rudge, Personal Communication, March 11, 2023). Another respondent stated that relying on paper maps evokes a sense of the vastness of outdoors while still safely navigating (C. Allen, Personal Communication, March 11, 2023). Furthermore, maps can implicitly tell users where they can and cannot go within the physical space by conveniently omitting off-limits areas such as rangers’ homes in the example of Zion National Park (Senda-Cook, 2013). Because of their low-tech nature and lack of a battery requirement, maps are reliable over long distances. Two respondents noted specifically how they carry paper maps for longer hikes and backpacking in particular because of this reliability (Madeline Wolfe and Ryan Tripp, Personal Communication,

March 11 & 12, 2023). Furthermore, some identified the usefulness of maps as a backup navigational tool to their phone due to their lightweight form and reliability.

Maps are not without their issues for hiking. They require of basic cartographic skills to make maps legible for hikers as mentioned above. Maps are inaccessible to those without knowledge of how to read or orient them. Furthermore, maps are static, and as one respondent noted, this can be “scary” (W. Pinkston, Personal Communication, March 11, 2023). Moreover, one must put faith into the cartographer who created the map to necessitate that it conveys accurate information about the hiking environment. Because of this requirement of accurate survey data, Grant Pinkston asserted that a hiker must buy the right map to avoid navigational problems, and that he finds trail maps to be the most helpful geospatial technology because of this reason (Personal Communication, March 11, 2023).

There have been some studies on how to improve maps for hikers, especially novices. In his 2007 study, Schobesberger compared the effectiveness of 2D vs. 3D maps (see Figure 3) at the trailheads of two popular trails with mixed results. Respondents on both trails generally agreed that 3D maps depict reality better (Schobesberger, 2007). However, the two map types had slightly different strengths for cartographic communication. 3D map users had a better understanding of distances, topography, and environment while 2D map users could better recall place names (Schobesberger, 2007). Maps have been similar for a long time, but it would be interesting to see how they could be improved for modern hikers in terms of accessibility.

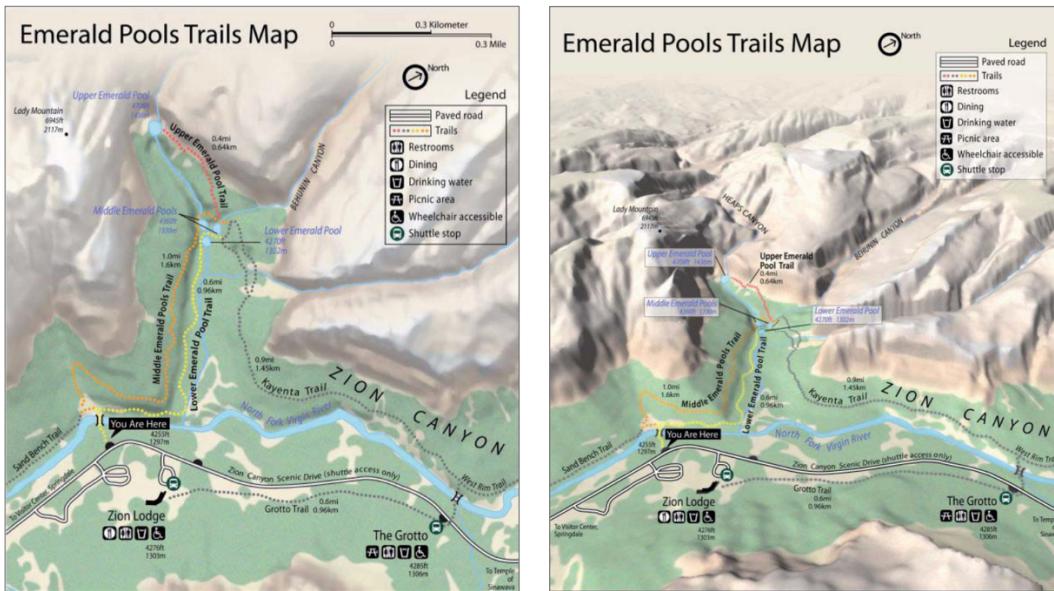


Figure 3 – The 2D Map (Left) and the 3D Map (Right) from the Study (from Schobesberger, 2007)

### GPS Enabled Devices

With the proliferation of smartphones and other small, portable GPS receivers, devices with GPS connectivity and location-based service (LBS) have now entered every facet of our life, including hiking. Computers within these devices provide a fast method of generating and updating maps to consider one's dynamically changing spatial orientation and environmental conditions (Smith, 2021). In a Hyatt's 2021 study of backpackers, when devising hiking routes, 37.9% of participants reported using exclusively digital maps and 58.9% use a combination of physical and digital maps, adding up to 96.8% of hikers using GPS-compatible maps during the process. This trend is amplified for younger respondents (Hyatt, 2021). Thus, GPS-compatible digital technologies continue to take over the hiking world.



Figure 4 – IOS View of AllTrails App While Hiking (accessed from [www.wired.com/story/apps-for-hiking-trails](http://www.wired.com/story/apps-for-hiking-trails))

Due to their popularity, it is unsurprising that GPS-enabled LBSs have numerous benefits for hikers in the wilderness. These advantages include fluidity of communications and access, and GPS technology can even replace learned experience to make life easier for hikers (Hyatt, 2021). Along those lines, GPS is extremely helpful for hikers who do not have the cartographic skills to navigate with a paper map and compass (Smith, 2020). Many participants in my survey are heavy proponents of GPS technologies when they hike. Natalie Vann thinks that she “can’t get lost with a map on [her] phone” (Personal Communication, March 11, 2023). E. Alberts uses the apps AllTrails, Strava, and Google Maps to re-find the trail when he gets lost on hikes (Personal Communication, March 11, 2023). C. Rudge feels much more in control when using GPS apps (Personal Communication, March 11, 2023). M. Wolfe feels “safe and confident” with GPS apps showing her specific location (Personal Communication, March 11, 2023). GaiaGPS

enables K. Friesen to feel capable of going on ambitious hikes where the route is more complex (Personal Communication, March 12, 2023). Evidentially, many hikers use GPS-enabled devices, and feel safe and confident using them.



Figure 5 – A View of GaiaGPS Compatibility Across Mobile Devices (accessed from [gaiagps.com](http://gaiagps.com))

Most of GPS devices' reported weaknesses or flaws are in its geo-epistemological implications in regard to hiking. Rankin (2016) asserts that GPS creates a parallel reality from the physical space: it exists as an intangible space of electronic points that share space with the physical space but does not refer to it. Thus, navigating by GPS means ignoring the physical landscape altogether and placing trust in the coordinates themselves (Rankin, 2016). One survey participant identified this quality as a dangerous flaw: he observed feelings of overconfidence while using GPS apps to navigate as well as feeling out of touch with the physical space;

therefore, he traveled to dangerous areas on his hike simply because the GPS app told him to walk there (C. Rudge, Personal Conversation, March 11, 2023). Furthermore, he had issues with trespassing on private property when using AllTrails because he blindly followed the instructions of the app. These personal anecdotes are backed up in research: Attarian (2002) suggests that technology “may also create a false sense of security, especially if climbers believe that help is just a phone call away.” Participants in my study also observed how they felt that the use of GPS apps took away from their hiking experience in general. R. Tripp notices that he feels more grounded and in touch with surroundings as well as mentally engaged when using maps instead of GPS apps (Personal Conversation, March 12, 2023). E. Alberts finds that limiting the use of GPS navigation systems generally makes him feel more present in the natural space that he is in (Personal Conversation, March 11, 2023). C. Allen avoids apps because they detract from the “rugged” appeal of the hiking experience (Personal Conversation, March 11, 2023). I. Jackson notes how the navigational techniques used with GPS apps can take him out of the physical space because he relies on the technology to do the work for him. (Personal Conversation, March 12, 2023). Research by Shultis (2012) similarly found that excessive reliance on GPS devices may lead to physiological distancing from the activity itself or even to a potentially dangerous lack of knowledge. Rankin (2016) also asserts that GPS coordinates can entirely supersede the familiar geographies of land and water. Finally, many are worried about the technical failures that may accompany the hi-tech features of GPS apps. Implied by the many participants in my survey who bring paper maps as a backup and directly studied elsewhere, battery life is a concern within GPS device users (Johnson, 2021). Furthermore, losing signal is a concern for one participant (W. Pinkston, Personal Conversation, March 11, 2023).

Novel studies have also explored the association between GPS navigation use and brain development, largely finding that the ease of GPS limits memory formation. Dustin (2019) found that relying on technology to navigate in the backcountry means that our brains do not have to do the work of creating our own internal cognitive maps. Similarly, Javadi (2017) found that relying on GPS for navigation purposes diminishes the brains hippocampus function, an important region in memory creation. This limited memory creation leads to limited spatial knowledge, and Ishikawa's (2008) study found that GPS users' configurational understanding of routes was worse than direct-experience participants, and GPS users' topological understanding of routes was also worse. These studies indicate that the ease of GPS apps may come at a cost.

### **Hiking & Social Media Platforms**

Another effect of increased use of smartphones as a tool on hikes besides their role as GPS receivers, is the increased connectivity to the outside world they provide, especially with the universal growth of social media. It would seem that no area of the world is safe from this phenomenon, as internet connectivity continues to grow. Furthermore, many smartphone platforms track your data as you hike, regardless of a network connection, and allow users to share their activity afterwards when they do have connection to the internet. In an age of a need to share every detail of our lives online, hiking is in no way an exception, especially amongst younger generations. The most common platforms used by hikers, and explored by this study, are Strava and online hiking blogs.

Strava is somewhat of a hybrid technology: it provides GPS navigation on-trail, and acts as a social media platform where hikers can share their activity with a vast network of friends and random users of the app. This unique functionality which makes Strava a self-proclaimed 'social fitness tracking app' has wide influence on the users in their activity, be it running,

biking, or hiking, perhaps inadvertently. Studies by Creany (2020) suggest that while Strava has no overt objective to change the behavior of app users, “the gamification mechanisms embedded in the app make use of persuasion techniques and social feedback to ‘[tap] into the basic desires and needs of the users which revolve around the idea of status and achievement.” A few participants in this study’s survey reported using Strava on hikes.

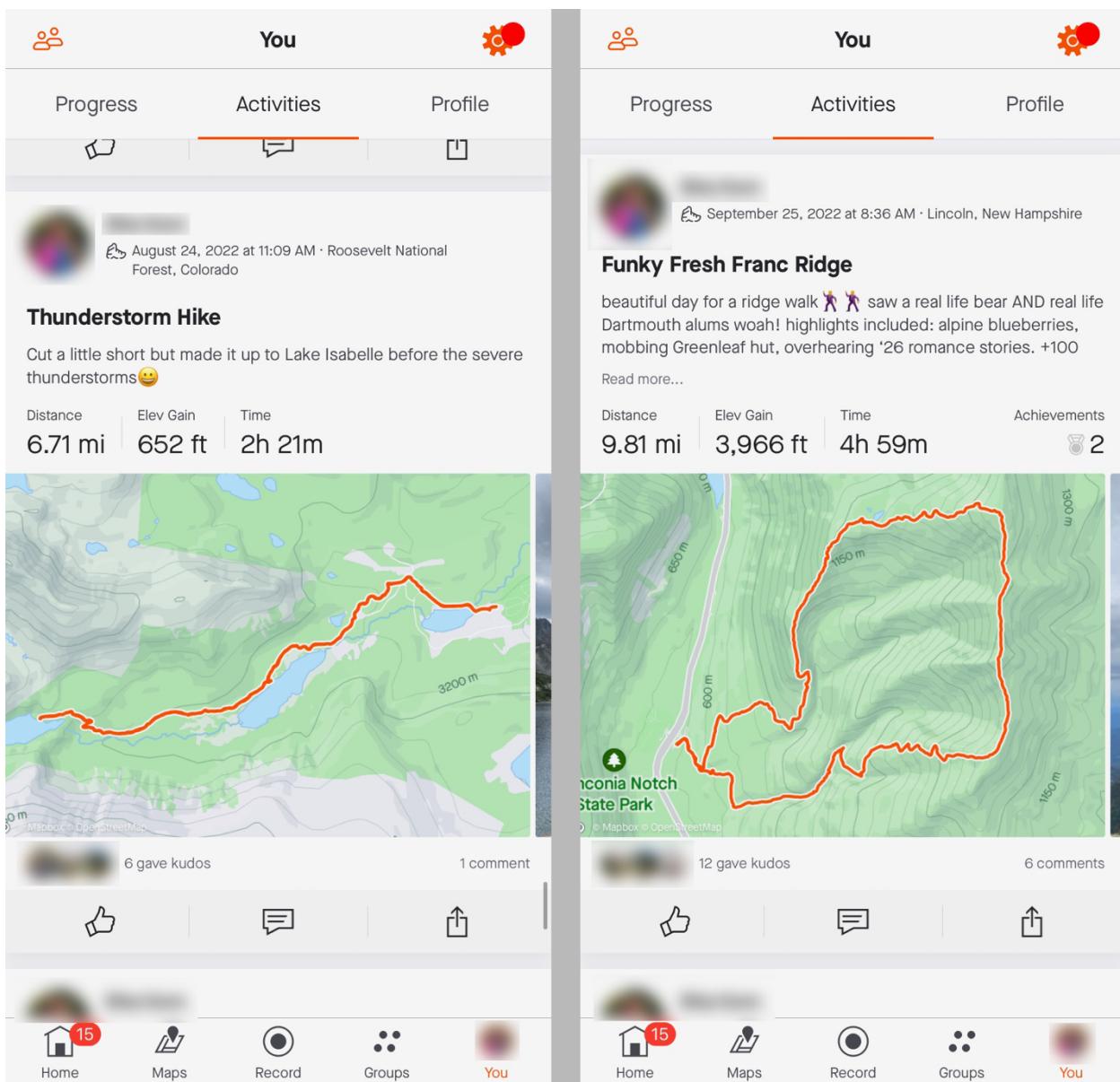


Figure 6 – A Look at Strava’s Activity Feed (personally accessed from the Strava iPhone app)

Hiking blogs are another common way to connect hikers, both regionally and globally, over the internet. Long gone are the days where local hiking organizations were the only way to establish a network of passionate hikers. Through platforms such as Reddit and hiking-specific forums, hikers are able to congregate as online aliases to discuss trail conditions and general information, gear recommendations, pictures from the hike, and simply connect – especially for backpackers on long thru-hikes. In her study of thru-hikers on the John Muir Trail (JMT), a 211 mile thru-hike in California, Hitchner (2019) asserts that the act of engaging with blogs, social media, or other ICTs, is the modern equivalent of the pen and paper used by earlier explorers and naturalists such as John Muir, Henry David Thoreau, and William Bartram. However, this modern platform is fundamentally different in that it can reach many more people much more quickly (Hitchner, 2019). These blogs and forums have become a major piece of the universal hiking community.

Naturally, the inclusion of social media in the previously remote areas of wilderness has widely affected the perception of physical space and general experience of hiking. While using GPS-tracking apps for navigation can take a hiker out of the physical space and into a parallel reality, social media apps can take you out of thinking about any sort of spatial conception altogether, and into a social space. This can have side effects ranging from taking more risks to compete with other users of the platform, to being a good Samaritan of the community and informing future hikers about certain sections of the trail and offering advice. 48.7 % of Strava users cite their primary reason to use the app is due to the social motives to follow friends/group and share achievements (Creany, 2020). By sharing achievements, and the natural tendency of self-comparison with peers, the platform has become an instigator of competition: Creany's (2020) study predicts higher velocities of mountain bikers with than their experience level and

the frequency at which they participate in the activity. This competition factor, and the need to compare one's achievements to others can lead to unnecessary risk-taking during hiking. One participant in my survey cited Strava as motivational tool to finish a hike, because she knew that her followers would see her activity on the app (E. Dunn, Personal Conversation, March 13, 2022). Furthermore, the app's collection of data mid-hike, which it includes in a conspicuous 'tracking screen,' can affect a hiker's priorities throughout their activity. Strava user E. Dunn, notices that she often gets wrapped up in the statistics, as "the space around [her] becomes secondary to information about how long the hike is, how far [she's] gone, or what the map of [her] progress will look like when [she] is done" (Personal Conversation, March 13, 2023). A Strava user may get so concerned with how the log of their activity may look in other users' activity feed, that they become completely removed from the present moment of their hike. Pre-hike however, one participant noted how the review feature of Strava holds helpful information about difficulty and navigational landmarks about a trail he plans to hike (W. Pinkston, Personal Conversation, March 11, 2023). While Strava has both positive and negative implications on hiking, it is evident that it affects the overall experience.

A few researchers have studied the presence of blogs and forums on those committing to thru-hikes. In Dustin's 2019 study, the 514 thru-hikers sampled spent an average of 3 hours and 23 minutes on their smartphones each day, an astonishing amount. The primary uses were for navigation and music, but this time also include taking photographs, social media, texting, and email (Dustin, 2019). This time spent on smartphones is time removed from the physical environment of the hike. In her study of JMT thru-hikers, Hitchner (2019) found that hikers started a blog and wrote entries for several reasons: to keep their family in the loop; convey their motivations and document the physical, mental, emotional, and spiritual rewards; motivate

themselves to complete the hike through self-imposed peer pressure; and personal reasons such as self-reflection. It is evident that blog use had a major effect on the hike itself for thru-hikers. Several bloggers noted social markers such as buttons or gaiters signifying membership in a particular online group, blurring the lines between virtual and real experiences/interactions (Hitchner, 2019). However, a common theme between both studies is that many hikers viewed technology usage as an interference with their experience, and many bloggers wrote in journals and then transcribed to an online blog later for minimal interference (Dustin, 2019; Hitchner, 2019).

### **Physical Features**

Finally, this study explores the interaction between hikers and the physical features found on trails. In fact, trails themselves are a man-made navigational tool which help trail-users to find their way during a hike. Other than trails, other physical features, man-made or not, help guide and shape hikers' experiences; these include trail signs, environmental features, cairns, and trail blazes.



Figure 7 – Trail Sign on Mt. Moosilauke Managed by the Dartmouth Outing Club (accessed from [vthikes.com/hike-the-whites](http://vthikes.com/hike-the-whites)).

As opposed to the technologies explored above, these features are literally embedded within the physical space of the hike itself, and thus produce a spatial representation which is more intimate with the natural environment. Besides being iconic components of a typical hike, these elements can also be a key part of navigation. Eight of thirteen students interviewed specifically reported using trail signs to navigate while hiking. I. Jackson noted that trail signs help him fully engross himself in the physical space while also synergizing with the trail representations he finds on topographical maps (Personal Conversation, March 12, 2023). W. Pinkston noted that trail signs are uniquely useful for estimating distances which are hard to estimate for a windy trail on a map (Personal Conversation, March 11, 2023). E. Dunn notes that the space around her becomes much more immediate and important, and that she pays more attention to the route as it appears in front of her when she navigates by trail signs rather than a screen (Personal Conversation, March 13, 2022). Beyond trail signs, one respondent noted the joy which using cairns (piles of rocks created by hikers on trails to show the way, see Figure 8) to navigate (J. Gart, Personal Communication, March 12, 2022). Combining the landscape with mapping technology, I. Jackson reports using physical features in his surrounding area to correctly orient a topographical map for navigational purposes (Personal Communication, March 12, 2023). Additional studies further back up these findings. One participant in Coble's (2003) study noted that a well-marked trail system with trail signs in strategic locations was the best way of suppressing her fear of getting lost. Smith (2020) found that environmental features, such as paths rivers, ridges, and slopes play a central part in navigation, and that among those, the path is most important because it is a pre-determined way se out by earlier hikers. On the topic grasping one's physical space, Meilenger's (2013) study found that those navigating using their surroundings could best sketch a representation of their general area after their travel. Though it

is clear that hikers feel more immersed when using trail signs, this may come at a risk of navigational failures; N. Vann notes that she feels immersed in the hike when she only uses trail signs, but she gets lost much easier (Personal Conversation, March 11, 2023). Just as this study explored with GPS navigation, using only physical features for navigation may come at a detriment to the hiking experience.



*Figure 8 – Cairns in the White Mountains of New Hampshire (accessed from sectionhiker.com)*

## Conclusion

This study revealed a few major findings regarding technology use and overall hiking experience. First, respondents overwhelmingly reported greater enjoyment when limiting technology use in the wilderness. However, they also indicated feeling much more confident in their navigational skills when they used GPS-based LBSs on their smartphones. This trend was also displayed in the geo-epistemologies of the different technologies. With physical features, and maps to a lesser extent, hikers report feeling grounded in their physical environment which leads to greater satisfaction, and closer to the experience which they seek to produce. On the

other hand, GPS navigational apps and general phone use cause hikers to feel removed and disconnected from their physical environment, and this is reported to be an undesirable effect for most hikers who seek to explore the natural world. One limitation in this study is its treatment of day-hikers and backpackers/thru-hikers as one category. From personal interviews and other research, there is a noted relationship between particular technology use and hiking duration. A future study could explore this nuance further. Overall, since hiking is an activity which both closely relates participants with the physical space which they occupy, and requires various technologies, it is interesting to view how spatial dynamics change with the use of these different tools.

*– A special thanks for the thirteen students who participated in a brief interview for this study*

## Bibliography

- Attarian, A. (2002). Rock Climbers' Self-Perceptions of First Aid, Safety, and Rescue Skills. *Wilderness & Environmental Medicine*, 13(4), 238–244.
- Coble, T. G., Selin, S. W., & Erickson, B. B. (2003). Hiking Alone: Understanding Fear, Negotiation Strategies and Leisure Experience. *Journal of Leisure Research*, 35(1), 1-22. <https://doi.org/10.18666/jlr-2003-v35-i1-608>
- Creany. (2020). *Kudos and K.O.M.'s: the Effect of Strava Use on Evaluations of Social and Managerial Conditions, Perceptions of Ecological Impacts, and Mountain Bike Spatial Behavior*. ProQuest Dissertations Publishing.
- Dustin, D., Amerson, K., Rose, J., & Lepp, A. (2019). The Cognitive Costs of Distracted Hiking. *International Journal of Wilderness*, 25(3), 12-21.
- Goldenberg, M., & Martin, B. (Eds.). (2007). *Hiking and backpacking*. Human Kinetics.
- Hitchner, S., Schelhas, J., Brosius, J. P., & Nibbelink, N. P. (2019). Zen and the art of the selfie stick: Blogging the John Muir Trail thru-hiking experience. *Environmental Communication*, 13(3), 353-365.
- Hooker, R. W. (2007). *Users' Perceptions of The Design and Value of Hiking Trail Systems: A Comparison from National, State, And Regional Parks* (Order No. 1447287). Available from ProQuest Dissertations & Theses Global. (304706874). <https://www.proquest.com/dissertations-theses/users-perceptions-design-value-hiking-trail/docview/304706874/se-2>
- Hull, R. B., & Stewart, W. P. (1995). The Landscape Encountered and Experienced While Hiking. *Environment and Behavior*, 27(3), 404. <https://www.proquest.com/scholarly-journals/landscape-encountered-experienced-while-hiking/docview/1292719360/se-2>
- Hyatt, E., Harvey, M., Pointon, M., & Innocenti, P. (2021). Whither Wilderness? An Investigation of Technology Use by Long-Distance Backpackers. *Journal of the Association for Information Science and Technology*, 72(6), 683–698. doi:10.1002/asi.24437
- Ishikawa, T., Fujiwara, H., Imai, O., & Okabe, A. (2008). Wayfinding with a GPS-Based Mobile Navigation system: A comparison with Maps and Direct Experience. *Journal of Environmental Psychology*, 28(1), 74–82. doi:10.1016/j.jenvp.2007.09.002
- Javadi, A.-H., Emo, B., Howard, L. R., Zisch, F. E., Yu, Y., Knight, R., ... Spiers, H. J. (2017). Hippocampal and Prefrontal Processing of Network Topology to Simulate the Future. *Nature Communications*, 8(1), 14652. doi:10.1038/ncomms14652
- Kotut, L., Horning, M., Stelter, T. L., & McCrickard, D. S. (2020). Preparing for the Unexpected: Community Framework for Social Media Use and Social Support by Trail Thru-Hikers. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–13. Presented at the Honolulu, HI, USA. doi:10.1145/3313831.3376391
- McLaughlin. (2021). Digital and Non-Digital Representations as Actors in the Enactment of Selfhood and Community on the Appalachian Trail. *Social & Cultural Geography*, ahead-of-print(ahead-of-print), 1–18. <https://doi.org/10.1080/14649365.2021.2000015>
- Meilinger, T., Frankenstein, J., & Bühlhoff, H. H. (2013). Learning to Navigate: Experience versus Maps. *Cognition*, 129(1), 24–30. doi:10.1016/j.cognition.2013.05.013
- Niedermeier, M., Einwanger, J., Hartl, A., & Kopp, M. (2017). Affective Responses in Mountain Hiking—A Randomized Crossover Trial Focusing on Differences Between Indoor and Outdoor activity. *PLoS One*, 12(5) <https://doi.org/10.1371/journal.pone.0177719>

- Nordbø, I., & Prebensen, N. K. (2015). Hiking as Mental and Physical Experience. In *Advances in Hospitality and Leisure* (Vol. 11, pp. 169-186). Emerald Group Publishing Limited.
- Pielot, M., Henze, N., & Boll, S. (2009). Supporting Map-Based Wayfinding with Tactile Cues. *Proceedings of the 11th International Conference on Human-Computer Interaction with Mobile Devices and Services*. Presented at the Bonn, Germany.  
doi:10.1145/1613858.1613888
- Rankin. (2016). After the Map: Cartography, Navigation, and the Transformation of Territory in the Twentieth Century. University of Chicago Press.
- Rieser, J. J., Narasimham, G., & Erdemir, A. (2012). Spatial Orientation. In V. S. Ramachandran (Ed.), *Encyclopedia of Human Behavior (Second Edition)* (pp. 519–524).  
doi:10.1016/B978-0-12-375000-6.00341-4
- Sarjakoski, L. T., Kettunen, P., Flink, H.-M., Laakso, M., Rönneberg, M., & Sarjakoski, T. (2012). Analysis of Verbal Route Descriptions and Landmarks for Hiking. *Personal and Ubiquitous Computing*, 16(8), 1001–1011. doi:10.1007/s00779-011-0460-7
- Schobesberger, D., & Patterson, T. (2007). Evaluating the Effectiveness of 2d vs. 3d Trailhead Maps. In *Mountain Mapping and Visualisation: Proceedings of the 6th ICA Mountain Cartography Workshop* (pp. 201-205).
- Senda-Cook, S. (2013). Materializing Tensions: How Maps and Trails Mediate Nature. *Environmental Communication*, 7(3), 355–371. doi:10.1080/17524032.2013.792854
- Shultis, J. (2012). *The Impact of Technology on The Wilderness Experience: A Review of Common Themes and Approaches in Three Bodies Of literature* (Vol. 66). Retrieved from <https://www.fs.usda.gov/treesearch/pubs/40913>
- Smith, T. A., Laurier, E., Reeves, S., & Dunkley, R. A. (2020). “Off the Beaten Map”: Navigating with Digital Maps on Moorland. *Transactions of the Institute of British Geographers*, 45(1), 223–240. doi:10.1111/tran.12336