




Time on the trail, smartphone use, and place attachment among Pacific Crest Trail thru-hikers

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ABSTRACT

Five hundred fourteen (514) surveys were conducted at three intercept points along the Pacific Crest Trail (PCT) in California and Oregon to gather information about time on the trail, smartphone use, and their relationship to thru-hikers' place attachment levels. Ninety-seven (97) percent of the thru-hikers surveyed carried smartphones and reported using them an average of 3 h and 23 min a day. Increased smartphone use was significantly associated with the number of days on the trail. Results indicated further that with increased time on the trail, the thru-hikers' sense of place identity and social bonding increased, while their sense of place dependence decreased. Finally, no relationship was found between smartphone use and place attachment. We conclude by tying the study's results to the extant literature on technology in wildland recreation, and further discuss management implications, limitations of our study, and recommendations for future research.

KEYWORDS

Place attachment; technology; social environment; outdoor recreation; backpacker

Smartphones have the potential to fundamentally alter the way we interact with each other and the world around us (Dustin, Amerson, Rose, & Lepp, *in press*; Jepson & Ladle, 2015; Shultis, 2012). The average American adult checks their smartphone every six and a half minutes (Turkle, 2015), and touches their smartphone screen 2617 times a day (Winnick, 2016). Such habits can lead to many hours per day using the device. In multiple studies, young adults (i.e., ages 18–28) report spending an average of five hours per day on their smartphones (Lepp, Barkley, & Karpinski, 2014, 2015; Lepp, Li, & Barkley, 2016). Use may decrease somewhat with age but remains high. In a recent study of adults aged 18 to 80 (mean age = 40), participants reported using their smartphones an average of four hours per day, and use was negatively correlated with age (Fennell, Barkley, & Lepp, 2019).

One of the biggest concerns surrounding smartphones is their likely distraction from other important endeavors (Dustin et al., *in press*; Vilhelmson, Thulin, & Ellder, 2017). The Displacement Hypothesis posits that substantial use of smartphones and similar forms of social media displace time and attention that would otherwise be given to strengthening human relationships (Kraut et al., 1998; Nie, 2001). Ahn and Shin (2013) found that social media use displaced time that could have been spent developing more

valuable face-to-face relationships, and, therefore, that social media hindered the development of social relationships and encouraged social isolation. Likewise, Lepp et al. (2016) found that problematic smartphone use was negatively related to parent and peer attachment. In explaining their results, the researchers hypothesized that heavy smartphone use displaced face-to-face communication and thereby diminished parental and/or peer attachment. Now that regular smartphone and Internet use is the social norm, the possibility of displacing other common activities may be of great concern to individuals who use these technologies obsessively (Ahn & Shin, 2013). Such individuals are displacing time that traditionally has been spent at meals, in face-to-face conversation, in recreation activities, or in carrying out other responsibilities when fixated on their Internet connected devices (Dustin et al., *in press*; Rasmussen et al., 2015; Synder, Li, O'Brian, & Howard, 2015; Vilhelmson et al., 2017).

At the same time, researchers have also found support for the Augmentation Hypothesis (Valkenburg & Peter, 2007), positing that the use of smartphones and similar forms of social media enhance traditional methods of developing and maintaining social relationships. For example, college students report that enhancing social relationships is a primary motivation for their smartphone use (Lepp, Barkley, & Li, 2017). Jin and Park (2010) found that college students who engage in more face-to-face communication are more likely to augment these interactions with calling and texting on their smartphones. Lepp et al. (2016) found that for female college students, frequency of smartphone calling was associated with enhanced parental attachment, and frequency of texting was associated with enhanced peer attachment. Their same study found no support for the Augmentation Hypothesis for males. In sum, researchers have found that smartphones and related technologies can both displace and augment the development and maintenance of social relationships.

Of particular concern in our study was how smartphones might displace or augment human relationships with the natural environment experienced through outdoor recreation. Shultis (2012) identified five key areas where wildland recreation experiences have been influenced by technology: access/transportation, comfort, safety, information, and communication. Shultis considered technology on a large scale, including everything from lighter weight and more effective equipment to Global Positioning Systems (GPSs), Personal Locator Beacons (PLBs), and mobile phone technology. Twenty years ago, the focus of the conversation was on how modern lightweight equipment was improving accessibility to remote areas (Stinson, 2017), but now there is growing concern regarding the impact of technological devices themselves. Global Positioning Systems, PLBs, and smartphones provide recreationists with a sense of security and appear to be replacing wilderness skills and knowledge with reliance on electronic devices for navigating one's way through recreational wildlands (Dustin, Beck, & Rose, 2017). Mobile phone and Internet use are thus thought to be displacing human-to-human interaction, while simultaneously creating stronger social connections through social media networks.

Place attachment

One established measure that has been used to assess humankind's relationship with the natural environment is place attachment. Place attachment is defined as the emotional,

symbolic, and functional attachments formed between a person and a place (Williams & Roggenbuck, 1989). Williams and Roggenbuck (1989) outlined two dimensions of place attachment: *place dependence* and *place identity*. Place dependence is the functional value of place. In this capacity, an individual is comparing a place to other known places, asking themselves, “Is this the best place for the activity I am engaged in?” (Trentelman, 2009). Place identity is defined as an affective connection to place, where place is rooted so deeply within the individual that it has become part of their identity (Trentelman, 2009). These two dimensions develop independently across time and are associated with different outcomes. Novice recreationists, for example, regularly report higher levels of place dependence because their lower skill level ties them functionally to specific recreation spaces. Bricker and Kerstetter (2000) found this to be the case in novice whitewater rafters who had strong ties to less technical rivers. These place dependent recreationists are often new to a setting with little previous knowledge of it. High levels of place dependence have also been associated with an increased tolerance for crowding (Budruk & Stanis, 2013; Kyle, Graefe, Manning, & Bacon, 2004), and an increased interest in educational opportunities (Kil, Holland, & Stein, 2015).

Place attachment has multiple known positive associations including increased environmentally responsible behavior (Halpenny, 2010; Kaltensborn, 1998; Vaske & Kobrin, 2001), approval of educational spending programs (Kyle, Absher, & Graefe, 2003), and reduced incivilities, such as gang activity within urban neighborhoods (Brown, Perkins, & Brown, 2003).

With the progression of time, repeated visitation to recreation areas, and increase in skill, place identity levels also appear to increase (Bricker & Kerstetter, 2000; Moore & Graefe, 1994). Recreationists who begin to identify with the resource become less tolerant of crowding (Kyle et al., 2004), have a positive attitude toward fee spending programs (Kyle et al., 2003), and demonstrate increased levels of environmentally responsible behavior (Halpenny, 2010; Vaske & Kobrin, 2001). Finally, a key element of strong place identity levels is repeated visitation (Moore & Graefe, 1994), which often means proximate visitors display a stronger emotional attachment than distant visitors (Kil et al., 2015; Lorimer & Lund, 2008; Maddrell et al. 2015; Quinlan-Cutler, Carmichael, & Doherty, 2014).

While place dependence and place identity are the most common dimensions of place attachment, Kyle, Graefe, and Manning (2005) observed the impact of meaningful social relationships and shared experiences on place attachment on the Appalachian Trail, leading to the development and validation of a third dimension of place attachment, *social bonding*. Social bonding has been positively correlated with a desire for knowledge of natural areas as well as learning and teaching initiatives (Budruk & Stanis, 2013). Storytelling has also been found to be an important aspect of social interaction, connecting the teller more deeply to place (Derrien & Stokowski, 2014).

Smartphones and place attachment

Prior to our study, we found only one other study that had investigated the relationship between smartphone use and place attachment. Oleksy and Wnuk (2017) researched how the smartphone augmented reality (AR) game, Pokémon Go, could develop place

attachment in players. The researchers assumed it might be possible for AR to foster place attachment through active contact and exploration, social activity, and joyful experiences in place. Their results indicated that AR games are not significantly related to place attachment except in a social context. Gamers developed strong social attachments through the game by communicating with other players about where to find Pokémon, but the nature of the game did not encourage repeat visitation to place, a key component of the emotional dimension of place attachment (Moore & Graefe, 1994). However, mobile games that do encourage repeat visitation to particular locations have shown development of mildly significant levels of place attachment (Sifonis, 2017).

Given the prevalence of smartphones in recreational wildlands (Beck & Dustin, 2016), the importance of place attachment as an element of wildland recreation (Kil et al., 2015), and the possibility that smartphone use might impact place attachment and its associated positive outcomes (Wick, 2016), the present study aimed to further explore the impact of mobile technology in wildland recreation settings.

Purpose

The purpose of our study was threefold. First, the study was an attempt to describe smartphone use among wildland recreationists in a remote setting and in town. Second, the study examined the relationship between time on the trail and place attachment. Third, the study examined the relationship between smartphone use and place attachment in wildland recreation.

Research Question 1: To what extent are smartphones used by recreationists when in a remote setting and in town?

Hypothesis 1: Recreationists' smartphone use in remote settings and in town will be different.

Second, while researchers have long studied place attachment in outdoor recreation settings and identified temporal relationships between place identity and place dependence, no research has focused on a possible temporal relationship with social bonding, leading to the second research question.

Research Question 2: What is the relationship between time on the trail (number of days on the trail) and place attachment?

Hypothesis 2: Place identity will be positively associated with the number of days on the trail.

Hypothesis 3: Place dependence will not be associated with the number of days on the trail.

Hypothesis 4: Social bonding will be positively associated with the number of days on the trail.

There has also been limited research on a possible relationship between smartphone use and place attachment in wildland recreation. Recalling that researchers have determined that smartphone use may simultaneously displace and augment social relations, including parent and peer attachment, do these relationships extend to place

attachment? We found only one previous study (Oleksy & Wnuk, 2017) that had investigated the connections between smartphone use and place attachment, specifically the social dimension of place attachment. Would research with a sample of wildland recreationists confirm this relationship? This supposition informed the third research question.

Research Question 3: What is the relationship between frequency of smartphone use and place attachment?

Hypothesis 5: Place identity in wildland recreation will be negatively associated with smartphone use (i.e., displacement).

Hypothesis 6: There will be no significant association between place dependence in wildland recreation and smartphone use.

Hypothesis 7: Social bonding in wildland recreation will be positively associated with smartphone use (i.e., augmentation).

Methods

Setting

To address these research questions, this study was conducted along the Pacific Crest Trail (PCT) during the summer of 2018. Hiking the PCT is largely a recreational wildland experience as it stretches 2666 miles from Campo, California to Manning Park, British Columbia. Hikers from across the globe thru-hike the PCT each year. (A thru-hiker is an individual attempting to hike the entire trail in a calendar year, usually over the course of five to six months.) In the last few years, thru-hiking has become increasingly popular for a number of reasons, including the cinematic rendering of Bryson's (1997) *A Walk in the Woods* and Strayed's (2012) *Wild*, as well as the benefits provided by modern technology aiding many outdoor enthusiasts to get farther faster (Borrie, 2000; Pohl, 2006; Stinson, 2017), a key requirement in completing a thru-hike (Moor, 2016). The availability of mobile technologies such as smartphones, GPSs, and PLBs also provides many thru-hikers with an added sense of security (Pope & Martin, 2011). In total, permits to thru-hike the PCT increased from 1879 in 2013 to 7313 in 2018 (PCTA, 2019), making it an ideal setting for this study.

Study design

Data were collected in the summer of 2018 through convenience sampling of PCT thru-hikers via an on-site self-report questionnaire employing Qualtrics software. The data were then uploaded onto a first generation iPad, iPad 2s, and an iPad mini via the Qualtrics Mobile Survey application. Questionnaires were administered in three phases in order to capture PCT thru-hikers during early, middle, and later stages of their thru-hike (see Figure 1).

The first intercept location was mile 265 for northbound hikers (Go, 2013), where Highway 18 intersects the PCT outside of Big Bear, California. The second intercept

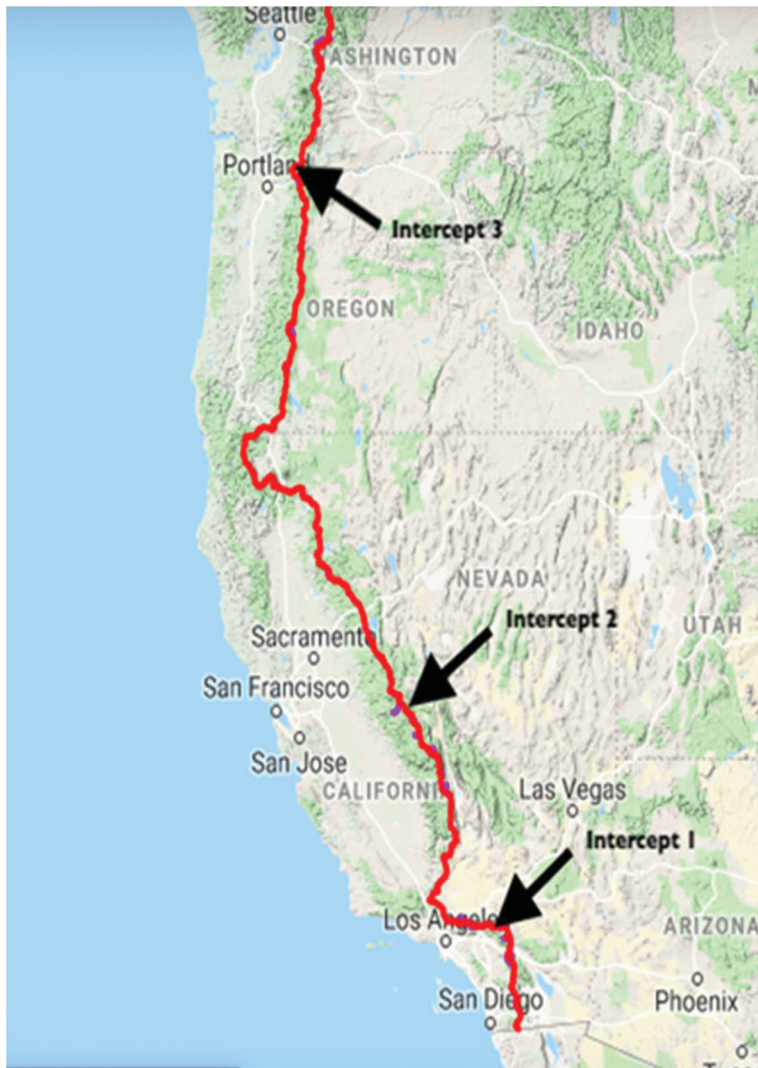


Figure 1. Map of Pacific Crest Trail intercept points.

site, at mile 906 for northbound hikers (Go, 2013), was at Reds Meadow Resort and Pack Station in California's Inyo National Forest. The third and final intercept site was at Cascade Locks, Oregon, during the PCT Trail Days event. This was mile 2153 for northbound hikers (Go, 2013).

Instrument

The questionnaire was divided into three sections: demographic information, smart-phone usage, and place attachment. Seventeen statements were used to measure place attachment: six items measured place identity, six items measured place dependence, and five items measured social bonding. All place attachment items were selected because previous research had found them to be valid and reliable (Raymond, Brown, & Weber, 2010; Williams & Vaske, 2003).

Measures of smartphone use were also constructed based on previous research (Ahn & Shin, 2013; Lepp, 2014). Traditional measures of smartphone use have focused on the number of text messages sent and received daily as well as the number of calls made and received daily. These measures were included in this survey; however, understanding that this traditional measure of smartphone use might not be applicable to wildland recreationists, an additional question was added that measured thru-hikers' self-reported average daily smartphone use. This item included all uses with the exception of taking pictures, because the research team felt picture taking was a direct interaction with the environment, and therefore should be treated as a separate variable. In order to capture how thru-hikers were using their smartphones, an additional 20 individual measures of smartphone use were included to assess how frequently, on a scale from "never" (1) to "sometimes" (3) to "always" (5), thru-hikers used various smartphone applications. These statements asked about the frequency with which thru-hikers used each app on the PCT (remote setting) and in town. This distinction enabled researchers to obtain measures of the thru-hikers' place attachment to the PCT itself and not to towns along the way. The final section of the questionnaire included demographic and recreational history questions.

Data analysis

Using SPSS 24/25, data were first analyzed for descriptive purposes. Multiple paired *t*-tests compared smartphone use on the trail to use in town. Bivariate correlations were then run to investigate relationships between time on the trail, smartphone use, and place attachment on the PCT. Finally, linear regression analysis further explained the relationships between time on the trail, smartphone use, and place attachment to answer the latter two primary research questions.

Results

A total of 514 useable surveys were completed at the three intercept points, with a response rate of 78%. The majority of thru-hikers surveyed were from the United States (71%), male (63%), Caucasian (90%), between the ages of 18 and 37 (71%), well educated, having completed a 4-year college degree or higher (70%), and making <\$75,000 (68%) annually. The vast majority of thru-hikers were carrying a smartphone with them (96.7%), and only 1.9% were not carrying any type of mobile phone. Thru-hikers carrying smartphones reported using them an average of 203 minutes each day ($sd=220$), and almost 5% of the respondents reported using their smartphones 600 minutes each day.

Smartphone use on the PCT and in town

The frequency with which hikers used a variety of common smartphone applications was assessed with a 5 point Likert scale (i.e., 1 = never, 3 = sometimes, 5 = always). As Table 1 shows, PCT smartphone use was focused on trail-related navigation apps ($M=4.01$), taking photos ($M=3.91$), and listening to music ($M=2.81$). Smartphone use in town differed considerably from PCT use, providing support for Hypothesis 1 (Recreationists' smartphone use in remote settings and in town will be different). The

Table 1. Paired T-tests of smartphone use on the trail and in town.

Question Group	Trail <i>M (sd)</i>	Town <i>M (sd)</i>	<i>Sig.</i>
Trail Apps (All)***	4.01 (1.137)	3.04 (1.061)	$p < .001$
Guthooks***	3.93 (1.061)	2.83 (1.260)	$p < .001$
Halfmile's PCT***	1.99 (1.292)	1.47 (.941)	$p < .001$
BackCountry Navigator	1.06 (.384)	1.07 (.398)	$p = .732$
My Topos*	1.05 (.337)	1.06 (.390)	$p = .045$
Social Media			
Facebook***	1.74 (.961)	2.84 (1.314)	$p < .001$
Twitter***	1.07 (.359)	1.21 (.682)	$p < .001$
Snapchat***	1.21 (.584)	1.46 (.939)	$p < .001$
Instagram***	2.01 (1.182)	2.92 (1.489)	$p < .001$
Pinterest***	1.02 (.233)	1.1 (.452)	$p < .001$
Entertainment			
Listening to Music***	2.8 (1.287)	1.77 (.941)	$p < .001$
Playing Games***	1.22 (.612)	1.3 (.731)	$p = .001$
Surfing the Internet***	1.88 (.920)	3.46 (1.066)	$p < .001$
Other			
Taking Photos***	3.9 (1.172)	3.05 (1.216)	$p < .001$
Editing Photos***	2.57 (1.163)	2.96 (1.184)	$p < .001$
Check Email***	1.89 (1.005)	3.26 (1.112)	$p < .001$
Talking on Phone***	1.86 (.949)	2.99 (1.070)	$p < .001$
Video Communication***	1.34 (.678)	2.07 (1.168)	$p < .001$
Expected to be Available***	2.06 (.043)	3.16 (1.172)	$p < .001$
Perceive Accessibility as Stressful***	2.16 (1.140)	2.42 (1.169)	$p < .001$

*indicates $p < .05$; ***indicates $p < .001$.

most common in town uses included surfing the Internet ($M=3.46$), checking email ($M=3.26$), general trail navigation apps ($M=3.05$), taking photos ($M=3.05$), talking on the phone ($M=2.99$), editing photos ($M=2.97$), Instagram ($M=2.92$), Facebook ($M=2.86$), and Guthooks ($M=2.84$). Overall, thru-hikers reported using their smartphones significantly more ($p < .05$) in town than on the trail. The only exceptions were trail navigation apps, listening to music, and taking photos.

Relationships between time on the trail, smartphone use, and place attachment

The place attachment items seemed to be a good fit to this sample (Table 2). Place identity was reliable as the original 6-item measure ($\alpha=0.872$). The original 6-item place dependence measure produced a Chronbach's alpha of 0.652. Internal consistency was improved by removing a single item (i.e., "The things I do on the PCT I would enjoy doing just as much at a similar site") resulting in a Chronbach's alpha of 0.765. The original 5-item social bonding measure, however, was a less reliable fit to this sample ($\alpha=0.354$). Three items did not fit well and were dropped (i.e., "Without my relationships with other thru-hikers on the PCT, I would probably stop hiking;" "I will/do bring my children to this place;" and "I am thru-hiking because a friend or family member is hiking it with me"). Dropping these three items produced a 2-item scale with a Chronbach's alpha of 0.649.

Results of the correlation analysis are presented in Table 3. The three place attachment variables (place identity, place dependence, social bonding) were significantly and positively associated with each other ($r \geq .228$, $p < .001$). In support of Hypothesis 2 (Place identity will be positively associated with the number of days on the trail) and Hypothesis 4 (Social bonding will be positively associated with the number of days on the trail), place identity and social bonding were significantly and positively associated with number of days on the

trail ($r \geq .108$, $p \leq .016$). Hypothesis 3 (Place dependence will not be associated with the number of days on the trail) was not supported as place dependence was significantly and negatively associated with days on the trail ($r = -.128$, $p = .004$). Smartphone use was significantly and positively associated with days on the trail ($r = .240$, $p < .001$). In other words, daily smartphone use increased as hikers spent more days on the trail. Hypothesis 5 (Place identity in wildland recreation will be negatively associated with smartphone use [i.e., displacement]) was not supported by this analysis nor was Hypothesis 6 (There will be no significant association between place dependence in wildland recreation and smartphone use). Smartphone use was not significantly associated with place identity or place dependence ($r \leq .063$, $p \geq .153$). Smartphone use was also significantly and positively associated with social bonding ($r = .150$, $p = .001$).

Because days on the trail were also associated with smartphone use and social bonding, these relationships were examined more rigorously with a multiple regression (i.e., $\text{social bonding} = \text{days on the trail} + \text{smartphone use}$). Results are presented in Table 4 and suggest that the relationship between smartphone use and social bonding was mediated by days on the trail, thereby rejecting Hypothesis 7 (Social bonding in wildland recreation will be positively associated with smartphone use [i.e., augmentation]). In other words, when controlling for days on the trail, the relationship between smartphone use and social bonding was rendered non-significant.

Table 2. Place attachment items and scale reliability (i.e., Chronbach's alpha).

	Mean	SD	Chronbach's alpha
Place identity ($N = 513$)	4.05	0.668	0.872
I feel that the PCT is a part of me	3.79	0.904	
The PCT is very special to me	4.41	0.705	
I am very attached to the PCT	4.03	0.875	
I identify strongly with the PCT	3.82	0.914	
Thru-hiking the PCT says a lot about who I am	3.91	0.957	
The PCT means a lot to me	4.33	0.742	
Place dependence ($N = 512$)	3.26	0.748	0.765
The PCT is the best place for hiking/backpacking	3.27	0.908	
No other place can compare to the PCT	2.98	1.097	
I get more satisfaction out of hiking the PCT than other trails I have hiked	3.57	1.038	
Thru-hiking the PCT is more important to me than thru-hiking other long distance trails	3.37	1.111	
I wouldn't substitute any other location for the PCT for thru-hiking	3.08	1.039	
Social bonding ($N = 512$)	4.29	0.682	0.649
I have a lot of fond memories of the PCT	4.42	0.666	
My relationships with other thru-hikers on the PCT are very special to me	4.17	0.902	

Notes: Scale from 1 (strongly disagree) to 5 (strongly agree). PCT: Pacific Crest Trail.

Table 3. Correlation analysis of time on the trail, smartphone use, and place attachment variables.

		Place Dependence	Social Bonding	Daily PCT Phone Use	Days on Trail
Place Identity	Pearson Correlation	.421**	.499**	.063	.108*
	Sig. (2-tailed)	.000	.000	.153	.016
Place Dependence	Pearson Correlation	1	.228**	.020	-.128**
	Sig. (2-tailed)		.000	.648	.004
Social Bonding	Pearson Correlation		1	.150**	.287**
	Sig. (2-tailed)			.001	.000
Daily PCT Phone Use	Pearson Correlation			1	.240**
	Sig. (2-tailed)				.000

* $p < .05$.

** $p < .01$.

PCT: Pacific Crest Trail.

Table 4. Multiple regression analysis of social bonding.

Variable	Model	B	Std. Error	Beta	T	<i>p</i>
Social bonding	(Constant)	4.023	.051		79.174	.000
	Daily PCT Phone Use	.000	.000	.077	1.745	.082
	Days on Trail	.004	.001	.269	6.103	.000*

**p* < .001.

Discussion

Smartphones are now common in wildland recreation settings (Dustin et al., 2017, *in press*), and effective wildland recreation management requires understanding the role smartphones play in recreationists' experiences and attachments to their surroundings. This study sought to contribute to that understanding by examining the relationships between time on the trail, smartphone use, and place attachment among PCT thru-hikers. Three research questions were addressed: to what extent are smartphones used by PCT hikers when on the trail and when in town, what is the relationship between time on the trail and place attachment, and what is the relationship between smartphone use and place attachment? The following discussion focuses on understanding how the study's results relate to each research question and their associated hypotheses as well as how the results relate to the extant literature.

Of the 514 respondents to our survey, 96.7% carried a smartphone with them and used it on average a reported 3 h and 23 min a day. As hikers spent more time on the trail their smartphone use significantly increased. These findings illustrate the widespread dependence on technology in contemporary life, even on remote trails in wildland settings. As noted in the comparisons between PCT smartphone use and in town smartphone use, even when smartphones are out of range of cell service, they are still used for many purposes, including navigation, listening to music, and taking photos. In town uses are much broader, including surfing the Internet, checking email, calling family and friends, and networking with others via Facebook, Twitter, etc. It follows that today's long distance hikers are connected to the outside world in ways that are very different from the past. Whether this phenomenon is a welcome change or not is debatable. While smartphones may be a valuable safety device, information source, and connector with other thru-hikers up and down the trail, they also may change the nature of long distance hiking in unwelcome ways, including reliance on smartphones for making one's way through wildland settings instead of relying on one's own outdoor skills and abilities to navigate the natural world (Dustin et al., *in press*). Smartphone use also changes recreationists' sense of solitude, a fundamental quality of wildland recreation experiences (Dustin et al., 2017).

Support for research Hypotheses 2 and 4 predicting a positive relationship between time on the trail and a heightened sense of place identity and social bonding also illustrate that long distance hiking is much more of a social experience than it used to be (Kliot & Collins-Kreiner, 2018; Lum, Keith, & Scott, 2019). These observed relationships support the existing place attachment literature and bode well for other outcomes associated with a heightened sense of place attachment, including increased interest in learning more about the environment (Kyle et al., 2003) and enhanced pro-environmental behavior (Vaske & Kobrin, 2001). If more people are choosing to "get back to nature" (Pacific Crest Trail Association, 2019), no matter their technological where-withal, such trends likely support environmental preservation in the long run. As

Chawla (2007, 2009) has noted, people who are exposed to nature are more inclined to take care of it.

At the same time, while days on the trail corresponded to a stronger sense of place identity and social bonding, time on the trail affected place dependence negatively, thus disconfirming Hypothesis 3 that had predicted no relationship. Recalling that place dependence refers to a particular place's importance in facilitating an activity, Moore and Graefe (1994) offered a reasonable explanation for this inverse relationship when they pointed out that "place dependence may develop relatively quickly as long as the setting is convenient and good for a user's chosen activity, whereas the more affective place identity could require longer periods of time to emerge" (Moore & Graefe, 1994, p. 28). In this study, place identity did indeed build over time on the trail while place dependence diminished. This finding could be explained by PCT thru-hikers' increasing familiarity with the trail resulting in less dependence on the functional character of the surrounding environment itself, or it could be explained by the replacement of the functional significance of the immediate environment by the technological support smartphones provide (Dustin et al., *in press*). Navigational apps like Guthooks and Halfmile reduce the need for the immediate environment to facilitate the thru-hike (Moore & Graefe, 1994).

Finally, the absence of a notable relationship between smartphone use and PCT thru-hikers' place attachment (Hypotheses 5, 6, and 7) means that the results of this study could be interpreted as lending support to either the Augmentation or Displacement Hypothesis. Because place identity and social bonding increased with time on the PCT, and because the rate of smartphone use on the PCT also increased with time on the trail, it is reasonable to assume that smartphone use was augmenting the social experience even though this relationship was not statistically significant. At the same time, the average amount of time thru-hikers spent on their smartphones (3 h and 23 min a day) implies that they must have displaced something else they could have been experiencing on the hike due to the distracting nature of smartphone use. Just what that something might have been remains highly speculative, but, as we discuss in the recommendations for future research, it warrants further investigation.

Recognizing the numerous outcomes that have been associated with mobile phone use, it remains puzzling why no significant relationship was found between smartphone use and place attachment along the PCT. Referring again to the place attachment literature, place identity has been shown to be "focused on the importance of the setting independent of their activities" (Moore & Graefe, 1994, p. 27). Perhaps that explains why smartphone use did not correlate with, or explain, variance in place identity, place dependence, or social bonding. What the study did show is that time on the trail—not smartphone use—was related to the three place attachment dimensions.

Management implications

Perhaps the most useful outcome of this study for recreation land managers and others interested in the future of outdoor recreation is the picture it presents of younger generations of outdoor enthusiasts and their preferred mode of finding their way in wildland recreation settings (Schwab, Goldenberg, & Dustin, 2019). No matter how one feels about the appropriateness of smartphones in recreational wildlands, they are likely here

to stay, and more technological advances are likely on the way. How should recreation policymakers, planners, and land managers respond to such technological innovations (Dustin, Beck, & Rose, 2018)?

Given that smartphones will likely become an increasingly common feature in outdoor recreation, it seems that caretakers of these environments should determine how best to take advantage of the technology for educational and experience-enhancing purposes. Relaying both the costs and benefits of relying on smartphones in wildland recreation would be an appropriate start. Utilizing this same technology to communicate the underlying rationale for creating long distance trails like the PCT, the Appalachian Trail, the Continental Divide Trail, and others, and to discuss the principles underpinning the National Park Service mandate and the Wilderness Act, for example, as well as articulating the values expected to be gained from visiting these places with or without one's smartphone, would be valuable information for recreationists to have. This same technology could be employed as well to communicate minimum impact philosophy, Leave No Trace principles, and other information relevant to wildland recreation safety and etiquette.

Limitations of study

In the recreation management place attachment literature, where users are visitors as opposed to residents, place attachment is often a three-dimensional measure of place identity, place dependence, and social bonding (Kyle et al., 2005). Place identity and place dependence measures have been traditional measures of place attachment since Williams and Roggenbuck (1989) began using them as a 16-item measure. Williams and Vaske (2003) narrowed these two measures to 12-items (6-items each) and found them to be both reliable and generalizable, which was true of this research as well. The 6-item place identity measure had a high Cronbach's alpha score of .872. Similar to Williams and Vaske's (2003) research, the place dependence item, "The things I do at X I would enjoy doing just as much at a similar site" had a lower reliability, and the place dependence measure was stronger (.765) after dropping it.

Based on this research, and previous work, the social bonding measure needs further development. Though many researchers have argued that there is a social component to the development of place attachments (Derrien & Stokowski, 2014; Hidalgo & Hernández, 2001; Kyle et al., 2005), it has consistently been a less reliable measure, a pattern that continued with this study. While the place identity and place dependence items have remained almost identical to Williams and Roggenbuck's (1989) original phrasing, there has been more adjustment to the social bonding items with variations in study design and populations sampled. Kyle et al. (2005) developed the social bonding measure as a 4-item measure, and found 2 items to be reliable ("I have a lot of fond memories about X," and "I have a special connection to X and the people who hike along it"). Raymond et al. (2010) built on the work of Kyle et al. (2005), but changed the name of the measure from social bonding to family and friend bonding, and used 5 items (3 specifically related to family, and 2 for friends). Their results found this to be a valid 5-item measure of place attachment, with the 3-item family bonding measure having a Cronbach's alpha score of .72, and the 2-item friend bonding measure having a

Cronbach's alpha score of .83. Given Raymond et al.'s (2010) family/friend bonding measure was five, not four, items, and had a higher reliability score including all items, this measure was chosen for this study and the statements were adapted to the PCT for the questionnaire. However, in the PCT thru-hiking population, the family/friend social bonding measure was significantly less reliable than it had been for Raymond and colleagues, thus suggesting that the social bonding scale needs further development.

Did we choose the correct set of items for this study's sample? Though Kyle et al.'s (2005) items had lower reliability and had to be reduced to two items, their sample consisted of temporary recreationists on the Appalachian Trail (day, weekend, and thru-hikers), a sample that parallels PCT thru-hikers closely. Raymond et al.'s (2010) sample consisted of permanent landholders in rural South Australia, and though their items were more reliable, and all inclusive, that sample and their social relationships had fewer similarities to this study's PCT thru-hiker sample. Given the complexity of social relationships and the role of place in them, this study may have benefited from using Kyle and colleagues' original 4-items, despite their lower reliability scores.

Recommendations for future research

When conducting this survey, thru-hikers were asked two questions related to their perceptions of availability by smartphone and how that availability was associated with stress. For both questions, the thru-hikers answered that their stress was significantly higher ($p < .001$) in town than on the trail. The thru-hikers felt they were expected to be available by smartphone more in town ($M = 3.18$) than on the trail ($M = 2.06$) and that this expectation was stressful ($M = 2.43$ in town, $M = 2.17$ on the trail). This implies that thru-hikers are expecting their trail experience, in part, to be an escape from the stress associated with being available via smartphone technology. At the same time, 97% of the thru-hikers surveyed carried smartphones with them, and used them on average close to 3.5 h a day. This apparent confliction warrants further investigation.

The possibility that smartphone technology somehow distances thru-hikers from the place they are walking through also raises several intriguing researchable questions. What, for example, might thru-hikers be missing when listening to music on the trail? Or what might they be missing when relying on their smartphone to give them advice about where to find water or a good campsite? Might there even be other unanticipated perils when thru-hikers' attention is diverted from the immediacy of the place they are passing through (Dustin et al., *in press*)?

Future research might also benefit from moving away from self-reporting technology use. It is likely that the thru-hikers in this study dramatically underestimated their daily usage. Winnick (2016) used an online platform and an app to capture users' smartphone behaviors more precisely. That study measured how frequently 94 participants touched their Android phone screens over five days, 24 h a day. Everything was recorded; from tapping it to check the time, to online shopping and gaming, to online dating, social media use, and beyond. The average user touched their phone screen 2617 times a day, and high users touched their phone screen more than twice that each day. However, when the study's participants were asked how frequently they thought they touched their phone screen per day, answers were dramatically underestimated,

with common answers closer to 500 touches a day. It is highly likely, then, that self-reported mobile phone use reported in this study also underestimated the actual usage. Future studies might utilize more accurate methods of usage in order to successfully portray the relationship with measured outcomes. This technique may be easier moving forward, as iPhones can now track and average daily screen time sending periodic updates to the user.

The number of smartphone users on long distance trails is so large now that it is difficult to effectively sample non-users for comparison purposes. Ideally, future research might employ an experimental design to better identify causal effects. Based on this study, however, finding a balanced sample of smartphone users and non-users would be extremely difficult, and would require contacting a large number of thru-hikers before they embark on their hike, requiring some to carry a smartphone and others not to.

Future research might also take into account the role of gender, ethnicity, and nationality, among other demographic variables, as possible mediators of the relationship between time on the trail, smartphone use, and place attachment. Perhaps a more significant relationship exists when viewed through a moderator.

Finally, there is the more general question of the role technology plays in wildland recreation. Many wildland recreationists claim to bring technology with them for safety purposes (Pohl, 2006; Pope & Martin, 2011), which is often encouraged by friends and family. If recreationists are keeping friends and family informed of their journey through updates on PLBs and blog updates, how does one's experience influence the attachment of others who are interacting with the place indirectly through technology? Would close friends and family of a PCT thru-hiker show elevated place attachment levels to a place they have never been, but experienced vicariously through another? Similarly, does continued connection with home while on the trail aid thru-hikers' reintegration into the life they have left behind during their trail experience? How does technology during such an experience relate to immediate versus recalled experience (Dustin et al., *in press*)? Barr et al. (2015) reason that the human capacity for memory has been hindered by technology, but could the memory of an experience be enhanced through social media posts, blogs, and technology that reminds one of past events?

Conclusion

This study provided insight into the relationships between time on the trail, smartphone use, and place attachment among thru-hikers along the Pacific Crest Trail. Ninety-seven percent (96.7%) of the thru-hikers surveyed ($N = 514$) carried a smartphone with them, and they used their smartphone on average a reported 3 h and 23 min a day while on the trail. The thru-hikers reported using their smartphones with greater frequency the longer they were on the trail, and the longer they were on the trail the more their place identity and social bonding grew while their place dependency declined. Long distance hiking appears to be an increasingly social experience and smartphones contribute in a variety of ways to the nature of that experience. Whether that will be desirable or undesirable over the long run remains to be seen.

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