

Article

Co-Occurrence of Landscape Values and Activities in Three Protected Areas

Jackie Delie ^{1,*} , Kelly Biedenweg ¹ and Lee K. Cervený ² ¹ Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, OR 97331, USA; kelly.biedenweg@oregonstate.edu² US Forest Service, Pacific Northwest Research Station, 400 N. 34th St., Suite 201, Seattle, WA 98103, USA; lee.cervený@usda.gov

* Correspondence: deliejacqueline3@gmail.com

Abstract

(1) Background: Analyses using participatory GIS (PGIS) data have primarily focused on reporting landscape values (e.g., subsistence, spiritual) or activities (e.g., hunting, meditation) and less frequently on identifying patterns of value and activity co-occurrence. This paper explores whether consistent combinations of landscape values and activities associated with meaningful places identified by visitors—referred to as “bundles”—emerge across protected areas. These bundles represent the cognitive-behavioral components of sense of place. (2) Methods: We used exploratory factor analysis on aggregated PGIS data collected between 2011 and 2017 to identify value-activity bundles across three protected areas administered by the Forest Service in the northwestern United States. (3) Results: We found no universal bundles of landscape values and activities across the protected areas, limiting the ability to describe consistent sense of place bundles. Instead, relationships between landscape values and activities varied across areas. Weak associations between them highlight heterogeneity in how individuals perceive and interact with meaningful places, reflecting the subjective and context-dependent nature of the sense of place. (4) Conclusions: These findings suggest that identifying visitor “types” for outreach and planning may be more nuanced than anticipated. To provide diverse opportunities for visitors to protected areas, planners and decision-makers may need to move beyond standard audience segmentation practices and consider the context-dependent nature of sense of place.

Keywords: environmental psychology; exploratory factor analysis; landscape values; place attachment; sense of place



Academic Editor: Hongxu Wei

Received: 9 June 2025

Revised: 15 July 2025

Accepted: 16 July 2025

Published: 24 July 2025

Citation: Delie, J.; Biedenweg, K.; Cervený, L.K. Co-Occurrence of Landscape Values and Activities in Three Protected Areas. *J. Parks* **2025**, *1*, 3. <https://doi.org/10.3390/jop1010003>

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The development, refinement, and broad adoption of landscape values and activities mapping has drawn attention to meanings people attach to places and the geospatial variation in how they use their environment [1,2]. These participatory geographic information system (PGIS) methodologies have been used in research to elicit values or benefits associated with physical landscapes to understand place attachments among different individuals and groups [3,4]. Analyses of PGIS data have generally focused on the spatial density and diversity of either mapped values or activities, e.g., [5,6]. However, theoretical understandings of sense of place [7] and its subcomponent, place attachment [8], encompass multidimensional aspects of meaning-making through cognitive structures (e.g., landscape

values), experiences (e.g., outdoor activities), and place specifics (e.g., natural features). While sense of place is an inherently subjective individual experience, there are both practical and theoretical benefits in exploring whether population segments share similar types of relationships within specific spaces. Some place-based studies have identified that forms of place attachment and sense of place can be spatially localized or generalized [9,10], and systematic place attachment can be measured through PGIS [7].

Analyzing the relationships between spatially explicit landscape values and uses (e.g., outdoor activities, cultural practices, natural resource uses) provides an opportunity to explore these structural components that shape sense of place. Moreover, and appropriately, most PGIS studies examine landscape values and activities within specific managed land and/or marine conservation areas (e.g., parks, protected areas) to inform policy-relevant decisions [11]. Rarely have scientists explored theoretical questions related to sense of place across multiple PGIS studies. In this paper, we explore landscape values and activities associated with identified meaningful places by visitors to three protected areas.

1.1. Understanding Spatially Explicit Patterns in Human–Environment Relationships

A deeper understanding of human–environment relationships often hinges on the concept of sense of place, which co-develops through the relationships between people and their biophysical environment [7,12]. According to Masterson et al. (2017) [7], sense of place consists of three core components: place meanings, place attachments, and place-related behaviors, with place attachment further divided into place identity and place dependence. The concept of place attachment has long been studied in environmental psychology and human geography, described as the emotional bonds formed between people and places where they live, work, visit, or remember [13]. It was later expanded into a three-dimensional framework that encompasses interactions among person, place, and psychological processes [8]. The “person” dimension encompasses individual attributes such as personal memories, past experiences (e.g., where someone first harvested a deer), or cultural background; the “place” dimension covers the physical and social characteristics of the place itself to which an individual or group is attached; and the “psychological process” dimension involves the cognitive, affective, and behavioral mechanisms that develop attachment. In both Masterson et al.’s (2017) [7] and Scannell and Gifford’s (2010) [8] frameworks, people’s place attachment (and sense of place) are shaped by direct experiences, memories, and shared stories, which begin to assign symbolic importance to a physical location in the process of “meaning making” [14]. Both the physical characteristics of a setting and the lived experiences within it contribute to a person’s place attachment and, subsequently, sense of place [15–17].

While the tripartite view of place attachment (i.e., person–place–psychological process) is widely described, landscape values, such as economic, aesthetic, spiritual, and recreational, have often been used as proxies for place attachment in PGIS studies [9]. These values represent cognitive associations people have with natural landscapes [4,18]. However, using only landscape values as proxies for place attachment can conflate the affective and behavioral dimensions that develop attachment. Specifically, landscape values reflect both the emotional connections individuals have with a place and the ways in which they engage with it, blurring the distinction between affective bonds and the actual behaviors associated with a place [19].

The parallel development of PGIS methods and frameworks for sense of place and ecosystem services has substantially advanced the consideration of human benefits in natural resource and conservation planning [20]. While PGIS is largely methodological, it has been broadly informed by geographic and environmental psychology frameworks of sense of place to explore the interactive meaning-making between people and places,

revealing areas of subjective human importance [4]. These studies typically involve individuals spatially mapping where they derive benefits, including tangible opportunities for use (e.g., work, recreation) and intangible values (e.g., the benefit of knowing a place exists). In contrast, ecosystem services approaches focus on mapping human benefits by modeling the biophysical processes and attributes of ecosystems and their ability to support human well-being, drawing mainly on supply side dynamics and economic theories [11]. Although both PGIS values mapping and ecosystem services mapping contribute to advancing theoretical understandings of human–environment relationships [20], we propose that PGIS methods are particularly well-suited for exploring sense of place bundles, as they emphasize beneficiary-defined values and activities.

Looking for human–environment relationship patterns in PGIS data has commonly focused on spatial hotspots of values that individuals assign to specific places. For example, across a sample population of visitors and residents in the Otways region of Australia, aesthetic, recreation, economic, spiritual, and therapeutic landscape values spatially co-locate with mapped special places [21]. However, focusing solely on values limits our understanding of human–environment relationships to only the affective component of sense of place and overlooks the behavioral component. People often seek to engage in behaviors that align with their values [22], suggesting that value-behavior congruence (e.g., economic values with logging activities or aesthetic values with outdoor art activities) may co-occur in specific locations. Despite this, the assumption of value-behavior correlation has not been fully supported by research, and, to date, we have not seen published analyses of these cognitive-behavioral co-occurrences in PGIS studies. Assessing both assigned landscape values and stated activities within specific spaces would provide a more complete understanding of sense of place bundles based on Scannell and Gifford’s tripartite framework (2010) [8].

The identification of human–environment benefit co-occurrences is more frequently used in ecosystem services analyses, where identifying ecosystem service bundles—sets of co-occurring services within a geographic space—is important for synthesizing large datasets to prioritize conservation locations and strategies [11]. Although some studies have aligned ecosystem services with landscape values, e.g., [4], and others have identified services used by people in a given area, e.g., [23], much of the research on ecosystem service bundles focuses on the co-location of service supply by the natural environment rather than human engagement or the meanings attached to those services [24]. This supply side focus in ecosystem service analyses differs from approaches (e.g., sense of place bundle approach) that focus on understanding cognitive-behavioral congruence associated with places identified by individuals. The ecosystem service bundle approach identifies opportunities to meet human needs, whereas a sense of place bundle approach uncovers cognitive and behavioral interactions within places. The latter offers a more nuanced understanding of people’s preferences, defined by their assigned values and stated actions.

1.2. Conceptualizing Sense of Place Bundles

In this study, we apply the concept of “bundles” to explore the cognitive-behavioral components of sense of place. We do this by examining landscape values (representing cognitive associations) and activities (reflecting behavioral actions) associated with meaningful places identified by visitors to three protected areas. We view “bundles” as frequently co-occurring combinations of landscape values and activities that reveal meaningful associations between visitors and places within an area.

We posit that when completing a PGIS task, an individual identifies meaningful places within a protected area and then assigns landscape values (e.g., economic, spiritual) to those places alongside the activities (e.g., fly fishing, meditation, harvesting berries) they

engage in at those same places. For example, an individual may identify a meaningful place where they go to experience nature and value that place for its environmental health. Alternatively, an individual may identify a place within a protected area for motorized recreational use, such as riding an all-terrain vehicle, and associate that same place with economic value. This approach acknowledges that each individual holds unique values and behaviors toward the places they identify without assuming overlap in geographic identification between individuals. Importantly, this approach does not directly account for specific landscape or environmental attributes (e.g., topography, vegetation type, ecological conditions) of a place or larger area that other PGIS studies may include. Instead, it focuses on how individuals perceive and engage with places based on their associated values and activities. This distinction enables us to study the cognitive-behavioral components of sense of place.

Through this lens, we aim to identify whether value–activity combinations at meaningful places emerge from aggregated PGIS data. Specifically, we address the following questions:

- (a) How variable are place values and activities among a sample population of visitors to protected areas?
- (b) Do consistent cognitive-behavioral sense of place bundles emerge across different protected areas?

Understanding whether values and behaviors are consistently attributed to places is both theoretically and practically relevant. While sense of place is often considered an individual phenomenon, it can also emerge from shared history, traditions, and cultural practices [25,26]. This suggests the potential for common cognitive–behavioral connections to specific places and larger areas. From a practical perspective, identifying these relationships can provide natural resource managers and planners with valuable insights for segmenting visitors to enhance visitation experiences, improve planning processes, and inform conservation strategies [27,28].

2. Materials and Methods

2.1. Study Areas

This paper utilized existing PGIS data collected in three protected areas administered by the U.S. Forest Service (USFS) in the northwestern United States (U.S.). The first study area includes the Olympic National Forest (254,189 hectares) and Olympic National Park (373,383 hectares), both located on the Olympic Peninsula in Washington (Figure 1). The Peninsula’s four counties—Jefferson, Clallam, Mason, and Grays Harbor—have a combined population of 250,445, with residents primarily living in small cities and dispersed rural communities. The Seattle Metropolitan Area, with a population of four million, is a two-hour drive away [29]. The Olympic National Forest is often described as a “doughnut” that surrounds the heart of the Olympic National Park, and a portion of the forest also includes 73 miles of Pacific coastline. Olympic National Forest received 722,000 visits in 2020 [30], while Olympic National Park received an average of three million annual visitors between 2011 and 2023, ranking as the tenth most visited national park in the U.S. in 2023 [31]. The area’s attractions include wilderness beach trails, boreal rainforests, old-growth trees, waterfalls, and well-known steelhead and salmon runs.

The second study area was the Deschutes National Forest (647,500 hectares) in central Oregon (Figure 1). This protected area is located on the eastern slope of the Cascade Range and encompasses Jefferson, Klamath, Lake, and Deschutes counties, which have a combined population of 308,973 residents [29]. The city of Bend, the economic hub of central Oregon, is just a twenty-minute drive away, with a population of 99,178. The Deschutes National Forest received 2.1 million visitors annually in 2018 [30], offering

a range of outdoor recreational activities, including hiking, camping, whitewater use, motorized boating, downhill skiing, camping, and more.



Figure 1. Map of the three northwestern United States protected areas in this study: Olympic National Park and Forest in Washington State, Deschutes National Forest in Oregon, and Ochoco National Forest/Crooked River National Grassland in Oregon.

The third study area was the Ochoco National Forest, spanning 344,401 hectares, located in the Ochoco Mountains of central Oregon (Figure 1). This protected area is located within Crook, Harney, Wheeler, and Grant counties, which have a combined population of 40,917 [29], and is a two-hour drive from Bend. The Ochoco National Forest received 116,000 annual visitors in 2018 [30]. It offers outdoor recreation opportunities, including fishing, hunting, gathering forest products, camping, and horseback riding. The USFS also manages 64% of the land (45,073 hectares) within the adjacent Crooked River National Grassland [32]. For the purposes of this paper’s analysis, the Ochoco National Forest and the Crooked River National Grassland are treated as one protected area due to their adjacent geophysical setting and physical topography.

2.2. Data Collection

The data analyzed in this study were collected by original research teams affiliated with the USFS and partnering institutions; the current authors conducted an analysis using these datasets. Those original teams developed data collection methodologies for each study area to identify places of importance and activity locations, providing insights into visitors’ connections with national forests and informing planning processes. These original research teams employed a PGIS method adapted from Brown and Reed (2009) [5] with modified landscape values. For the Olympic study area, these methodologies are detailed in McLain et al. (2013) [33] and Todd (2014) [34], and Banis et al. (2019) [35] describes the approaches used for the Deschutes and Ochoco study areas. The core methodology was consistent across the study areas, but the approaches to data collection were tailored to the specific context of each study area, as summarized below.

For all study areas, participants (18 years or older) provided verbal or written informed consent. They were reminded that their participation was voluntary, that they could skip questions or withdraw at any time without reason, and that all information would be treated anonymously. Demographic information collected included sex (male, female), year born or age range, and area of residency (ZIP code) for each study area. The Olympic project did not require ethics approval, as it was conducted as an internal study led by USFS researchers in partnership with Portland State University under a Joint Venture Agreement

(#08-JV-11261985-177) and U.S. Forest Agreement (#10-CR-11261975-080). At the time, no formal institutional review board review was required by the university. The Portland State University Office of Research Integrity provided an Institutional Review Board exemption for the Deschutes and Ochoco projects.

The Olympic study area consisted of two data collection phases, conducted in 2011 and 2013. In Phase 1, the original research team facilitated workshops in eight local communities, with group sizes ranging from 10 to 39 participants per workshop [33]. Community leaders and local organizations helped recruit Olympic Peninsula residents with diverse occupational backgrounds and land use interests (e.g., fishing, logging, conservation). Each volunteer participant was asked to identify up to five “meaningful places” on a paper map (scale of 1:750,000) of the Olympic Peninsula with points, lines, or polygons. Then, from a list of 14 landscape values, they were asked to assign a primary value for each identified place, with the option to select up to three additional values, to describe why each place was meaningful to them. They were also asked to describe all the activities they engaged in at each identified place, either by selecting from a list of 34 provided activities or by writing in other activities (as many as they wanted). In Phase 2, the focus shifted to sampling visitors [34]. A researcher approached visitors at various locations around the Olympic Peninsula (e.g., campgrounds, trailheads, visitor centers, ferry dock) and invited them to participate in a survey. Those who agreed were given a paper map (56 × 46 cm) of the area and asked to identify up to five meaningful places using points, lines, or polygons. Participants then selected up to three landscape values (from a list of 14 values, slightly different from those in Phase 1) [34] and described the activities they perform at each identified place, with the option to write in as many activities as needed.

The Deschutes and Ochoco study areas collected data between 2016 and 2017 using two different sampling approaches. The first sampling approach used an interactive online survey [35]. The national forest public affairs staff and Discover Your Forest, a non-governmental organization, used direct outreach to community members, partner organizations, and a targeted list of stakeholders to invite individuals to participate in the online survey. The second approach was a visitor-intercept survey, where staff from Deschutes and Ochoco were equipped with tablets and approached visitors at public events. In both approaches, those who agreed to take the survey (either online or in-person) were asked to identify up to five “important places” in Deschutes and/or Ochoco on a digital map. The map had three fixed zoom scales: 1:63,000, 1:250,000, and 1:800,000. Participants were then asked to assign up to three landscape benefits (referred to as values in this paper) from a list of 11 and describe the activities they engage in at each identified place, with the option of writing in as many activities as needed.

The variations in sampling and implementation across study areas reflect decisions made by the original research teams (as detailed in McLain et al. [33], Todd [34], and Banis et al. [35]) to best engage participants in each context. Differences in recruitment methods, map formats, landscape value lists, and data collection tools were shaped by the specific goals, timelines, and logistical considerations of each project. Each study was co-designed with end-users to reflect local needs and capacities; an approach aligned with best practices in PGIS research. As such, the datasets reflect the realities of applied research, and we aim to analyze whether overarching patterns can be identified within such contexts. Our study does not assume direct comparability across protected areas. Instead, we examine cognitive-behavioral patterns within each protected area and assess if similar bundles emerge across contexts.

2.3. Landscape Value and Activity Categories

To analyze cognitive-behavioral patterns within each protected area using a shared analytical framework, we developed a common set of landscape value and activity categories using thematic analysis methods [36]. We first used deductive coding to compile all landscape values listed on each study area's questionnaire, resulting in an initial codebook of 29 values. This codebook was iteratively reviewed and grouped by all three researchers until we reached eight mutually agreed-upon landscape value categories. We adopted descriptions of landscape values from Brown and Reed (2000) [37] to define these categories.

For categorizing landscape activities, since each study area's questionnaire asked participants to write in their responses to "What activities do you do at this place?", we began with inductive coding of these responses. The codebook underwent several iterations, during which we grouped individually listed activities into broader categories until we reached a consensus on 15 landscape activity categories. We aimed to create categories that closely align with how natural resource management might make decisions regarding visitor behaviors in protected areas. Some landscape activity categories were straightforward, such as "hunting" or "fishing," while others were less obvious such as "motorized recreation," which includes activities such as driving, jet skiing, snowmobiling, motorcycling, and all-terrain vehicle use.

We recoded all landscape values and activities into their respective category (e.g., snowmobiling into motorized recreation) and created dichotomous variables to indicate the presence (1) or absence (0) of each value or activity for meaningful places identified by respondents within the protected areas. By recoding landscape values and activities into this shared typology, we created an internally consistent dataset.

2.4. Analyses

Data was analyzed using SPSS 29.0. Although we harmonized the original PGIS datasets into a shared typology, we analyzed each protected area separately to account for contextual (e.g., ecological attributes, cultural) and methodological (i.e., data collection protocols) differences among the study areas, and did not conduct cross-site statistical comparisons. We ran descriptive frequencies on the demographic variables (i.e., gender, age range) and the recoded landscape value and activity categories for each protected area.

Since we aimed to explore rather than confirm specific sense of place bundles, we conducted three separate exploratory factor analyses (EFA)—one for each protected area—to uncover cognitive-behavioral sense of place components within the dataset. EFA is not a spatial statistical test; rather, it is a multivariate statistical method used to identify latent constructs that explain the relationships among measured variables. This statistical analysis allowed us to explore patterns of association between landscape values and activities tied to meaningful places identified by respondents, ultimately revealing sense of place bundles within each protected area.

We considered alternative analytical approaches, such as cluster analysis, which groups cases (e.g., respondents or places) rather than variables, and multidimensional scaling, which visualizes similarity among variables. However, cluster analysis does not reveal the underlying structure among landscape values and activities, and multidimensional scaling cannot model latent constructs—central to our research objective. While confirmatory factor analysis is used to test theoretical models, our study aimed to identify patterns from the data itself inductively.

EFA has limitations, including sensitivity to sample size, data distribution, and methodological decisions (e.g., number of factors, rotation methods). To mitigate this, we followed best practices: for each protected area, we assessed the suitability of the data for EFA using Kaiser-Meyer-Olkin value greater than 0.60 and the significance of Bartlett's test of

sphericity value ($p < 0.05$) [38]. Once suitability was confirmed, we used the FACTOR program to run an unweighted least-squares factor extraction method using tetrachoric correlations, which is the most recommended procedure for evaluating the relationships among dichotomous variables [39]. We examined parallel analysis and factor eigenvalues (≥ 1.0) to determine the number of factors. Although EFA typically refers to the results as “factors,” we used the term “bundles” to better align with our conceptual framework of sense of place bundles. We applied a normalized promax rotation, expecting some correlations among bundles. Variables with correlation coefficients below 0.30, which are often excluded in EFA [40], we retained to ensure the analysis captured the diversity of values and activities associated with meaningful places.

3. Results

3.1. Respondent Characteristics

A total of 1197 participants contributed to the PGIS data in our study across the Olympic, Deschutes, and Ochoco protected areas. The Olympic study included 509 respondents, with 33% from in-person workshops and 67% from field surveys. Deschutes had 491 respondents, of whom 99% completed an online survey and 1% participated through a field survey. Ochoco included 197 respondents, with 98% from a field survey and 2% from an online survey. Demographic characteristics are summarized in Table 1. Across all protected areas, the largest proportion of respondents were between 45 and 65 years old, and most identified as male. In the Olympic sample, 17 (4%) participants selected both male and female as their gender.

Table 1. Participant demographics by protected area.

Total Respondents	Olympic		Deschutes		Ochoco	
	509		491		197	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Gender						
Female	193	38%	232	47%	90	46%
Male	299	59%	244	50%	99	50%
Male and Female	17	4%				
Nonresponse			15	3%	8	4%
Age						
18–24 yrs	21	4%	8	2%	3	2%
25–34 yrs	61	12%	54	11%	13	18%
35–44 yrs	87	17%	97	20%	35	18%
45–65 yrs	204	40%	177	36%	76	38%
≥66 yrs	138	27%	130	26%	61	31%
Nonresponse			25	5%	9	4%

3.2. Landscape Value and Activity Frequency

A total of 4353 meaningful places were identified by respondents across the three protected areas (Table 2). In the Olympic, 2315 meaningful places were identified, with recreation value being the most frequently assigned to these places, while subsistence value was the least frequent (Table 2). In Deschutes, among 1630 identified meaningful places, aesthetic value was the most assigned, while economic and subsistence values were assigned infrequently (Table 2). In Ochoco, 408 meaningful places were identified, with aesthetic value being the most frequently assigned to these places, while economic value was the least frequent (Table 2).

Table 2. Frequency of landscape values associated with meaningful places identified by visitors in three northwestern United States protected areas.

Total Meaningful Places		Protected Area ^a					
		Olympic ^b		Deschutes ^c		Ochoco ^c	
		2315		1630		408	
Value	Description ^d	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Aesthetic	The sounds, smells, sights of nature or beauty.	992	43%	1203	74%	251	62%
Economic	Provides income and employment opportunities.	311	13%	43	3%	19	5%
Environmental Health	Provides air, clean water, wildlife, or fish habitat.	471	20%	540	33%	149	37%
Heritage	Connects to culture, history, or tradition.	270	12%	110	7%	49	12%
Mental health/Spiritual	Enhances physical or emotional health.	573	25%	577	35%	172	42%
Recreation	Engage in outdoor activities and learning.	1296	56%	1075	66%	199	49%
Social	Connects to friends, family, community.	268	12%	320	20%	59	15%
Subsistence	Provides food/resources to sustain a household.	135	6%	52	3%	57	14%

^a Since participants could select more than one value for each identified meaningful place, the percentage values by protected area do not add to 100%. ^b Olympic = Olympic National Park and Forest. Participants could identify up to 5 meaningful places in Olympic and select up to 4 values for each place. ^c Deschutes = Deschutes National Forest; Ochoco = Ochoco National Forest and Crooked River National Grassland. Participants could identify up to 5 meaningful places in Deschutes and/or Ochoco and select up to 3 values for each place identified. ^d Descriptions of landscape values adopted from Brown and Reed (2000) [37].

Hiking (e.g., walk, backpack, exercise) was the most frequent activity assigned to meaningful places in all three protected areas (Table 3). In Olympic, experience nature (e.g., view scenery, observe wildlife, explore) was the second most common activity assigned to meaningful places, while in Deschutes, non-motorized recreation (e.g., ski, mountain bike, rock climb) was second (Table 3). In Ochoco, camping was the second most frequent activity in meaningful places (Table 3). Since respondents could select more than one landscape value or activity per identified meaningful place, percentage totals for each protected area do not sum to 100% (Tables 2 and 3). See the Supplementary Material Tables S1–S3 for frequency results on bivariate demographics by landscape values and activities.

Table 3. Frequency of landscape activities associated with meaningful places identified by visitors in three northwestern United States protected areas.

Total Identified Meaningful Places		Protected Area ^a					
		Olympic ^b		Deschutes ^c		Ochoco ^c	
		2315		1630		408	
Activity	Examples ^d	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Camping	Recreational vehicle camp, tent camp	351	15%	288	18%	111	27%
Education/Heritage	Environmental education, scientific study, history	97	4%	35	2%	26	6%
Equestrian use	Ride horses, trail ride, horse camp	20	1%	154	9%	40	10%
Experience nature	View scenery, enjoy nature, observe wildlife	382	17%	169	10%	83	20%
Fishing	Fish, fly fish, deep sea fish	231	10%	174	11%	36	9%
Gathering	Mushrooms, berries, firewood, rocks, shellfish	139	6%	21	1%	30	7%
Hiking	Hike, walk, backpack, play, run, health, exercise	1099	47%	815	50%	185	45%
Hunting	Hunt, trap	118	5%	43	3%	92	23%
Motorized recreation	Snowmobile, motorcycle, drive, ATV	70	3%	52	3%	26	6%

Table 3. Cont.

Activity	Total Identified Meaningful Places Examples ^d	Protected Area ^a					
		Olympic ^b		Deschutes ^c		Ochoco ^c	
		2315		1630		408	
		<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Non-motorized recreation	Mountain bike, ski, snowshoe, rock climb	179	8%	457	28%	46	11%
Water recreation	Sail, kayak, canoe, surf, hot springs, swim, boat	243	11%	247	15%	7	2%
Socialize	Visit family, hang out, festivals, picnic	124	5%	55	3%	11	3%
Therapeutic recreation	Church, solitude, peace, meditate, relax, sit	82	4%	69	4%	17	4%
Visual art	Take pictures, paint, create art, wild-craft	136	6%	43	3%	23	6%
Working/Volunteering	Guide, mine, graze, farm, trail maintenance	155	7%	29	2%	12	3%

^a Since participants could select more than one value for each identified meaningful place, the percentage values by protected area do not add to 100%. ^b Olympic = Olympic National Park and Forest. Participants could identify up to 5 meaningful places in Olympic and write any number of activities they do at each place. ^c Deschutes = Deschutes National Forest; Ochoco = Ochoco National Forest and Crooked River National Grassland. Participants could identify up to 5 meaningful places in Deschutes and/or Ochoco and write any number of activities they do at each place. ^d Examples reflect the activities participants wrote in response to “What activities do you do at this place?” after identifying meaningful places. Activities were recoded into broader landscape activity categories, as shown in the left column of the table.

3.3. Sense of Place Bundles Across Protected Areas

The sample included 2315 meaningful places in Olympic, 1630 in Deschutes, and 408 in Ochoco. There were no missing responses because landscape values or activities were either present (1) or absent (0) for each identified meaningful place. The Kaiser-Meyer-Olkin measure of sampling adequacy was slightly above the recommended threshold of 0.60 for the Olympic and Ochoco data, and just below 0.60 for the Deschutes data (Tables 4–6). Bartlett’s Test of Sphericity was significant at $p < 0.001$ for all three protected areas (Tables 4–6), supporting the suitability of factor analysis despite the lower-than-recommended Kaiser-Meyer-Olkin value for Deschutes.

Table 4. Exploratory factor analysis (EFA) results for landscape values and activities associated with meaningful places identified by visitors in the Olympic National Park and Forest.

Sense of Place Bundles Value (V) or Activity (A)	Olympic ^a			
	Bundle 1: Heritage and Social	Bundle 2: Equestrian	Bundle 3: Working Forests and Subsistence	Variable Communality ^b
V—Aesthetic		0.19		0.20
V—Recreation		0.13		0.03
V—Environmental Health		0.11		0.14
V—Economic			0.50	0.45
V—Heritage	0.30			0.08
V—Social	0.32			0.14
V—Subsistence			0.42	0.22
V—Mental health/Spiritual		0.17		0.10
A—Experience nature		0.08		0.01
A—Visual art		0.25		0.06
A—Education/Heritage	0.31			0.14
A—Fishing			0.70	0.46
A—Hunting			1.04	1.00
A—Gathering			0.50	0.27
A—Equestrian use		0.89		1.00
A—Therapeutic recreation		0.32		0.10
A—Water recreation		0.12		0.01
A—Hiking		0.24		0.21
A—Non-motorized recreation		0.10		0.01
A—Motorized recreation			0.46	0.25
A—Camping		0.12		0.02
A—Socialize	0.24			0.10
A—Working/Volunteering			0.31	0.21

Table 4. Cont.

Sense of Place Bundles Value (V) or Activity (A)	Olympic ^a			
	Bundle 1: Heritage and Social	Bundle 2: Equestrian	Bundle 3: Working Forests and Subsistence	Variable Communality ^b
Eigenvalue	3.503	1.821	1.660	
Variance explained of rotated factors	1.019	1.385	2.800	
Proportion (%) of total variance ^c	15.23%	7.92%	7.21%	
Bartlett's statistic	3675.80 (df = 253, $p < 0.001$)			
Kaiser-Meyer-Olkin test	0.61			

^a EFA with an unweighted least-squares factor extraction method using tetrachoric correlations and a normalized promax rotation. Based on data from 2315 meaningful places in Olympic, identified by 509 respondents.

^b Proportion of variation in that variable explained by the three bundles. Communality ranges from 0 (low) to 1 (high). ^c Total cumulative variance = 30.36%.

Table 5. Exploratory factor analysis (EFA) results for landscape values and activities associated with meaningful places identified by visitors in the Deschutes National Forest.

Sense of Place Bundles Value (V) or Activity (A)	Deschutes ^a			
	Bundle 1: Working Forests and Subsistence	Bundle 2: Equestrian	Bundle 3: Connecting to Nature	Variable Communality ^b
V—Aesthetic			0.22	0.07
V—Recreation			−0.18	0.06
V—Environmental Health			0.36	0.12
V—Economic	0.68			0.48
V—Heritage	0.35			0.19
V—Social	0.27			0.10
V—Subsistence	0.69			0.48
V—Mental health/Spiritual		0.10		0.02
A—Experience nature			0.38	0.16
A—Visual art			0.59	0.46
A—Education/Heritage	0.45			0.31
A—Fishing			0.17	0.06
A—Hunting	0.53			0.30
A—Gathering	0.62			0.50
A—Equestrian use		0.98		1.00
A—Therapeutic recreation			0.35	0.20
A—Water recreation		−0.34		0.12
A—Hiking			0.60	0.42
A—Non-motorized recreation		−0.45		0.30
A—Motorized recreation	0.42			0.17
A—Camping		0.19		0.06
A—Socialize	0.47			0.23
A—Working/Volunteering	0.65			0.42
Eigenvalue	3.896	2.160	1.940	
Variance explained of rotated factors	1.568	3.052	1.652	
Proportion (%) of total variance ^c	16.49%	9.39%	8.44%	
Bartlett's statistic	2925 (df = 253, $p < 0.001$)			
Kaiser-Meyer-Olkin test	0.55			

^a EFA with an unweighted least-squares factor extraction method using tetrachoric correlations and a normalized promax rotation. Based on data from 1630 meaningful places in Deschutes, identified by 491 respondents.

^b Proportion of variation in that variable explained by the three bundles. Communality ranges from 0 (low) to 1 (high). ^c Total cumulative variance = 34.32%.

EFAs using an unweighted least-squares factor extraction method suggested a three-bundle structure within each protected area's data, explaining 30.36% of the variance for Olympic, 34.32% for Deschutes, and 41.43% for Ochoco (Tables 4–6). Eigenvalues indicated that the first bundle in each protected area explained 15% (Olympic), 16% (Deschutes), and 23% (Ochoco) of the total variance, respectively. The second and third bundles had eigenvalues of just over 1.50, explaining an additional 7 to 11% of the variance (Tables 4–6). Parallel analysis supported the three-bundle structure for each protected area. Oblique analyses showed small but nonzero correlations between bundles; therefore, we report normalized promax rotation results.

Table 6. Exploratory factor analysis (EFA) results for landscape values and activities associated with meaningful places identified by visitors in the Ochoco National Forest/Crooked River National Grassland.

Ochoco ^a				
Sense of Place Bundles	Bundle 1: Connecting to Nature	Bundle 2: Working Forests and Heritage	Bundle 3: Social and Subsistence	Variable Communality ^b
Value (V) or Activity (A)				
V—Aesthetic	0.55			0.31
V—Recreation			0.25	0.05
V—Environmental Health	0.29			0.09
V—Economic		0.83		0.62
V—Heritage		0.50		0.21
V—Social			0.89	0.51
V—Subsistence			0.36	0.59
V—Mental health/Spiritual		0.21		0.03
A—Experience nature		0.41		0.18
A—Visual art		0.53		0.36
A—Education/Heritage	0.35	0.61		0.41
A—Fishing			0.26	0.19
A—Hunting		0.20		0.43
A—Gathering			0.30	0.27
A—Equestrian use	0.18			0.07
A—Therapeutic recreation		0.50		0.36
A—Water recreation		0.65		0.79
A—Hiking	0.47			0.26
A—Non-motorized recreation		0.37		0.12
A—Motorized recreation			0.68	0.50
A—Camping			0.33	0.09
A—Socialize			0.64	0.72
A—Working/Volunteering		0.86		0.67
Eigenvalue	5.366	2.598	1.566	
Variance explained of rotated factors	1.897	3.671	2.261	
Proportion (%) of total variance ^c	23.33%	11.29%	6.81%	
Bartlett's statistic	1448.8 (df = 253, $p < 0.001$)			
Kaiser-Meyer-Olkin test	0.63			

^a EFA with an unweighted least-squares factor extraction method using tetrachoric correlations and a normalized promax rotation. Based on data from 408 meaningful places in Ochoco, identified by 197 respondents. ^b Proportion of variation in that variable explained by the three bundles. Communality ranges from 0 (low) to 1 (high). ^c Total cumulative variance = 41.43%.

Rotated primary loadings for landscape values and activities varied across protected areas, ranging from 0.08 to 1.04 (Tables 4–6) (see Supplementary Material Tables S4–S6 for all promax rotated loadings). Landscape values and activities with “weak” variable-bundle relationships (<0.30 loadings) contributed minimally to the analysis, as indicated by communalities below 0.40 (Tables 4–6). Generally, the closer a variable’s communality is to one, the better the variable is explained [41]. We observed three cases where estimation artifacts (i.e., Heywood cases) emerged. In the Olympic data, hunting showed a factor loading of 1.04 and a communality of 1.00, and equestrian use showed a communality of 1.00. In Deschutes, equestrian use showed a communality of 1.00. These may reflect overly strong variable-factor associations or model estimation limitations, which are not uncommon in EFAs with dichotomous data. For example, hunting in Olympic had a strong positive correlation with fishing ($r = 0.733$) and economic value ($r = 0.455$). Equestrian use had low to moderate correlations with other variables in Olympic ($r = 0.540$ with social value) and Deschutes ($r = 0.259$ with heritage value), yet its variance was still largely explained by the factor solution. We kept these variables due to their conceptual relevance and the exploratory aim of our study.

Distinct yet generalizable sense of place bundles emerged across protected areas (Tables 4–6). For communication purposes, we labeled these bundles to reflect the predominant landscape values and activities within each.

- **“Heritage and Social”**, bundle 1 for Olympic, reflects the social and cultural connections visitors have with the land. This bundle included places associated with social (loading = 0.32) and heritage (0.30) values, as well as activities education/heritage (0.31) and socialize (0.24).
- **“Equestrian”**, bundle 2 for both Olympic and Deschutes, highlights the importance of equestrian use as a niche activity for visitors, with it being the strongest loading in both Olympic (loading = 0.89) and Deschutes (0.98). In Olympic, other activities—experience nature, visual art, therapeutic recreation, water recreation, hiking, non-motorized recreation, and camping—also loaded onto this bundle but more weakly (all loadings ≤ 0.32). Associated values included mental health/spiritual, aesthetic, recreation, and environmental health, though all showed low loadings (≤ 0.19). In Deschutes, aside from equestrian use, only activities water recreation, non-motorized recreation, and camping showed minor associations (loadings ≤ 0.45), and just the value mental health/spiritual (0.10) grouped under this bundle.
- **“Working Forests and Subsistence”**, bundle 3 for Olympic and bundle 1 for Deschutes, reflects visitors’ utilitarian and subsistence-oriented relationships with the land. In the Olympic, this bundle was most strongly defined by activities such as hunting (loading = 1.04) and fishing (0.70), followed by gathering (0.50), motorized recreation (0.46), and working/volunteering (0.31). It also included the values economic (0.50) and subsistence (0.42). In Deschutes, the top-loading variables were the values subsistence (0.69) and economic (0.68), and the activities working/volunteering (0.65) and gathering (0.62). Other associated activities included hunting (0.53), socialize (0.47), education/heritage (0.45), and motorized recreation (0.42), as well as the values heritage (0.35) and social (0.27).
- **“Connecting to Nature”**, bundle 3 for Deschutes and bundle 1 for Ochoco, reflects visitors’ shared values of nature appreciation but with place-specific activities. In Deschutes, the bundle was defined by the values environmental health (loading = 0.36) and aesthetic (0.22), and activities hiking (0.60), visual art (0.59), experience nature (0.38), and therapeutic recreation (0.35). Recreation value had a weak negative loading (-0.18) with this bundle. In Ochoco, the bundle included the values aesthetic value (0.55) and environmental health (0.29), and was associated with activities hiking (0.47), education/heritage (0.35), and equestrian use (0.18). Hiking was the only common activity grouped under both bundles, with other activities varying between the two protected areas.
- **“Working Forests and Heritage”**, bundle 2 for Ochoco, reflects the multifaceted relationships visitors have with the land, where economic use and wellbeing are intertwined. This bundle was most strongly defined by economic value (loading = 0.83) and working/volunteering (0.86). Other associated values and activities included heritage value (0.50) and mental health/spiritual value (0.21), and activities water recreation (0.65), education/heritage (0.61), visual art (0.53), therapeutic recreation (0.50), experience nature (0.41), non-motorized recreation (0.37), and hunting (0.20).
- **“Social and Subsistence”**, bundle 3 for Ochoco, highlights the interconnectedness of social interaction and resource use for visitors. This bundle was primarily defined by social value (loading = 0.89), followed by the activities motorized recreation (0.68) and socialize (0.64). Other associated values included subsistence (0.36) and recreation (0.25), along with activities camping (0.33), gathering (0.30), and fishing (0.26).

Patterns on how landscape values and activities grouped into bundles were observed across the three protected areas (Tables 4–6). For example, places of subsistence value consistently grouped with the activity motorized recreation: in bundle 3 for Olympic, bundle 1 for Deschutes, and bundle 3 for Ochoco. Places of social value grouped with

socialize: in bundle 1 for Olympic, bundle 1 for Deschutes, and bundle 3 for Ochoco. Places of aesthetic and environmental health value grouped with hiking: in bundle 2 for Olympic, bundle 3 for Deschutes, and bundle 1 for Ochoco. Places of economic value grouped with working/volunteering: in bundle 3 for Olympic, bundle 1 for Deschutes, and bundle 2 for Ochoco. Additionally, places of heritage value grouped with the activity education/heritage: in bundle 1 for Olympic, bundle 1 for Deschutes, and bundle 2 for Ochoco. While recreation value was one of the most frequently assigned values in respondents identified places across protected areas (Table 2), it showed weak associations with bundles (loadings < 0.30) and was inconsistently grouped with activities (Tables 4–6).

Despite these shared patterns, subtle variations emerged across protected areas. For example, equestrian use strongly loaded into the “Equestrian” bundle for Olympic and Deschutes (Tables 4 and 5), even though it appears in only 1% of the places identified by visitors in Olympic (Table 3). In contrast, equestrian use weakly loaded into the “Connecting to Nature” bundle for Ochoco (loading = 0.18, Table 6). Additionally, in Olympic and Ochoco, places associated with fishing and gathering activities are grouped with places of subsistence value (Tables 4 and 6), whereas in Deschutes, fishing is grouped with aesthetic and environmental health values within the “Connecting to Nature” bundle (Table 5).

4. Discussion

Our findings show that place values and activities identified by visitors were highly variable, and cognitive-behavioral “bundles” of sense of place emerged within each protected area but were weak and not fully consistent across the three northwestern U.S. protected areas. While some value-activity associations co-occurred, overall patterns were heterogeneous and context-dependent, reflecting the deeply individual ways visitors perceive and interact with meaningful places.

This limited consistency was evident in the data, where relationships between values and activities associated with meaningful places were neither strong nor stable, as shown by relatively low variable loadings within bundles and modest explained variance in each EFA. Although conventional EFA practice would remove variables with loadings below 0.30 [42], we retained them to support our exploratory objectives. The cumulative variance explained (30.36% to 41.43%) suggests that while certain place-based values and activities are captured through PGIS data, much of the unexplained variance likely reflects individual differences in how visitors perceive and use these protected areas and places within them. As a result, we did not identify fully generalized sense of place bundles across the protected areas. Nonetheless, a few shared patterns of place-based associations did emerge, such as economic value grouping with activity working/volunteering or aesthetic value with hiking, illustrating the subtle and context-specific ways values and activities co-occur. These findings support existing sense of place research, which suggests that a protected area’s attributes can shape users’ cognitive and behavioral patterns, and that there is heterogeneity in how values and behaviors align across individuals [7,43], even within the same protected area.

The relationship between a person and a place is highly subjective [4]; as such, we can expect variability in mapped landscape values among visitors who participated in the studies, even when mapping the same geographic location. This variability in how people value specific places results in dispersed responses or behaviors [7]. For example, Cervený et al. (2017) [43], using qualitative narratives linked to a subset of the same Olympic PGIS dataset used in this study, found that individuals described deeply personal meanings for places within the same landscape. These ranged from spiritual and aesthetic experiences to memories and personal histories, illustrating that mapped landscape values can hold very different underlying meanings for different people, and that fixed value categories

may only partially capture this complexity. Psychological literature suggests that people tend to seek behaviors that concur with their values, yet research shows mixed results for these relationships [22]. Values and behaviors can appear inconsistent, or even conflict with other values a person holds, but such patterns reflect the genuine complexity of cognitive-behavioral interactions rather than simple contradictions. Such interactions may be further shaped by social and contextual factors, including site accessibility, visitation frequency, and socio-cultural influences [44]. In some cases, personal or social values such as the desire to connect with nature, relieve stress, or engage in family activities, may influence behavior more strongly than direct engagement with the ecological attributes of a specific place. Although demographic effects were beyond the scope of this study, characteristics such as socioeconomic status or place of residence may also shape how individuals relate to and use protected areas. Demographic differences could influence the formation of sense of place bundles, particularly within the person-place-psychological process framework [8].

Even with variability in value–activity combinations associated with meaningful places, we observed some internal factoring of cognitive-behavioral patterns. Place-based distinctions likely influenced the co-occurrence of certain landscape values and activities for visitors of the protected areas studied, supporting the person–place–psychological process framework of place attachment proposed by Scannell and Gifford (2010) [8]. All three protected areas have histories tied to natural resource commodities (e.g., ranching, logging, fishing, farming) but are now experiencing a shift toward outdoor recreation and tourism [32]. In Ochoco, economic value was linked to heritage and mental health values, alongside activities experiencing nature, hunting, visual art, education/heritage, therapeutic recreation, water recreation, non-motorized recreation, and working/volunteering. In contrast, in Olympic and Deschutes, economic value was more closely tied to subsistence-oriented values and activities such as hunting, fishing, and gathering (reflected in the “Working Forests and Subsistence” bundle in Olympic and Deschutes, compared to the broader “Working Forests and Heritage” bundle in Ochoco). Equestrian use, despite being associated with only a small fraction of places, emerged as a distinct bundle in Olympic and Deschutes, suggesting that even niche activities can strongly structure sense of place for some visitors. Notably, recreation was among the most frequently assigned values in identified meaningful places, yet it showed weak and inconsistent bundling across protected areas. This suggests that recreation as a value does not always align directly with recreation as a behavior, reflecting its broad and variable interpretation among individuals. This conceptual ambiguity has been noted in previous research, which questions whether recreation functions as a distinct landscape value given its diverse underlying motivations and behaviors [19]. Other protected area attributes, such as size, accessibility, and crowding levels, also likely play a role in shaping which values and activities co-occur. For example, more remote or less accessible protected areas may attract visitors with distinct values and behaviors compared to more popular and accessible areas, influencing the strength and consistency of relationships between values and activities [45]. These place-based variations in cognitions and behaviors are important for understanding variations in social-ecological system dynamics [7].

Although previous PGIS studies have mapped landscape values or ecosystem services separately, e.g., [46], and some have synthesized spatial value data across sites [47], few have statistically examined the co-occurrence of place values and activities as latent constructs. Plieninger et al. (2013) [48], for example, examined bundles of ecosystem services, but these were based on biophysical indicators or land-use patterns, not perceptions or behaviors. By applying EFA to dichotomous PGIS data, our study offers an additional way to explore the cognitive-behavioral components of sense of place. Even with high

within-area variability, understanding how people relate to specific places through both values and behaviors can inform context-specific conservation strategies.

4.1. Management Implications

The localized relationships we observed, especially if found more pronounced in other studies, could help inform protected area planning by integrating patterns of cognitive and behavioral relationships to places. For example, place-based insights can be applied during early planning to detect valued use areas, in communications design to align messaging with locally relevant meanings, or in monitoring to track shifts in how people perceive and interact with specific places. Conservation and natural resource managers are increasingly working to understand their “market niches” [49,50], and similar analytic approaches could help identify common user groups. For example, in promoting hiking in the Deschutes, messaging might emphasize environmental health, whereas in Ochoco, it could highlight aesthetic experiences. These distinctions illustrate how targeted communication can align with the place values and activities associated with a protected area.

Cognitive-behavioral analysis, as demonstrated in this paper, offers a way to “see” how people conceptualize natural spaces beyond what traditional maps reveal. While spatial mapping can show where valued places and specific activities overlap, these types of factor analyses can uncover patterns in how individuals perceive and use spaces. Map data can inform where to prioritize interventions in natural resource management, while cognitive data can reveal how these interventions might better align with visitors’ mental perceptions and behaviors. Thus, this cognitive approach to analyzing PGIS data can yield insights into the shared mental perceptions and behavioral uses of space.

That said, we reiterate that our analysis showed limited cognitive-behavioral consistencies across protected areas, underscoring the complexity of value–behavior relationships. We interpret the weak interactions among individual values and behaviors as indicative of the inherent heterogeneity of sense of place. Our findings support theoretical understandings of sense of place and place attachment as being primary individual and subjective experiences [8], and it emphasizes the importance of integrating social management strategies into the diverse social realities of protected area users.

While audience segmentation can be a valuable approach for tailoring communication frames and management strategies to different visitor groups, e.g., [46,51], our findings caution against over-reliance on fixed visitor archetypes. Instead, planners and managers should maintain flexibility and adaptability, recognizing the diversity of individual experiences in protected areas. For example, the cognitive-behavioral relationships observed in Ochoco, such as the alignment of economic value with heritage and recreation activities, contrast with those in Olympic and Deschutes, where economic value was more closely tied to subsistence activities. Such nuanced differences suggest that efforts to categorize visitors into fixed archetypes may oversimplify the richness of people-place interactions.

4.2. Limitations

This study has several limitations that should be considered when interpreting the findings. First, our dataset was compiled from data collected by the original research teams working across multiple projects in three different protected areas. While the same overall participatory mapping approach was used, the projects differed in objectives, as well as their sampling strategies, data collection methods (e.g., intercept, public meeting, online), map formats, and landscape value lists. These methodological variations limit the direct comparability of data across sites. Although we harmonized the datasets using thematic coding, inconsistencies may still have influenced observed patterns.

Second, the PGIS data are self-reported and rely on participants' subjective perceptions and recollections, introducing potential recall and social desirability bias. Additionally, because participants could assign multiple values and activities to each meaningful place, we could not assess the relative importance of specific value–activity associations.

Third, while EFA is useful for identifying latent patterns, its outcomes are sensitive to factors such as sample size, variable distributions, and modeling decisions (e.g., the number of factors to retain, rotation methods). We retained variables with loadings below conventional thresholds to align with the study's exploratory purpose, but doing so may have reduced the strength of the bundles identified.

5. Conclusions

Rarely has PGIS been used to explore theoretical questions across multiple protected areas. By applying EFA to identify value–activity “bundles,” our study contributes a novel approach to understanding the cognitive and behavioral dimensions of place-based meaning. Our findings highlight the potential of cognitive-behavioral analysis as a tool for revealing localized relationships between landscape values and activities through PGIS data. They also remind us of the importance of nuance in both research and management. The weak and variable place-based value-activity relationships we observed across three protected areas suggest that quantitative approaches alone may not fully capture the intricacies of sense of place. As such, our findings emphasize the importance of mixed-methods research that accounts for the deeply personal and context-specific nature of human–environment interactions to inform inclusive and adaptive conservation planning.

Supplementary Materials: The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/jop1010003/s1>, Table S1: Demographic variable “local” by landscape values and activities associated with meaningful places identified by visitors in three protected areas in the northwestern United States. Table S2: Self-identified gender by landscape values and activities associated with meaningful places identified by visitors in three protected areas in the northwestern United States. Table S3: Age range by landscape values and activities associated with meaningful places identified by visitors in three protected areas in the northwestern United States. Table S4: Exploratory factor analysis (EFA) results for landscape values and activities associated with meaningful places identified by visitors in Olympic National Park and Forest. Table S5: Exploratory factor analysis (EFA) results for landscape values and activities associated with meaningful places identified by visitors in Deschutes National Forest. Table S6: Exploratory factor analysis (EFA) results for landscape values and activities associated with meaningful places identified by visitors in Ochoco National Forest and Crooked River National Grassland.

Author Contributions: Conceptualization, J.D., K.B. and L.K.C.; methodology, J.D., K.B. and L.K.C.; formal analysis, J.D.; data curation, J.D.; writing—original draft preparation, J.D., K.B. and L.K.C.; writing—review and editing, J.D., K.B. and L.K.C.; project administration, L.K.C.; funding acquisition, L.K.C. All authors have read and agreed to the published version of the manuscript.

Funding: Funding for the original data collection in Olympic National Park and Forest was provided by the U.S. Forest Service (USFS), Pacific Northwest Research Station, under a cost reimbursable Agreement (CR- 17CR11261985091), and with contributions from the former Institute for Culture and Ecology and Portland State University. The original data collection for the study in central Oregon was funded by the Pacific Northwest Research Station and the USFS Region 6.

Institutional Review Board Statement: The Olympic project did not receive ethics approval as it was an internal study led by USFS researchers in partnership with Portland State University under a Joint Venture Agreement (#08-JV-11261985-177) and U.S. Forest Agreement (#10-CR-11261975-080) and no formal ethical approval was required from the university review board at the time the study was conducted. The Portland State University Office of Research Integrity provided an Institutional Review Board exemption for the Deschutes and Ochoco projects.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets analyzed in this study are not publicly archived but are available upon request to the authors. Full descriptions of the original studies conducted in Olympic National Park and Forest and in central Oregon, including detailed maps and methodological context, can be found on the Portland State University website: https://pdxscholar.library.pdx.edu/geog_occasionalpaper/. Relevant publications include “Mapping Human Environment Connections on the Olympic Peninsula: An Atlas of Landscape Values [33]” and “Socio-Ecological Interactions in the National Forests and Grasslands of Central Oregon: A Summary of Human Ecology Mapping Results [35]”.

Acknowledgments: Thank you to all project participants and those who worked on these projects, including Rebecca McLain, David Banis, Diane Besser, Alexa Todd, Melissa Poe, Kathy LaPlante, Lis Grinspoon, and Brye Lefler. We are grateful to David Banis for developing the map in Figure 1.

Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Abbreviations

The following abbreviations are used in this manuscript:

PGIS	Participatory Geographic Information System
USFS	United States Forest Service
U.S.	United States
NPS	National Park Service
EFA	Exploratory Factor Analysis

References

1. Sherrouse, B.C.; Clement, J.M.; Semmens, D.J. A GIS Application for assessing, mapping, and quantifying the social values of ecosystem services. *Appl. Geogr.* **2011**, *31*, 748–760. [CrossRef]
2. Tyrväinen, L.; Mäkinen, K.; Schipperijn, J. Tools for mapping social values of urban woodlands and other green areas. *Landsc. Urban Plan.* **2007**, *79*, 5–19. [CrossRef]
3. Brown, G.; Kyttä, M. Key issues and research priorities for public participation GIS (PPGIS): A synthesis based on empirical research. *Appl. Geogr.* **2014**, *46*, 122–136. [CrossRef]
4. Brown, G.; Reed, P.; Raymond, C.M. Mapping place values: 10 lessons from two decades of public participation GIS empirical research. *Appl. Geogr.* **2020**, *116*, 102156. [CrossRef]
5. Brown, G.; Reed, P. Public participation GIS: A new method for use in national forest planning. *For. Sci.* **2009**, *55*, 166–182. [CrossRef]
6. Nielsen-Pincus, M. Mapping a values typology in three counties of the interior Northwest, USA: Scale, geographic associations among values, and the use of intensity weights. *Soc. Nat. Resour.* **2011**, *24*, 535–552. [CrossRef]
7. Masterson, V.; Stedman, R.; Enqvist, J.; Tengo, M.; Giusti, M.; Wahl, D.; Svedin, U. The contribution of sense of place to social-ecological systems research: A review and research agenda. *Ecol. Soc.* **2017**, *22*, 49. [CrossRef]
8. Scannell, L.; Gifford, R. Defining place attachment: A tripartite organizing framework. *J. Environ. Psychol.* **2010**, *30*, 1–10. [CrossRef]
9. Brown, G.; Raymond, C.; Corcoran, J. Mapping and measuring place attachment. *Appl. Geogr.* **2015**, *57*, 42–53. [CrossRef]
10. Lin, C.; Lockwood, M. Forms and sources of place attachment: Evidence from two protected areas. *Geoforum* **2014**, *53*, 74–81. [CrossRef]
11. Meacham, M.; Norström, A.V.; Peterson, G.D.; Andersson, E.; Bennett, E.M.; Biggs, R.; Crouzat, E.; Cord, A.F.; Enfors, E.; Felipe-Lucia, M.R.; et al. Advancing research on ecosystem service bundles for comparative assessments and synthesis. *Ecosyst. People* **2022**, *18*, 99–111. [CrossRef]
12. Tuan, Y.F. *Space and Place: The Perspective of Experience*; University of Minnesota Press: Minneapolis, MN, USA, 1977.
13. Low, S.M.; Altman, I. Place attachment: A conceptual inquiry. In *Human Behavior & Environment: Advances in Theory & Research*; Springer: Boston, MA, USA, 1992; Volume 12, pp. 1–12. [CrossRef]
14. Schroeder, H.W. Preference and meaning of arboretum landscapes: Combining quantitative and qualitative data. *J. Environ. Psychol.* **1991**, *11*, 231–248. [CrossRef]

15. Reineman, D.; Ardoin, N. Sustainable tourism and the management of nearshore coastal places: Place attachment and disruption to surf-spots. *J. Sustain. Tour.* **2017**, *26*, 325–340. [CrossRef]
16. Stedman, R. Is it really just a social construction?: The contribution of the physical environment to sense of place. *Soc. Nat. Resour.* **2003**, *16*, 671–685. [CrossRef]
17. Wynveen, C.J.; Schneider, I.E.; Arnberger, A.; Cottrell, S.; von Ruschkowski, E. Integrating place attachment into management frameworks: Exploring place attachment across the recreation opportunity spectrum. *Environ. Manag.* **2020**, *66*, 248–262. [CrossRef] [PubMed]
18. Rolston, H.; Coufal, J. A forest ethic and multivalue forest management. *J. For.* **1991**, *89*, 35–40. [CrossRef]
19. Biedenweg, K.; Williams, K.; Cervený, L.; Styers, D. Is recreation a landscape value?: Exploring underlying values in landscape values mapping. *Landsc. Urban Plan.* **2019**, *185*, 24–27. [CrossRef]
20. Gottwald, S.; Albert, C.; Fagerholm, N. Combining sense of place theory with the ecosystem services concept: Empirical insights and reflections from a participatory mapping study. *Landsc. Ecol.* **2021**, *37*, 633–655. [CrossRef]
21. Brown, G.; Raymond, C. The relationship between place attachment and landscape values: Toward mapping place attachment. *Appl. Geogr.* **2007**, *27*, 89–111. [CrossRef]
22. Schwartz, S.H.; Cieciuch, J.; Vecchione, M.; Davidov, E.; Fischer, R.; Beierlein, C.; Ramos, A.; Verkasalo, M.; Lönnqvist, J.E.; Demirutku, K.; et al. Refining the theory of basic individual values. *J. Personal. Soc. Psychol.* **2012**, *103*, 663–688. [CrossRef]
23. Plieninger, T.; Torralba, M.; Hartel, T.; Fagerholm, N. Perceived ecosystem services synergies, trade-offs, and bundles in European high nature value farming landscapes. *Landsc. Ecol.* **2019**, *34*, 1565–1581. [CrossRef]
24. Oliver Reader, M.; Eppinga, M.B.; de Boer, H.J.; Petchey, O.L.; Santos, M.J. Consistent ecosystem service bundles emerge across global mountain, island and delta systems. *Ecosyst. Serv.* **2024**, *66*, 101593. [CrossRef]
25. Lewicka, M. Place attachment, place identity, and place memory: Restoring the forgotten city past. *J. Environ. Psychol.* **2008**, *28*, 209–231. [CrossRef]
26. Manzo, L.C.; Perkins, D.D. Finding common ground: The importance of place attachment to community participation and planning. *J. Plan. Lit.* **2006**, *20*, 335–350. [CrossRef]
27. Kil, N.; Stein, T.V.; Holland, S.M.; Kim, J.J.; Kim, J.; Petite, S. The role of place attachment in recreation experience and outcome preferences among forest bathers. *J. Outdoor Recreat. Tour.* **2021**, *35*, 100410. [CrossRef]
28. Wolf, D.; Brown, G.; Wohlfarth, T. Applying public participation GIS (PPGIS) to inform and manage visitor conflict along multi-use trails. *J. Sustain. Tour.* **2018**, *26*, 470–495. [CrossRef]
29. United States Census Bureau. Census Bureau Apportionment Results. 2020. Available online: <https://www.census.gov/data/tables/2020/dec/2020-apportionment-data.html> (accessed on 8 May 2022).
30. United States Department of Agriculture (USDA). USA Forest Service National Visitor Use Monitoring Program. Available online: <https://apps.fs.usda.gov/nvum/results> (accessed on 21 September 2024).
31. National Park Service (NPS). Visitor Use Statistics Dashboard. Available online: <https://www.nps.gov/subjects/socialscience/visitor-use-statistics-dashboard.htm> (accessed on 21 September 2024).
32. U.S. Forest Service. U.S. Department of Agriculture. About the Area–Crooked River National Grassland. Available online: <https://www.fs.usda.gov/r06/ochoco/about-area#:~:text=The%20Crooked%20River%20National%20Grassland,are%20under%20Forest%20Service%20administration> (accessed on 21 September 2024).
33. McLain, R.; Cervený, L.; Besser, D.; Banis, D.; Biedenweg, K.; Tua, A.; Kimball-Brown, S.; Rohdy, S. *Mapping Human-Environment Connections on the Olympic Peninsula: An Atlas of Landscape Values*; Occasional Papers in Geography Series #7; Department of Geography Portland State University: Portland, OR, USA, 2013. Available online: <http://archives.pdx.edu/ds/psu/15667> (accessed on 15 July 2025).
34. Todd, A. *Mapping Sociocultural Values of Visitors on the Olympic Peninsula, Washington*. Master’s Thesis, Portland State University, Portland, OR, USA, 2014. [CrossRef]
35. Banis, D.; McLain, R.; Milligan, A.; Harrell, K.; Cervený, L. *Socio-Ecological Interactions in the National Forests and Grasslands of Central Oregon: A Summary of Human Ecology Mapping Results*; Occasional Papers in Geography Series #8; Department of Geography Portland State University: Portland, OR, USA, 2019.
36. Babbie, E. *The Practice of Social Research*, 15th ed.; Cengage Learning: Boston, MA, USA, 2021.
37. Brown, G.; Reed, P. Validation of a forest values typology for use in national forest planning. *For. Sci.* **2000**, *46*, 240–247. [CrossRef]
38. Tabachnick, B.G.; Fidell, L.S. *Using Multivariate Statistics*, 5th ed.; Allyn Bacon/Pearson Education: Boston, MA, USA, 2007.
39. Lorenzo-Seva, U.; Ferrando, P. Tetra-com: A comprehensive SPSS program for estimating the tetrachoric correlation. *Behav. Res. Methods* **2012**, *44*, 1191–1196. [CrossRef]
40. Nunnally, J.C.; Bernstein, I.R. *Psychometric Theory*, 3rd ed.; McGraw-Hill: New York, NY, USA, 1994.
41. Costello, B.; Osborne, J. Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Pract. Assess. Res. Eval.* **2005**, *10*, 7. [CrossRef]

42. Howard, M.C. A review of exploratory factor analysis decisions and overview of current practices: What we are doing and how can we improve? *Int. J. Hum.-Comput. Interact.* **2016**, *32*, 51–62. [[CrossRef](#)]
43. Cervený, L.; Biedenweg, K.; McLain, R. Mapping meaningful places on Washington's Olympic Peninsula: Toward a deeper understanding of landscape values. *Environ. Manag.* **2017**, *60*, 643–664. [[CrossRef](#)] [[PubMed](#)]
44. Delie, J.; Dietsch, A.M. The sensitivities and adaptive capacity of public lands visitors. *J. Environ. Manag.* **2024**, *352*, 120010. [[CrossRef](#)] [[PubMed](#)]
45. Manning, R.E. *Studies in Outdoor Recreation: Search and Research for Satisfaction*, 3rd ed.; Oregon State University Press: Corvallis, OR, USA, 2011.
46. Raymond, C.; Bryan, B.; MacDonald, D.; Cast, A.; Strathearn, S.; Grandgirard, A.; Kalivas, T. Mapping community values for natural capital and ecosystem services. *Ecol. Econ.* **2009**, *68*, 1301–1315. [[CrossRef](#)]
47. Brown, G.; Fagerholm, N. Empirical PPGIS/PGIS mapping of ecosystem services: A review and evaluation. *Ecosyst. Serv.* **2015**, *13*, 119–133. [[CrossRef](#)]
48. Plieninger, T.; Dijks, S.; Oteros-Rozas, E.; Bieling, C. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy* **2013**, *33*, 118–129. [[CrossRef](#)]
49. Cervený, L.; Derrien, M.; Miller, A.B. *A Research Strategy for Enhancing Sustainable Recreation and Tourism on Public Lands*; General Technical Report, Pacific Northwest Research Station. PNW-GTR-991 U.S.; U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: Portland, OR, USA. [[CrossRef](#)]
50. Armatas, C.A.; Campbell, R.M.; Watson, A.E.; Borrie, W.T.; Christensen, N.; Venn, T.J. An integrated approach to valuation and tradeoff analysis of ecosystem services for national forest decision-making. *Ecosyst. Serv.* **2018**, *33*, 1–18. [[CrossRef](#)]
51. Deng, J.; Li, J. Segmentation of nature-based tourists in a rural area (2008–2009): A single-item approach. *Sustainability* **2019**, *11*, 2052. [[CrossRef](#)]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.