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Relatively Wild Urban Parks Can Promote Human Resilience and Flourishing: A Case Study of Discovery Park, Seattle, Washington

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Human interaction with nature is vital for physical health and mental well-being, and positions a community to be resilient to urban stressors. Yet urban development continues to put pressures on natural areas within urban boundaries. As a case in point, Seattle's largest park, Discovery Park, of over 500 acres, is often under threat of some form of development. The central question of this study was whether the benefits to visitors of Discovery Park depend, in no small measure, on the park's very size and relative wild landscape. Toward addressing this question, 320 participants provided written narratives (through our web portal) about the meaningful ways in which they interacted with nature at Discovery Park. Each individual narrative was then analyzed and coded using an Interaction Pattern (IP) approach, which provides characterizations of human-nature interaction that have ontogenetic and phylogenetic significance. Results revealed 520 Interaction Patterns (IPs). The most frequently occurring IPs clustered under the keystone IPs of *Encountering Wildlife* (27%), *Following Trails* (14%), *Walking to Destination Spots in Nature* (8%), *Gazing out at the Puget Sound or Mountains* (6%), *Walking Along Edges of Beach or Bluffs* (5%), and *Walking with Dogs* (4%). Results also revealed that visitors' meaningful interactions with nature in Discovery Park depended on the park's relative wildness. For example, (a) 77% of participants' IPs depended on Discovery Park's relative wildness; (b) of the participants who specified an especially meaningful experience with nature, 95% of them had an interaction that depended on Discovery Park's relative wildness; and (c) of the participants whose IPs were linked to other aspects of the nature in the park or to their own positive mental states, 95 and 96%, respectively, had an interaction that depended on Discovery Park's relative wildness. Discussion focuses on how human interaction with large and relatively wild urban parks helps reverse the trend of environmental generational amnesia, and a domination worldview, and thus should be prioritized in urban planning.

Keywords: urban parks, nature and health, interaction patterns, environmental generational amnesia, rewilding, urban sustainability, human resilience and flourishing

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INTRODUCTION

Large urban parks can provide important buffers to the stressors of city living (Hartig and Kahn, 2016; Wood et al., 2018). Such effects have been shown in even some of the largest cities of the world, such as in New York City (Sain-Baird, 2017) and Beijing (Hongxiao et al., 2017), and fit within a growing body of research that show that interaction with nature benefits people physically and psychologically. These benefits are not trivial. As reviewed by Frumkin et al. (2017) and Bratman et al. (2019), interaction with nature has been shown to reduce stress, depression, aggression, ADHD symptoms, rumination, and obesity, and to improve immune function, eyesight, mental health, and social connectedness.

One might think, based on this body of research, that cities would seek to keep as much park land undeveloped as possible, so as to provide residents a natural buffer to urban stressors. However, most cities worldwide continue to grow in population, and thereby put increasing pressures on basically all available open lands to be developed (Semuels, 2017).

This tension—between wanting large urban parks to remain undeveloped, while wanting to develop some of the open space in these parks to address other pressing urban needs—characterizes the situation that has been happening in Seattle, Washington. The open space involves Seattle's largest park, Discovery Park, which encompasses over 500 acres, and almost 12 miles of walking trails. This park was created in the early 1970's, and enjoined with a Master Plan for its protection. For example, in the section of the Master Plan that states the park's primary role, it says:

> The seclusion of the site, the magnificent vistas, the stretches of tidal beaches, the stands of native trees, the meadowlands—all combine to make this site one of surpassing beauty and serenity… The primary role of this park… should be to provide an open space of quiet and tranquility for the citizens of this city—a sanctuary where they might escape the turmoil of the city and enjoy the rejuvenation which quiet and solitude and an intimate contact with nature can bring (Kiley et al., 1972, p. 4).

Yet while the Master Plan's charter for "open space of quiet and tranquility" may seem fine by itself, people who are pro-development often believe that it needs to be interpreted within the context that Seattle is one of the fastest growing cities in the US. With this growth has come many common urban challenges and problems, including traffic congestion and often gridlock, increasing costs of living (especially for housing), income inequality, homelessness, and opioid and other substance addictions. Thus, sometimes people, including politicians and those in other public agencies, believe that the open land of Discovery Park is underutilized, and that at least some of it could be better used to mitigate Seattle's urban problems. For example, one Seattle City Council member stated that Discovery Park "seems like the perfect place" to address the city's need to build affordable housing (The Debate Over Housing at Discovery Park, 2017).

More generally, people in Seattle who are pro-development often maintain one or more of these 4 propositions regarding parks and other open lands: (i) the city needs more development to accommodate an increasing population, (ii) the city benefits economically and culturally from development; (iii) in a proposed new development (e.g., for affordable housing or a new music and art center), just a little more open land is being developed; and thus (iv) surely the open land that will remain is enough to satisfy the basic needs of people in Seattle for urban nature.

Against this backdrop, one goal of this study was to understand how people who visit Discovery Park interact with and value the nature in the park. One possibility is that most of their interactions and values involve the most domesticated parts of the park. Such a result would lend support to the view that other more wild parts of the park could be developed without adverse effects to the visitors. Another possibility is that visitors' uses and values depended on the park's comparatively large size and relatively wild nature. If this result was the case, it would lend support to the original charter of the park, that it never be developed.

Our basic research method was to ask visitors at the park, once they were home, to enter our online web portal and (in addition to providing some demographic information) to write a few sentences to a few paragraphs that would describe at least one meaningful experience they had interacting with nature at the park. Thus, our data comprised their qualitative written experiences; and our challenge was to systematically characterize and then code and quantify those experiences, so as to address our main goal.

Toward this end, we employed what Kahn and colleagues call an Interaction Pattern Approach (Kahn et al., 2010, 2012, 2018a,b). In brief, interaction patterns refer to characterizations of essential features of interaction between humans and nature, specified abstractly enough such that countless different embodied versions of each one can be uniquely realized given different types of nature, people, and purposes.

To convey the idea of an interaction pattern more informally, think of a meaningful nature experience in your own life. What were you doing? What was the nature you were interacting with? Next try to describe what you were doing with a verb, preposition, and a nature noun in such a way that you could envision engaging in many different examples of this interaction and yet they would all be this same form. That characterization is likely an interaction pattern. For example, it is wonderful to walk along the edge of a lake or along a river. This interaction pattern has been named *walking along the edges of water*. Notice that this pattern can be enacted in countless different environments: walking along the seashore or walking around a lake in the city. It can be enacted walking alongside a public fountain that is designed to allow for this form of interaction. Each enactment of an interaction pattern is different—and can embody attributes that are more urban or more wild—but each pattern shares this common feature that you can easily recognize the pattern whenever it occurs.

Our idea of interaction patterns draws from Christopher Alexander and his colleagues work in architecture wherein they developed 253 design patterns (Alexander et al., 1977; Alexander, 1979). According to Alexander, each pattern describes a solution to a problem wherein the solution can be enacted in an infinite

number of ways, yet still be recognized as the same pattern. An example is the pattern of having windows on at least two sides of a room. Alexander says that this pattern makes the room more convivial for people to be in. The pattern does not say where to place the windows, or what sort of windows, or what views to have out the windows. But the pattern is easy to recognize, and to keep in mind during the design process. Alexander's and colleagues idea of patterns and what they call a pattern language has been extended into many disparate fields, including software engineering (Gamma et al., 1995; Gabriel, 1996), ubiquitous computing (Chung et al., 2004), human–computer usability (Graham, 2003), interaction design (Borchers and Thomas, 2001), and human–robot interaction (Kahn et al., 2008).

One difference between Alexander's design patterns compared to interaction patterns is that while design patterns describe patterns in the physical built environment, interaction patterns seek to characterize the structure not just of the natural environment, but of the interaction between humans and the natural environment. Thus, *walking along the edges of water* requires not only the edge of water and land, but of the human who is doing the walking. *Watching birds* requires not only birds but the human who is doing the bird watching. *Gazing up at the night sky*, *foraging for mushrooms*, *walking a trail*, *swimming in a lake*, *resting on a log*, *lying on grass*, *smelling a rose*, *encountering a bear*, *holding a bunny rabbit*, *petting a dog*, *running with a dog*: they all require an aspect of nature and the human interacting with it.

The idea of a *keystone interaction pattern* provides further specificity on our approach. As explained in (Kahn et al., 2018a,b):

> A keystone interaction pattern is any interaction pattern that plays a disproportionately large role in human–nature interaction because (a) it occurs frequently, (b) it is itself hugely beneficial or meaningful, (c) it engenders dozens or even hundreds of complementary, subsidiary, or overlapping interaction patterns, and/or (d) its loss leads to the subsequent loss of dozens or even hundreds of complementary, subsidiary, or overlapping interaction patterns (cf. Kahn et al., 2018b). This use of the term keystone partly mimics the term keystone species in conservation biology, which refers to a species (such as a top predator) that has a disproportionate benefit to its environment relative to its abundance (Mills et al., 1993; Paine, 1995, p. 5).

To date, over 170 interaction patterns have been identified and described, and some with photos them (Kahn et al., 2010, 2012, 2018a,b,c). In addition, an Interaction Pattern Approach has been used to develop an urban design agenda—Interaction Pattern Design—that complements Biophilic Design (Kellert, 2005; Kellert et al., 2008), with an emphasis on enhancing the diversity and depth of people's interaction with urban nature (Kahn et al., 2018c).

Each time we move into a new domain, we discover new meaningful Interaction Patterns even as we employ existing ones. The new interaction patterns emerge because of new landscape affordances, new populations of people interacting with the landscapes, and new research questions in hand. This process will never stop because in principle the number of interaction patterns are infinite given increasingly fine-grained specifications. But in practicality, over time, the process of identifying meaningful interaction patterns will settle down, and the Interaction Pattern Approach will then be seen—similar to Alexander's Pattern Language—as a more codified system than it is now. Thus, another goal of this study was to further develop this Interaction Pattern Approach.

As mentioned, in this study our data involved written responses—what we call their Nature Language—from Discovery Park visitors about their interactions with nature in the park. Initially in our analysis we sought to develop a coding system for coding the interaction patterns and keystone interaction patterns in their written responses. But as we were developing our coding system, we recognized that the rich qualitative data afforded insights that went beyond an interaction pattern analysis. Thus, we also developed ways to code four other parts of participants' Nature Language: (1) the nature they described; (2) events in nature—nature action—described by the participants, that involved only natural entities, (3) the psychological experience they described through interacting with nature, and (4) repeating overarching themes of what they valued about their park experience.

In brief, in this study, we sought:

- To characterize, through an Interaction Pattern Approach, how visitors at Discovery Park interacted with the nature in the park, and what they found meaningful.
- To develop further an Interaction Pattern Approach, and to showcase its power in characterizing human-nature relationships.
- To investigate the research question of whether participants' meaningful interactions with the nature in Discovery Park depended on the park's relative wildness.

METHODS

Recruitment and Participants

Data collection began in June 2017 and ended in September 2018. Participants were recruited through various methods, such as going to Discovery Park and asking visitors to participate, posting signs at the outskirts of Discovery Park, emailing various neighborhood communities through list-serves, posting on social media, and word of mouth. In this recruitment process, potential participants were asked to "help us understand how people interact with the nature in Discovery Park."

In total 325 people participated in this study. Five participants were then excluded from our data analysis because they did not make it clear in their narrative that they had ever been to Discovery Park, resulting in a final sample size of 320 participants. For demographic information, the breakdown in terms of age was: 18–24 years old (14%), 25–34 (16%), 35–44 (16%), 45–54 (20%), 55–64 (16%), 65 and over (14%), and 4% preferred not to answer. In terms of gender: female (61%), male (36%), "Not Listed/Other" (1%), and 4% preferred not to answer. In terms of ethnicity, participants identified as: White (80%), Asian/Pacific Islander (8%), Hispanic/Latinx

(1%), African American/Black (1%), Native American/American Indian (0%, 1 participant), Multiracial (3%), and 7% preferred not to answer. In terms of household income, <$25,000 (11%), $25,000–$34,999 (4%), $35,000–$49,000 (4%), $50,000–$74,999 (13%), $75,000 and $99,999 (10%), $100,000–$149,999 (20%), $150,000 or more (21%), and 17% preferred not to answer. In terms of geographical diversity, there were a total of 64 different zip codes for where participants lived.

Online Prompts That Generated the Participant Data

This study was approved by the Institutional Review Board at the University of Washington. When participants entered the online portal, they were provided information about the study, and asked to consent to their participation. If they consented, they were then asked for demographic information, and to write based on the following prompts: "Please describe an interaction you had with nature in the park that was meaningful to you. For example, what were you doing in the park? Where were you? Why was this meaningful? This can be as short as a few sentences, but we would love a few paragraphs. Thank you!"

Coding Manual Development for Qualitative Data

Analyzing the qualitative data—the participants' written responses—posed one of the most challenging parts of this study. Our method here was to have meetings once to twice a week over a period of about 7 months, as we sought for ways to characterize (code) the data that we believed was "true" to the participants' viewpoints while being amenable to systemization and reliability. Six main types of analyses were conducted.

Interaction Patterns

At the most fundamental level of coding, the Interaction Pattern (IP) characterizes any physical and/or sensorial activity between the participant and nature. We sought to standardize each participant's unique way of writing their human-nature interaction through coding the IP in "present progressive tense verb-(preposition)-noun" form, with a few exceptions, where all extra words or information (such as adjectives) are excluded. For example, consider the following data entry: "We *sat and listened to the waves at the beach* for a while. We were also lucky enough to *see a seal in the water*, which was an especially meaningful experience for us." The italicized text indicates where there are codeable Interaction Patterns. In this example, there are three Interaction Patterns, which we coded as *sitting at beach*, *listening to waves*, and *seeing seal*. Our approach to simplifying the language of Interaction Patterns is intentional, as its purpose is to distill complex Nature Language to its "essential features" in order to find common forms of human-nature interaction.

Keystone Interaction Patterns

Based on our definition of Keystone Interaction Patterns presented earlier, we coded for two distinct types of Keystone Interaction Patterns: (1) Most Meaningful Interaction Patterns (MMIPs), and (2) Most Foundational Interaction Patterns (MFIPs). In turn, (3) the Most Frequent Interaction Patterns (MFIPs) were discovered through data analysis.

Most meaningful interaction patterns (MMIPs)

Given that participants were already prompted to write about a meaningful experience they had interacting with nature in the park, all coded Interaction Patterns are, by definition, "meaningful." Yet sometimes participants identified a specific interaction that was especially meaningful. For example, look again at the example used above: "We sat and listened to the waves at the beach for a while. We were also lucky enough to see a seal in the water, which was an *especially meaningful experience for us*." Here the participant explicitly says that the IP of *seeing seal* was especially meaningful, and thus coded as a MMIP.

Most foundational interaction patterns (MFIPs)

This class of IPs refer to those that make possible other IPs. For example, consider the following example: "I have had many experiences at Discovery Park. One of my favorite moments was *sitting with my young daughter for a snack break by the pond* below the Daybreak Center. We sat there, *watching the ducks, observing the insects,* and then my daughter played a bit around edges. Before heading onward we had the good fortune to *hear owls* caterwauling in the surrounding forest." Here the IP of *sitting by pond* helped make possible the other IPs of *watching ducks*, *observing insects*, and *hearing owls*. In this way, MFIPs play a disproportionate role in supporting many other forms of human-nature interaction in the park.

Nature Description

A "Nature Description" is the portion of the participant's written response that directly describes any of the nature identified by the participant. In contrast to the "Nature Action"—which describes either an interaction between different components of nature or a general action happening within nature – the Nature Description is relatively stationary. For example, consider the following data entry: "When I got home that evening and thought about my day, I felt great about the physical exercise we did, but I also felt so enriched by the sites we enjoyed during the *hike across the clean, open fields, through the forest to the driftwood lined beach and back again." The underlined text identifies the Nature Descriptions. Like the Nature Action, the Nature Description provides supplemental information to the coded Interaction Patterns. A coding of only the Interaction Patterns would yield: (1) hiking across fields, (2) hiking through forest, and (3) hiking to beach. Yet with the Nature Description, coded data additionally includes the other information provided by the participant: clean, open fields, and driftwood lined beach.*

Nature Action

A "Nature Action" refers to a nature event initiated by a non-human cause described by the participant. Similar to a human-nature interaction, in which the human and nature interact with each other, a Nature Action characterizes when nature is "interacting" with other nature. A Nature Action includes: (1) an interaction between at least two biotic organisms (i.e., *eagle catching fish*), (2) an interaction between biotic organisms

and abiotic components (i.e., *crab hiding under rock*), (3) an interaction between at least two abiotic components (i.e., *rocks falling over cliffs*), and (4) a general action of one biotic organism or abiotic component on its own (i.e., *eagle flapping wings; blooming flowers*). The Nature Action is meant to capture the rich and diverse ways in which people notice and characterize aspects of their surrounding natural environment.

Psychological Description

A "Psychological Description" is the portion of the participant's Nature Language that describes their personal reflections on and feelings about their experience in Discovery Park, including cognitive, emotional, and other psychological experiences. There are three possible forms that a Psychological Description can take: (1) the participant's description of their personal feelings ("*I felt happy*"), (2) the participant's description of an action, where the verb is more "psychological/emotional" oriented ("*I marveled at the views*"), and (3) the participant's description of the general feelings surrounding their larger experience ("*It was just so serene and relaxing*").

Themes

This category emerged later in the coding manual development process, when our research group started to step back from our micro-level coding and ask: "But what are the big ideas that people are talking about for why they value Discovery Park?" Through the course of many meetings, against the backdrop of the researchers knowing the data quite well, the following six themes were distilled: (1) Absence of Civilization, (2) Seclusion, (3) Generating New Social Relationships, (4) Deepening Existing Social Bonds, (5) Nature Sparking Memories/Happy Rumination, and (6) Biodiversity/Diverse Landscapes.

Reliability of Coding System and Technical Report

The entire data set was coded by a single researcher (the first author). Then 25% of the data was randomly selected from the entire data set and recoded by a second researcher (the third author). Cohen's kappa is the commonly accepted method for assessing percentage agreement between coders, but could not be used with our data because the statistic requires a defined number of categories while our categories (e.g., the number of IPs) always remained open-ended. Thus, we settled upon percent agreement of the core variable, of IPs, where reliability between the two coders was 72%. It is worth keeping in mind that the coding system had undergone about 7 months of consensus development, where difficult passages were brought forward to our working group of about 5 researchers, and then to our larger lab group of about 12 researchers. While this form of reliability may not satisfy every reader, what is gained is a coding system that, at least in our estimation, opens itself up to the richness of the data, rather than confining itself so as to be more tractable quantitatively. As an additional means to provide the reader with confidence in our coding system–and for us to be as intellectually transparent as possible–we have published our entire coding system as a technical report (Kahn et al., 2019). It runs at over 19,000 words, and can also serve as a resource to other research groups that are interested in characterizing human-nature interaction with parks and open landscapes. Note that some of the qualitative examples presented in this article are explained more fully in the technical report.

RESULTS

We calculated percentages of use of the coded categories in two different ways: in terms of percentage of (1) participants, and (2) total variables coded. Each way provides a different way to interpret the results. For example, reporting Interaction Patterns (IPs) in terms of percentage of total IPs in the data provides a straightforward way to answer the question: "What percentage of IPs in the data were of this form?" On the other hand, reporting IPs in terms of percentage of participants provides a straightforward way to answer a somewhat different question: "What percentage of participants used that IP?" Depending on one's interests, one or the other way might be the most interesting. Thus, in reporting our results, we provide both types of percentages when we think both offer equally interesting perspectives on the data; in turn—for simplicity in reporting—when we think one way clearly addresses our research questions mostly directly, then we go with that method. We also provide illustrative qualitative data, so as to help the reader feel the richness of how participants interacted with and spoke of the nature in Discover Park.

Interaction Patterns (IPs)

From coding the 320 participants' narrative data, results showed 520 IPs total, and 331 discrete IPs. A full list of the IPs can be found in our technical report (Kahn et al., 2019). To synthesize this descriptive list of 331 discrete IPs, we drew on two of the critical ways to establish the Keystone Interaction Patterns—those IPs that were used most frequently, and those IPs that participants said were most meaningful to them.

Most Frequent Interaction Patterns (MFIPs)

Results showed six higher order IPs that were used most frequently. Each of these six IPs were themselves comprised of groupings of IPs, which were categorized in what seemed to us in the most meaningful and usually straightforward of ways. For example, we grouped the IPs of *watching owl*, *watching eagle*, *watching Western Grebes*, *watching Horned Grebes*, *watching Common Loon*, *watching herons, watching shorebirds,* and so forth, all under the group of IPs *watching birds*. Quantitative results are as follows:

1. *Encountering Wildlife* (141 IPs; 27% of total IPs. 72 participants; 22% of participants)
    a. *Watching birds* (68 IPs; 48% of this MFIP)
    b. *Seeing sea life* (32 IPs; 21% of this MFIP)
    c. *Seeing land animals* (8 IPs; 6% of this MFIP)
    d. Other: (10 IPs; 7% of this MFIP)

2. *Following Established Trail* (71 IPs; 14% of total IPs. 69 participants; 22% of participants)
   a. *Walking trail* (54 IPs; 76% of this MFIP)
   b. *Running trail* (13 IPs;18 % of this MFIP)
   c. Other (4 IPs; 6% of this MFIP)
3. *Walking to Destination Spot in Nature* (41 IPs; 8% of total IPs. 34 participants; 11% of participants)
   a. *Walking to beach* (32 IPs; 78% of this MFIP)
   b. *Walking to bluffs* (9 IPs; 22% of this MFIP)
4. *Gazing out at Puget Sound or Mountains* (32 IPs; 6% of total IPs. 28 participants; 9% of participants)
   a. *Gazing out at Puget Sound* (13 IPs; 41% this MFIP)
   b. *Gazing out at mountains* (8 IPs; 25% of this MFIP)
   c. *Gazing out at sunset* (7 IPs; 22% of this MFIP)
   d. Other (4 IPs; 13% of this MFIP)
5. *Walking along Edges (Beach or Bluffs)* (28 IPs; 5% of total IPs. 24 participants—8% of participants)
   a. *Walking the edge of water and shoreline* (21 IPs; 75% of this MFIP)
   b. *Walking the edge of bluff and meadow:* (7 IPs; 25% of this MFIP)
6. *Walking with Dog (or Running)* (20 IPs; 4% of total IPs. 20 participants;6% of participants)
   a. *Walking with dog* (16 IPs; 80% of this MFIP)
   b. *Running with dog* (4 IPs; 15% of this MFIP)

Here is an example of one participant's narrative that shows the rich style of reflection that was often in the data, and from which we distilled the specific IPs. The snippets in italics were the specific that formed our analysis of IPs.

> I have come to Discovery Park ever since I was young and have been in awe of its natural beauty for 20 years. Every time I visit the park, I experience nature in a new and breathtaking way. I often *walk along the beach* and *gaze at the gorgeous Olympic Mountains*. I have *seen orca whales, seals, fish, eagles, herons, shorebirds, and many other sea creatures* in their natural habitat all from shore. I always *take long, calming walks on the trails* and I appreciate the vast amount of native vegetation. Several times I have *seen owls, rabbits, foxes, and snakes*. The meadow shines in sunset and the sunrise, which are my favorite times to go for a run and take advantage of the hilly terrain. I remember when I was young my favorite place to go was the visitor center. This park has sparked a passion in me for protecting the rest of the natural beauty Washington State has left. I cannot describe the beauty Discovery Park had brought into my life. I only hope to 1 day share these experiences with future children and show them the last place in Seattle where the land's natural beauty is preserved.

As this example illustrates, it was often the case the participants wrote about their thoughts and experiences in ways that integrated pretty deeply into their lives, and thereby provides evidence that the data likely has good ecological validity (Gouvier et al., 2018). Note that only occasionally did participants write of human artifacts, such as of seeing ships out on the water, or of referencing the visitor's center or light house. We assume that the reason we garnered so little data of this form is that we asked specifically for participants to write about their *nature* interactions.

Most Meaningful Interaction Patterns (MMIPs)

Of the 520 total IPs, 52 IPs were coded as Most Meaningful IPs (MMIPs), with 39 participants having at least one MMIP. Higher order IPs within the total coded MMIPs are reported below with their frequency relative to the 52 total MMIPs:

1. *Encountering wildlife* (20 IPs; 38% of MMIPs)
2. *Walking through open space* (14 IPs; 27% MMIPs)
3. *Exploring beach* (7 IPs; 13% MMIPs)
4. *Finding views* (6 IPs; 12% MMIPs)
5. Other (5 IPs; 10% MMIPs).

Most Meaningful Interaction Patterns (MMIPs)

Here is an example of this category:

> It's always meaningful to come to this park. It's a total gem in the middle of the city. I live in Wallingford and come here all the time. There are two big leaf maples at either end of the park I always stop and hug. This is meaningful to me because my father was a big tree hugger. He's dead now. I imagine I'm hugging him when I reach for the trees. I frequently hike from the top of the hill down along the bluffs, down to the beach, along the beach from South to North Beach, back up the hill, through the loop trail, and back to the visitor's center parking lot. It's just a fantastic way to just be with myself or a friend I'm hiking with. This place cannot be replaced. Just love it!

In this example, the MMIP *hugging big leaf maples* is one of the five IPs included in the above "Other" category, as it was too unique to be grouped with the four main overarching MMIPs. We highlight this example to illustrate our limitations in being able to characterize fully all of the individual voices of the participants.

Nature Descriptions, Nature Actions, and Psychological Descriptions

The results from these three categories are of only modest interest by themselves, especially given the space limitations of this manuscript. But where these categories take on more meaning—especially in terms of extending an Interaction Pattern Approach, and investigating the central research question of this study—is in how they were linked to specific interaction patterns. For example, in one of the passages below, a participant refers to the psychological experience of feeling "so peaceful and serene." In this context, our coding question was: "what was she interacting with in nature for her to have this psychological experience?" The answer becomes clear in the fuller section of her narrative: "A friend and I swim in the Puget Sound every Sunday morning–year round! We've been doing this for nearly 10 years… It is so peaceful and serene–a big dose of the outdoors in 2 h." In other words, her psychological experience was engendered by her *swimming in Puget Sound*.

Thus, in what follows are the results of how these three categories—Nature Descriptions, Nature Actions, and

Psychological Descriptions—are linked, and how often, to overarching IPs. Given that later we interpret nature descriptions and nature actions as a single unit, we combine them here, for simplicity of presentation.

Nature Description and Nature Action Linked-IPs (NLIPs)

There were a total of 146 nature descriptions and/or nature actions that were directly linked to the following five overarching IPs. We include a qualitative example for each, wherein we italicize the IPs and underline the linked nature description and/or nature action:

1. *Encountering wildlife* (62 IPs; 42% of NLIPs). "I ride my bicycle to the park often, and love to sit on a driftwood log and *watch the sanderlings play keep away with the waves*. One morning I saw a *bald eagle snatch a fish out of the waves just off the lightho use point*."
2. *Exploring large open green space* (42 IPs; 29% of NLIPs). "The *hike in the wooded glens* was very peaceful, serene, and beautiful. We *saw several old growth trees*. The *air smelled earthy and the foliage was extremely lush*."
3. *Exploring beach* (16 IPs; 11% of NLIPs). "…It was low tide, and we were able to walk out to *see a few anemones on small rocks and anchored to the sand. I don't even remember seeing anemones directly in sand before... is that common?*"
4. *Finding views* (12 IPs; 8% of NLIPs). "My wife and I hiked the loop trail. We were visiting Seattle for the first time but love hiking outdoors so did that as perhaps an escape from the normal city sightseeing. What we discovered on the loop trail was the huge sized maple leaves, being able to *see the snowcapped [Mt.] Rainier and [Mt.] Olympus* from one vantage [point], and the bark, moss, and warts of the ancient trees."
5. *Walking to destination spot in nature* (5 IPs—3% of NLIPs). "A memory in particular that we enjoy was just this last February. We took a nice *walk down to the beach*, enjoying the trees, with peeks at the water and sun along the way. Upon reaching the beach, we were treated to a *beautiful and dynamic sky,* which quickly turned a little too dynamic on us. Our fun at the beach became a mad dash away from a hail storm!"

Psychological Description Linked-IPs (PLIPs)

There were a total 97 Psychological Descriptions that were linked to four overarching IPs. We include a qualitative example for each, wherein we italicize the IPs and underline the linked psychological description.

1. *Exploring large open areas of green space* (44 IPs; 45% of PLIPs). "I was there with my two kids (4 & 1) and we were exploring the new playground. They loved exploring the heights of it, as well as the spiderweb network of ropes. We also loved just *following random trails* that intersect all over. It was a meaningful way to explore nature without a defined path."
2. *Encountering wildlife* (22 IPs; 23% of PLIPs). "Hanging out at the overlook on a break from a trail run and seeing an *eagle* flying from a nearby tree out into the water to catch a fish. This inspired me to feel strong and even in empowering me to move forward and open a private practice."
3. *Exploring beach* (17 IPs; 18% of PLIPs). "A friend and I *swim in the Puget Sound* every Sunday morning – year round! We've been doing this for nearly 10 years… It is so peaceful and serene–a big dose of the outdoors in 2 h.
4. *Finding views* (8 IPs; 8% of PLIPs). "I went to the park with my friend because it is a sunny day. *Watching the sunset near the water makes me feel peaceful*. I was surprised at the current. They were still, like a piece of enormous oil painting."

Themes

From the 320 participants, 96 instances of one of six themes were coded. We provide two examples of each of the six themes so as to convey some of the range of how participants expressed them.

1. Absence of Civilization (30 instances; 31% of total coded Themes. Nine percentage of total participants).

> I love running the Loop Trail in this park. It makes me feel like I am out in the wilderness, and it is quiet but for the birds. The huge old trees create a beautiful shaded canopy. Went to the park to get away from the cement of the city... to walk and relax.

2. Seclusion (15 instances; 16% of total coded Themes. Five percentage of total participants).

> I prefer to walk alone, as I enjoy the solitude, something so hard to find in the city. When walking alone in the park, I can imagine I am miles away from Seattle. The air seems fresher, and the sounds of wind rustling leaves or causing branches to "moan" as they rub together help to remind me of my smallness in relation to the world. Discovery Park is a gem. It's the one place in Seattle where there [are] places to be in nature and find solitude.

3. Generating New Social Relationships (10 instances; 10% of total coded Themes. Three percentage of total participants).

> We had a spotting scope and were able to show others some of these birds. It is always fun to show the birds to people who do not have binoculars or spotting scopes. When they can see birds close up they have an appreciation for how amazing the birds really are. Discovery Park is great for experiencing other people in a pleasant environment. I suppose the natural surroundings play a role in how we act toward one another in that environment.

4. Deepening Existing Social Bonds (9 instances; 9% of total coded Themes. Three percentage of total participants).

> Going here with people has allowed me to connect and talk with them about conversation that simply does not happen in everyday life. I guess I feel closer to myself and those around me when I leave Discovery Park, and that is why it is so special to me.

5. Nature Sparking Memories and/or Happy Rumination (7 instances; 7% of total coded Themes. Two percentage of total participants).

> I will share with you that there is one place I visit that has special meaning to me—it's a high meadow that overlooks the bay. This is quiet open place and when I'm here, I most often think of and remember my Mom who passed not long ago. This meadow was one of the stops on my first hike in the park after my Mom passed last November...I spent a long time here remembering her. And, while I was looking out on the water a long cruise ship was pulling out on its way to Alaska...I had just taken my Mom on our first cruise—to see Alaska—a few months before her death—and we had sailed on our ship together in this same pass. So now, this stop is always a time for me to check in with my Mom and my remembrances of her.

6. Biodiversity and/or Diversity of Landscapes (25 instances; 26% of total coded Themes. Eight percentage of total participants).

> Discovery Park is I think the best park in Seattle. It's a special place. It combines so many things- birds and other wildlife, meadows, vistas, beaches and forest. Every time I visit the park, I experience nature in a new and breathtaking way. I often walk along the beach and gaze at the gorgeous Olympic Mountains. I have seen orca whales, seals, fish, eagles, herons, shorebirds, and many other sea creatures in their natural habitat all from shore. I always take long, calming walks on the trails and I appreciate the vast amount of native vegetation. Several times I have seen owls, rabbits, foxes, and snakes. The meadow shines in sunset and the sunrise, which are my favorite times to go for a run and take advantage of the hilly terrain.

Whether Participants' Meaningful Interactions With Nature in Discovery Park Depended on the Park's Relative Wildness

We first drew on criteria from the literature about what constitutes relatively wild landscapes (Turner, 1996; Thomas, 2006; Foreman, 2013), and then applied that criteria to Discovery Park, and thereby operationalized *relatively wild* as including the following features: Discovery Park's varied and relatively unmanaged land, its high levels of biodiversity, its "big nature" like old growth trees, its large open space, its expansive vistas, and people's experience of its solitude and being removed from civilization. Then we determined which of the IPs depended on one or more of these criteria, focusing on the IP's nature noun, the larger context of the written narrative, and the linked IPs (i.e., the Nature Description and Nature Action Linked-IPs, and the Psychological Description Linked-IPs). As a simple example, *spotting bald eagle* would count as an IP that depended on Discovery's Park's relative wildness because the bald eagle at Discovery Park is a relatively wild animal. A more complex example was when someone said that they were *watching birds perched on an old growth tree*, where it is the IP linked Nature Action (birds perched on old growth tree) that provides the basis for the application of our code. Results showed that of the 520 total coded IPs, 77% of the IPs (399 IPs) depended on Discovery Park's relative wildness. When analyzed in terms of the percentage of total participants, 53% of participants (168 participants) provided at least one IP that depended on Discovery Park's relative wildness.

Then we analyzed whether Discovery Park's relative wildness had an effect on what participants found most meaningful in Discovery Park. Of the 52 MMIPs, 96% (50 MMIPs) depended on Discovery Park's relative wildness. When analyzed in terms of the participants who noted an especially meaningful experience with nature, 95% of those participants (37 participants) had an interaction that depended on Discovery Park's relative wildness. As a point of contrast, here is an example of an interaction pattern that did not depend on the park's relative wildness: "I was hiking with my boyfriend. We were walking along the trails. It was meaningful because it was in summer, and it was my first time hiking there." In this nature language, the participant's reasons for why her hike was meaningful ("summer" and "first time hiking there") do not implicate any wild qualities of the park.

Next we focused on the set of 97 IPs that were linked to coded Psychological Descriptions (PLIPs). Results showed that 96% of those PLIPs (93 PLIPs) depended on Discovery Park's relative wildness. In terms of participants whose data contained a coded PLIP, 96% of those participants (64 participants) had an experience that depended on Discovery Park's relative wildness.

Finally, we focused on the set of 146 IPs that were linked to coded Nature Descriptions and Nature Actions (NLIPs), and found that 95% of those NLIPs (138 NLIPs) depended on Discovery Park's relative wildness. In terms of participants whose data contained a coded NLIP, 94% of those participants (85 participants) had an experience that depended on Discovery Park's relative wildness.

DISCUSSION

Discovery Park's 1972 Master Plan now appears prescient. In it, the planners wrote there would be "almost irresistible pressure" to develop parts of the park for other urban uses, and that such pressures, if not resisted, would lead to the landscape's fragmentation (Kiley et al., 1972, p. 4). That, in turn, the planners wrote, would undermine the park's goal to provide a respite from the stressors that arise from hardscaped and dense urban living.

Perhaps it was not that difficult for the planners to anticipate this future because in many ways it has been our species' past. Since the rise of agriculture a mere five to ten thousand years ago, humans have populated and spread out over the planet. The Earth accommodates over 7 billion of us now. More than half of the world's population and 80% of people in the United States now live in urban areas. Moreover, what we see in cities today will not stay this way, in large part due to increasing population growth. By 2050, the world population is expected to reach 9.8 billion, and by 2100, 11.2 billion (United Nations, 2017). Much of that growth will occur in increasingly populated and dense urban areas, leading to more megacities of over 10 million people. Even today, Seoul, for example, has over 25 million people; Delhi, 27 million; Jakarta, 31 million; Shanghai, 34 million; and Tokyo, 38 million. With such demographics in mind, almost all open

urban land in the big cities throughout the world is coveted for development.

But does developing that land lead to largely unrecognized costs in terms of human well-being and human flourishing? That is part of what our case study addressed. We first sought to understand how people interacted meaningfully with the nature in Discovery Park in Seattle, Washington, using an Interaction Pattern Approach. Then we asked the critical question: To what extent do those interactions depend on the largely non-fragmented and non-developed areas of the park?

Results showed that the most frequently occurring Interaction Patterns (IPs) clustered under the keystone IPs of *encountering wildlife* (27%), *following trails* (14%), *walking to destination spots in nature* (8%), *gazing out at the Puget Sound or mountains* (6%), *walking along edges of beach or bluffs* (5%), and *walking with dogs* (4%). We shared a few illustrative examples in Results, as when a participant ended by saying, "I only hope to 1 day share these experiences with future children and show them the last place in Seattle where the land's natural beauty is preserved." Taking these quantitative and qualitative results together, one can feel how people's physical senses and entire bodies engaged with specific aspects of nature, leading them into deeper relationship with the landscape (cf. Pasanen et al., 2018). Human-nature connections were formed that sometimes lasted decades, and could help shape their desire to preserve nature for future generations.

Results of participants' most meaningful IPs showed a similar pattern: *encountering wildlife* (38%), *walking through open space* (27%), *exploring the beach* (13%), and *finding views* (12%). In writing of what was most meaningful, participants' narratives often took their most poignant form, as when one participant wrote that before her dad had died, he was a "big tree hugger," and so that there "are two big leaf maples at either end of the park I always stop and hug," and that she imagines she is hugging him when she reaches for the trees.

More detailed analysis examined the linkages between IPs and (a) the nature they were describing (e.g., "the foliage was extremely lush"), (b) the ways that they saw nature interacting with other aspects of nature (e.g., "I saw a bald eagle snatch a fish out of the waves just off the lighthouse point"), and (c) how the IPs made them feel (e.g., "[w]atching the sunset near the water makes me feel peaceful"). In turn, 6 overarching themes emerged from the data: Absence of Civilization, Seclusion, Generating New Social Relationships, Deepening Existing Social Bonds, Nature Sparking Memories and/or Happy Rumination, and Biodiversity and/or Diversity of Landscapes.

These results support the proposition that there exists tremendous diversity and depth of interaction between people and nature at Discovery Park.

From here we move to the central question of the study: of whether participants' meaningful interactions with nature in Discovery Park depended on the park's relative wildness. We use the term "relative wildness" to couch what seems a truism, that there are no fully wild landscapes in any city, if by wild we mean nature that is unmanaged, untamed, not encompassed, self-organizing, and unencumbered and unmediated by technological artifice (Turner, 1996; Foreman, 2013; Kahn and Weiss, 2017). That said, it is certainly the case that some aspects or affordances of nature are more wild than others, even in a city. For example, a small grove of old growth trees is more wild than a planted sapling. A city lake is more wild than a concrete urban fountain. An eagle catching a fish is more wild than a crow eating potato chips.

Results showed that 77% of the IPs depended on Discovery Park's relative wildness (53% of the participants). Of the participants who noted an especially meaningful experience with nature, 95% of them had an interaction that depended on Discovery Park's relative wildness. Of the participants whose data contained an IP that was linked to a Nature Description or a Nature Action, 94% of those participants had an experience that depended on Discovery Park's relative wildness. Of the participants whose data contained an IP that was linked to a Psychological Description, 96% of those participants had an experience that depended on Discovery Park's relative wildness.

These data also help show how relatively wild urban parks provide urban people with ways to manage the stressors of city living. For example, one participant wrote:

> We walked about 4 miles along the main trails branching from the south parking lot, along the ridge, down to the beach and then back to our car through the woods. Having access to the park is important to me as I feel happiest when I am outside, in the mountains, and I am not always able to get to the mountains. Even when I am not in the park it is important to me as I lean on past experiences in the park to help me feel centered and relaxed. Things I noticed: birds – identified cormorants, eagles, herons, gulls, electric green moss on slick dark wood, sunshine over smooth seas.

Notice that it is the relative wildness of the park that makes this person's restoration possible. While not as wild as in the "mountains," in Discovery Park one can encounter wild animals ("cormorants, eagles, herons"), wild plants ("electric green moss") and the enormous scope of open sky and ocean ("sunshine over smooth seas"). Other participants explicitly wrote of the restoration that the park provided from urban stress, as in this example:

> I had been going crazy for weeks listening to the sounds of the city and I needed a break and some exercise. It felt good to listen to the water, and smell the sea, and have a moment of peace.

Also keep in mind that the richness of our qualitative data helps provide ecological validity to the quantitative results.

Taken together, the quantitative and qualitative results support the proposition that participants' meaningful interactions with nature in Discovery Park depended on the park's relative wildness. Much of that wildness exists because the park is still large enough, and has enough of itself still intact, and enough that is still unmanaged and un-encroached upon by humans.

While it is an open question how much the relative wildness of Discovery Park would be diminished or destroyed by further development in the park, the results of this study should be a signal to all those involved in future planning of Discovery Park that the park's relative wildness needs to

be front and center in these discussions (cf. Wood et al., 2018). That said, we do not minimize the importance of other green spaces or smaller and more domestic parks within urban environments. They all play important roles in providing people some access to nature, and thereby help promote human resilience and flourishing (Frumkin et al., 2017; Bratman et al., 2019).

Another benefit of people interacting with relatively wild landscapes is that such interactions can provide a solution to a largely unseen and insidious problem in the world today. Let us explain. Obviously, due to human impact, our planet is facing enormous pressures to sustain itself in ways that can allow all humans or even most humans to live healthy lives. Many of these impacts humans know about, such as climate change; and it remains an open question whether we as a world population can solve such problems before there is massive upheaval. But another kind of problem goes largely unrecognized, and has been referred to in the literature as the problem of *environmental generational amnesia* (Kahn, 2002, 2011, 2017), which refers to a specific form of the problem of the shifting baseline (Pauly, 1995; Pyle, 2002; Soga and Gaston, 2018) wherein children construct a conception of what is environmentally normal based on the natural world they encounter in childhood. The crux is that with each ensuing generation the amount of environmental degradation can and usually does increase, but each generation tends to take that degraded condition as the non-degraded condition, as the normal experience. In other words, the largely unseen and insidious nature of this problem is that even as environmental conditions worsen, and even as people suffer because of that, people are normalizing impoverished living conditions that are harmful to their physical health and mental well-being, and increasingly see themselves as distant from nature, which leads them not to protect nature, which allows for further destruction of nature, which leads to less nature to interact with. And so the downward cycle continues, without people even recognizing that that is happening. To shift this cycle upward, Kahn (1999, 2011) has suggested that people themselves need to experience the benefits of being in a nature that is slightly more wild than the nature they came of age with as children and/or currently have within their purview.

One question that can be asked of our research is the extent to which we think the results—and not just the methods—could generalize to other urban parks, in the United States if not internationally. In our view, we would expect some of our core findings would generalize pretty well, even as we presented a case study. For example, if we conducted a similar study in Central Park in New York City, our hypothesis would be that some of our keystone interaction patterns would emerge in visitors there, albeit is perhaps slightly modified forms. For example, *following trails* in Discovery Park might end up being better characterized as *following paths* in Central Park, given the slightly different affordances of the two parks. In turn, *encountering wildlife* and *walking to destination spots in nature* would presumably cut across both parks, even if the specific nature in both is slightly different. Indeed, that is part of the power of an Interaction Pattern Approach: it is one that allows for exploration of potentially universal forms of human-nature interaction, while allowing for huge diversity of how those interactions are manifested. More generally, our expectation would be that one of the core findings of this study—that people's meaningful interactions with nature in Discovery Park depended on the park's relative wildness—would generalize to many large urban parks that still retain some modicum of wild affordances in their landscapes. Future research would help answer whether we are correct in our position here.

Next we shift to a topic that involves a legacy of historical injustice. Most discussions in Seattle about the future of Discovery Park consider its history, if at all, as starting—as we did—with the 1972 master plan, after which the park was officially established in 1973. Occasionally the history begins about 115 years earlier. For example, the City of Seattle begins its history of the area starting in 1857, and of the hopes of the White settlers to build a major military installation on that land (Discovery Park History, n.d.). What is missing in such accounts is that the Duwamish people lived on this land prior to White colonization. The one-sided conflict between colonizers and Native Peoples was (barely) resolved by the United Indians of All Tribes leasing 17 acres of the "park" in the early 1970's. Without acknowledging this history of injustice to earlier inhabitants, we risk normalizing the mindset of domination that produced Discovery Park in the first place.

From our perspective, two limitations of this study stand out. One is that initially we had hoped for perhaps 1,000 participants, and from highly diverse groups of people. It did not happen that way. Given the difficulty of recruiting participants, we spent about 15 months collecting data, about a year longer than we had hoped. Eventually we had to settle for a reduced sample size. The second limitation is what emerged as a fairly homogenous group in terms of ethnicity. Eighty percent of participants self-identified as White. This limitation troubles us, especially given, as noted above, the history—what Madley (2016) refers to as an American Genocide—of the indigenous people of this land. Today Discovery Park is surrounded by a neighborhood (Magnolia) that is 81% White (Statistical, 2019), and which thus pretty much mimics the percentage of White ethnicity of our sample. And while the park is accessible by public buses, the routes are time consuming. Thus, it is difficult for people of color to get to the park. It is also an open question whether people of color feel welcome in White-constructed parks despite enjoying, often deeply so, nature experiences (Stack, 1996; Kahn, 1999; Finney, 2014). It would be important for future studies to directly investigate the perspectives of underrepresented and vulnerable populations. One way to achieve this would be through targeted focus groups.

One of the central problems of our world today is that people see themselves as dominating over other people, and dominating over nature. How is it possible to move people to a more relational way of being in the world?

The answer we would like to highlight here is that it is through interaction with wild nature, and allowing it to transform our

narrow conceptions of self (Turner, 1996; Kahn et al., 2018b). For example, when participants in this study watched an eagle snatch its prey from the ocean's surface, they did not control the destiny of either animal. They were in the presence of a great mystery: for something to live, something else must die. Visitors to Discovery Park do not control the sun rising or setting, or the tides, or the weather. Too, wild nature demands plenty of people: pay attention or get hurt. Humans are optimally equipped to thrive under these conditions because we naturally evolved for hundreds of thousands of years within them (Kahn and Hasbach, 2013). The power of relatively wild areas is that they allow people to feel some of this relationship where they are not in control over nature but living in balance with it, sometimes with quiet intimacy.

Can it be done in cities? Of course. Discovery Park is a case in point, if we can but keep from encroaching further upon it.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board at the University of Washington. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

PK, EL, and GE contributed conception and design of the study. EL led the data collection effort, with assistance from HC. PK, EL, HC, and GE contributed to the qualitative analyses. EL organized the data base, led the quantitative analyses, and coded all of the data. HC conducted reliability coding. PK wrote the main parts of the manuscript, with assistance from EL.

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REFERENCES

Alexander, C. (1979). *The Timeless Way of Building*. New York, NY: Oxford University Press.

Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I., and Angel, S. (1977). *A Pattern Language*. New York, NY: Oxford University Press.

Borchers, J. O., and Thomas, J. C. (2001). "Patterns: what's in it for HCI?," in *Extended Abstracts of CHI 2001* (New York, NY), 225–226.

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., de Vries, S., Flanders, J., et al. (2019). Nature and mental health: an ecosystem service perspective. *Sci. Adv.* 5:eaax0903. doi: 10.1126/sciadv.aax0903

Chung, E. S., Hong, J. I., Lin, J., Prabaker, M. K., Landay, J. A., and Liu, A. L. (2004). "Development and evaluation of emerging design patterns for ubiquitous computing," in *Conference: Proceedings of the Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques* (Cambridge, MA: ACM Press), 233–239.

Discovery Park History. (n.d.). Available online at: https://www.seattle.gov/parks/find/centers/discovery-park-environmental-learning-center/discovery-park-history (accessed September 7, 2019).

Finney, C. (2014). *Black Faces, White Spaces: Reimagining the Relationship of African Americans to the Great Outdoors*. Chapel Hill, NC: The University of North Carolina Press.

Foreman, D. (2013). "Five feathers for the cannot club," in *The Rediscovery of the Wild*, eds P. H. Kahn Jr. and P. H. Hasbach (Cambridge, MA: MIT Press), 181–232.

Frumkin, H., Bratman, G. N., Breslow, S. J., Cochran, B., Kahn, P. H. Jr., Lawler, J. J., et al. (2017). Nature contact and human health: a research agenda. *Environ. Health Perspect.* 125:075001. doi: 10.1289/EHP1663

Gabriel, R. P. (1996). *Patterns of Software: Tales From the Software Community*. New York, NY: Oxford University Press.

Gamma, E., Helm, R., Johnson, R., and Vlissides, J. (1995). *Design Patterns: Elements of Reusable Object-Oriented Software*. Boston, MA: Addison-Wesley Longman.

Gouvier, W. D., Musso, M. W., and Barker, A. A. (2018). *Ecological Validity*. Encyclopædia Britannica. Available online at: https://www.britannica.com/science/ecological-validity (accessed September 3, 2019).

Graham, I. (2003). *A Pattern Language for Web Usability*. London; Boston, MA: Addison-Wesley.

Hartig, T., and Kahn, P. H. Jr. (2016). Living in cities, naturally. *Science* 352, 938–940. doi: 10.1126/science.aaf3759

Hongxiao, L., Feng, L., Juanyong, L., and Yuyang, Z. (2017). The relationships between urban parks, residents' physical activity, and mental health benefits: a case study from Beijing, China. *J. Environ. Manage.* 190, 223–230. doi: 10.1016/j.jenvman.2016.12.058

Kahn, P. H. Jr. (1999). *The Human Relationship With Nature: Development and Culture*. Cambridge, MA: MIT Press.

Kahn, P. H. Jr. (2002). "Children's affiliations with nature: structure, development, and the problem of environmental generational amnesia," in *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*, eds P. H. Kahn Jr. and S. R. Kellert (Cambridge, MA: MIT Press), 93–116.

Kahn, P. H. Jr. (2011). *Technological Nature: Adaptation and the Future of Human Life*. Cambridge, MA: MIT Press.

Kahn, P. H. Jr. (2017). "Environmental generational amnesia," in *Nature, Love, Medicine: Essays on Wildness and Wellness*, ed T. L. Fleischner (Salt Lake City, UT: Torrey House Press), 189–199.

Kahn, P. H. Jr., Freier, N., G., Kanda, T., Ishiguro, H., Ruckert, J. H., Severson, R. L., et al. (2008). "Design patterns for sociality in human robot interaction," in *Proceedings of the 3rd ACM/IEEE International Conference on Human-Robot Interaction 2008* (New York, NY: Association for Computing Machinery), 271–278.

Kahn, P. H. Jr., and Hasbach, P. H. (2013). "The rewilding of the human species," in *The Rediscovery of the Wild*, eds P. H. Kahn Jr. and P. H. Hasbach (Cambridge, MA: MIT Press), 207–232.

Kahn, P. H. Jr., Lev, E., Chen, H., Esperum, G., Piatok, H., Aberg, N., et al. (2019). Coding Manual for "*The Nature Voices of People Who Visit Discovery Park: An Interaction Pattern Approach*." University of Washington, ResearchWorks Archive.

Kahn, P. H. Jr., Lev, E. M., Perrins, S. P., Weiss, T., Ehrlich, T., and Feinberg, D. S. (2018c). Human-nature interaction patterns: constituents of a nature language for environmental sustainability. *J. Biourban.* 17, 41–57.

Kahn, P. H. Jr., Ruckert, J. H., and Hasbach, P. H. (2012). "A nature language," in *Ecopsychology: Science, Totems, and the Technological Species*, eds P. H. Kahn Jr. and P. H. Hasbach (Cambridge, MA: MIT Press), 55–77.

Kahn, P. H. Jr., Ruckert, J. H., Severson, R. L., Reichert, A. L., and Fowler, E. (2010). A nature language: an agenda to catalog, save, and recover patterns of human-nature interaction. *Ecopsychology* 2, 59–66. doi: 10.1089/eco.2009.0047

Kahn, P. H. Jr., and Weiss, T. (2017). The importance of children interacting with big nature. *Child. Youth Environ.* 27, 7–24. doi: 10.7721/chilyoutenvi.27.2.0007

Kahn, P. H. Jr., Weiss, T., and Harrington, K. (2018a). Modeling child-nature interaction in a nature preschool: a proof of concept. *Front. Psychol.* 9:835. doi: 10.3389/fpsyg.2018.00835

Kahn, P. H. Jr., Weiss, T., and Harrington, K. (2018b). "Child-nature interaction in a forest preschool," in *Research Handbook on Childhood Nature*, eds A. Cutter-Mackenzie, K. Malone, and E. B. Hacking (Cham: Springer), 41–57.

Kellert, S. R. (2005). *Building for Life: Designing and Understanding the Human-Nature Connection*. Washington, DC: Island Press.

Kellert, S. R., Heerwagen, J. H., and Mador, M. L. (2008). *Biophilic Design*. Hoboken, NJ: John Wiley.

Kiley, D. U., Tyndall, I., and Ker Walker, P. (1972). *Discovery Park Master Plan*. Available online at: https://www.seattle.gov/Documents/Departments/ParksAndRecreation/Parks/masterplan1.pdf (accessed September 8, 2019).

Madley, B. (2016). *An American Genocide: The United States and the California Indian Catastrophe*. New Haven, CT: Yale University Press.

Mills, L. S., Soule, M. E., and Doak, D. F. (1993). The keystone-species concept in ecology and conservation. *BioScience* 43, 219–224. doi: 10.2307/1312122

Paine, R. (1995), A conversation on refining the concept of keystone species. *Conserv. Biol.* 9, 962–964. doi: 10.1046/j.1523-1739.1995.09040962.x

Pasanen, T., Johnson, K., Lee, K., and Korpela, K. (2018). Can nature walks with psychological tasks improve mood, self-reported restoration, and sustained attention? Results from two experimental field studies. *Front. Psychol.* 9:2057. doi: 10.3389/fpsyg.2018.02057

Pauly, D. (1995). Anecdotes and the shifting baseline syndrome of fisheries. *Trends Ecol. Evol.* 10:430.

Pyle, R. M. (2002). "Eden in a vacant lot: special places, species, and kids in the neighborhood of life," in *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*, eds P. H. Kahn Jr. and S. R. Kellert (Cambridge, MA: MIT Press), 305–327.

Sain-Baird, J. (2017). *How Central Park Keeps New York City Healthy*. Central Park Conservancy Blog. Available online at: http://www.centralparknyc.org/about/blog/central-park-keeps-nyc-healthy.html (accessed August 27, 2019).

Semuels, A. (2017). *From 'Not in My Backyard' to 'Yes in My Backyard'. The Atlantic*. Available online at: https://www.theatlantic.com/business/archive/2017/07/yimby-groups-pro-development/532437/ (accessed September 7, 2019).

Soga, M., and Gaston, K. J. (2018). Shifting baseline syndrome: causes, consequences, and implications. *Front. Ecol. Environ.* 16, 222–230. doi: 10.1002/fee.1794.

Stack, C. (1996). *Call to Home: African Americans Reclaim the Rural South*. New York, NY: Basic.

Statistical (2019). Available online at: https://statisticalatlas.com/neighborhood/Washington/Seattle/Magnolia/Race-and-Ethnicity (accessed November 18, 2019).

The Debate Over Housing at Discovery Park (2017). Available online at: https://www.seattlemet.com/articles/2017/6/12/housing-at-discovery-park (accessed September 21, 2017).

Thomas, E. M. (2006). *The Old Way: A Story of the First People*. New York, NY: Farrar, Straus, and Giroux.

Turner, J. (1996). *The Abstract Wild*. Tucson, AZ: The University of Arizona Press.

United Nations (2017). *World Population Projected to Reach 9.8 Billion in 2050, and 11.2 Billion in 2100*. Available online at: https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html (accessed September 7, 2019).

Wood, E., Harsant, A., Dallimer, M., Cronin de Chavez, A., McEachan, R. R. C., and Hassall, C. (2018). Not all green space is created equal: biodiversity predicts psychological restorative benefits from urban green space. *Front. Psychol.* 9:2320. doi: 10.3389/fpsyg.2018.02320

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