Understanding the Nature Play Milieu: Using Behavior Mapping to Investigate Children's Activities in Outdoor Play Spaces

Adina Cox
University of Kentucky

Janet Loebach
Centre for Addiction and Mental Health
London, Canada

Sarah Little
University of Oklahoma

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Abstract

When children engage with the natural world, they experience myriad benefits to their health and well-being. Play in outdoor and natural environments is critical for children's healthy social, emotional, physical, and cognitive development. Developing high-quality, engaging natural play spaces may be one strategy to afford children greater access to the outdoors and nature-based play. Additional research on children's play in nature is needed to inform the design of nature play spaces. Behavior mapping is a flexible observational research method that can effectively capture both children's behavior as well as its social and environmental context, or "milieu." The authors outline a customized behavior mapping protocol tailored to explore children's play behaviors in outdoor play spaces and provide examples of its value from a recent study in a naturalized play space.

Keywords: children, outdoor play, nature play spaces, behavior mapping, child-friendly research methods

The Importance of Connecting Children to Nature in Outdoor Play Spaces

When children engage with the natural world, they experience myriad benefits to their health and well-being (e.g., Hordyk, Hanley, & Richard, 2015; Kuo, 2015; McCormick, 2017). Experiences in nature can improve cognitive function (Kaplan & Kaplan, 1989; Kuo & Taylor, 2004; Taylor & Kuo, 2009; Taylor, Kuo, & Sullivan, 2001), improve mood (Berman, Jonides, & Kaplan, 2008; Hartig, Evans, Jamner, Davis, & Gärling, 2003; Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010; Roe & Aspinall, 2011), potentially increase physical activity level (Gray et al., 2015; Larouche, Garriguet, & Tremblay, 2016; Stone & Faulkner, 2014; Sallis, Prochaska, & Taylor, 2000), improve academic performance (Matsuoka, 2010), relieve stress (Chawla, Keena, Pevec, & Stanley, 2014; Thompson et al., 2012; Ulrich et al., 1991), and help children to develop an affinity for the natural world which can lead to pro-environmental behaviors in adulthood (Chawla, 2007). Many contemporary children, however, spend significant out-of-school time engaged in structured activities, or engaged with digital devices (Burdette & Whitaker, 2005; Rideout, Foehr, & Roberts, 2010). Increased use of digital media as well as parental concerns about neighborhood crime and safety may be contributing to the significant reduction in the time contemporary children are spending outdoors (Clements, 2004; Gray, 2011). Given the benefits of engagement with nature and the growing trend of "indoor childhoods" (Karsten, 2005), providing children access to and encouraging engagement with the natural world is critical.

Creating Diverse Play Spaces for Engaging Nature

Developing high-quality, engaging natural play spaces may be one strategy to afford children greater access to the outdoors, and nature-based play. A typical traditional playground consists primarily of manufactured play equipment surrounded by hard surfaces with little to no nature or natural materials (Woolley, 2007). A natural play space may include manufactured play equipment but vegetation and natural elements, such as water, dirt, mud, sticks, rocks and other natural loose parts, are also available to support play. One key to planning and designing successful, engaging outdoor and natural play spaces is understanding which natural elements and conditions will spark children's curiosity and support their desire to explore, build and imagine. With new and expanding interest in the value of nature-rich environments for children's play (Frost, 2012), it is essential to cultivate effective empirical methods for evaluating outdoor spaces in relation to children's preferences and their social, educational, emotional, and physical developmental needs.

There is limited knowledge to date about children's behavior in natural play spaces (Luchs & Fikus, 2013). Luchs and Fikus (2013) examined differences between the duration of play episodes on traditional and natural playgrounds, finding that play episodes lasted longer in the natural play space. Fjørtoft (2014) concluded that nature play supported an increase in motor fitness of 5- to 7-year-olds. Other studies have concentrated on the level of moderate to vigorous physical activity when children play in natural versus traditional play spaces (Coe, Flynn, Wolff, Scott, & Durham, 2014; Dyment, Bell, & Lucas, 2009; Luchs & Fikus, 2018). These studies form the base of an evolving body of scholarship on children's outdoor play

and nature engagement behaviors. Continuing research on play in nature is needed to inform the design of natural play spaces, including identifying the outdoor play settings that attract the most use, understanding which play settings or features children in different age groups prefer, and recognizing how different settings or conditions can support engagement with nature.

Behavior mapping is a promising, yet underutilized, field observation tool that can be effectively tailored to the study of children's behavior outdoors and in nature. This paper outlines a customized Behavior mapping protocol that can be used to answer diverse research questions on children's play behaviors *in situ* within natural play spaces. Capturing, understanding and sharing this kind of empirical evidence will benefit design professionals and play advocates looking to provide outdoor play spaces that will support diverse, fun, and meaningful nature play opportunities for children.

The Promise of Behavior Mapping

Behavior mapping was initially developed by environmental psychologists as a way to relate "various aspects of behavior to the physical spaces in which they are observed" (Ittelson, Rivlin, & Proshansky, 1970, p. 658). It was developed as a way to study environmental influences on behavior and recognizes the reciprocity of the environment and *in situ* behavior. Behavior mapping is one of the few tools that allows researchers to investigate and document both behavior and the social and environmental context, or the "milieu." It relies on direct observation of behavior coupled with a map of the geographical space on which the behaviors are recorded, analyzed, and displayed. Observers first note the geographic location of the observed participant on a map of the space. Data are then collected in relation to the behavior observed in that location and can include participant demographics, behavior, social interactions, and environmental conditions. The data are later displayed and analyzed in an iterative manner that allows researchers to explore relationships between the setting and the observed behavior. As an example, behavior mapping was used to observe and map children's science learning behaviors at the Bay Area Discovery Museum in Sausalito, California, which in turn allowed researchers to draw a number of conclusions about opportunities for engagement with loose parts in support of science learning for young children (Moore, Cosco, Kepez, & Demir, 2003).

One of the first uses of behavior mapping to explore *children's* outdoor behaviors was a study that examined outdoor play behavior in a residential setting (Sanoff & Coates, 1971). That study examined children's play as it related to spaces intended for prescribed behaviors (such as horseshoes or basketball), as well as more informal, ambiguous outdoor spaces, and found that the former were most popular, but that children playing in informal environments exhibited more diverse play behaviors (Sanoff & Coates, 1971). Other early work in the mapping of children's environmental behavior included examinations of children's play in neighborhoods and playgrounds (Nummenmaa & Syvänen, 1974; Björklid, 1982; van Andel, 1984; Moore & Wong, 1997). A more recent study used behavior mapping to determine that loose parts, a sense of enclosure, and natural settings support dramatic play (Drown & Christensen, 2014), while Bozkurt & Woolley (2017) used this method to

study children's behavior in urban water features. Cosco, Moore, and Islam (2010) refined behavior mapping methods while focusing on physical activity levels of preschoolers.

Behavior mapping can be particularly appropriate for studies involving children when other research methods, such as interviews or questionnaires, may be less effective (Sommer & Sommer, 2002). For instance, children do not necessarily understand what is expected of them in an interview situation, and so may try to guess at what the interviewer wishes them to say, or feel pressured to give a rapid or brief answer (Fargas-Malet, McSherry, Larkin, & Robinson, 2010; Eindarsdottir, 2007; Clark, 2005). Their knowledge on the interview topic may also be implicit, that is, not part of their conscious awareness, and therefore children may not be able to fully articulate their experience or preferences (Graue & Walsh, 1998). Questionnaires require a certain level of literacy or understanding of the language, and some children may respond to questions even when they do not know or understand the answer (Fargas-Malet et al., 2010). Methods that do not solely rely on children's understanding or communication skills can be more effective for capturing their activities.

A Behavior Mapping Protocol for Investigating Outdoor Play Environments

The aim of this paper is to illustrate how a customized behavior mapping protocol can be an effective method for capturing children's play activities in natural play spaces, and for examining how specific environmental components can support diverse play activities and social interactions. First, we provide a detailed outline of our behavior mapping protocol, tailored to observe play in natural play spaces, including discussion of data attributes highly useful for defining children's outdoor play behaviors and for evaluating the elements of natural play spaces. Following the outline of the protocol, examples from a recent study by the authors will illustrate the value of this behavior mapping approach for examining children's behavior and its context.

This behavior mapping protocol requires the following five core components: 1) a base map of the observation site; 2) selection of data collection tools; 3) establishment of a systematic protocol for collecting data, including among multiple observers; 4) a set of observable data variables that address the objectives of the research; and 5) a strategy for data analysis. These five components are described in detail below.

1. A Base Map of the Observation Site

Base maps of the environment can reveal a great deal of information about the site and are therefore key in the environment-behavior analysis. When evaluating outdoor play spaces, a map allows researchers to record numerous physical components of the site and document the layout of the environment. Maps can store information such as the location, scale and layout of vegetation, play structures, or pathways, as well as their proximity or adjacency to other objects in the space. Relationships between activities and the environment may be difficult to ascertain in the fluid, constantly changing outdoor play environment; base maps

can help to permanently capture conditions of the environment and preserve it for later evaluation.

1.1 Using Geographic Information System (GIS) Technology for Behavior Mapping

The use of Geographic Information Systems (GIS) for behavior mapping allows for more efficient, accurate, and complex data analysis and communication. A base map created in GIS can include a variety of data, such as site boundaries, existing vegetation, site structures, waterways, and pathways. Using GIS, information from an observed play interaction can be directly tied to the precise location of the observation; behavior data can then be stored and processed based on their location. Prior to the use of GIS, behavior mapping analyses tended to include only one or two data attributes such as gender differences in play, or the locations of imaginative play; however, it was difficult to consider the interaction of the two. Multiple play-related attributes such as child gender, activity intensity, and play type can now be easily stored, sorted, and displayed together in a GIS, allowing for the development of large data sets as well as faster and more complex analyses. The use of GIS does require expert knowledge and experience, but this is becoming more commonly available; those undertaking behavior mapping can often find GIS specialists for partnerships at most universities or governmental agencies.

1.2 Creating Observation Zones within the Base Map

Prior to conducting observations in the field, researchers should divide their base map into observation zones. Observation zones are created to divide large sites into multiple, smaller zones that facilitate observation by a single observer (see Section 3 below). By systematically rotating through each observation zone, observers can manage their time across the site and ensure that all zones are scanned equally and thoroughly. The size and number of observation zones established will vary by site, and depend on many factors, such as the number of observers, the visibility of various play settings, and user density at the site. Ideally all areas within a zone are visible from a single observation point. For high-density sites, each observation zone may only include a single play setting, such as a large sandbox area; for lower-density sites, the researcher may choose to include multiple play areas in a single observation zone. Utilizing natural boundaries, such as pathways, borders, and vegetation, is a good strategy for establishing the bounding edges of observation zones.

2. Data Collection Tools: Paper-Based, Digital, and Hybrid Methods

To conduct behavior mapping in outdoor play spaces, field data collection will include recording several elements of each play event being observed: its physical location in the space, demographic data about the child observed (e.g., gender, age group), data about the play interaction being observed (e.g., play type, physical activity level, social interaction, environmental engagement), and environmental data (e.g., ground surface, shade, or topography). The physical location of the play event is recorded as a point on the map of the study area. Corresponding demographic characteristics and behavioral or environmental data from the same play event are recorded in a table or database. Each event location recorded on the site map will be tied to a row, or record, of data in the table. For analyses and

display, these data will all need to be imported into a GIS, such as ESRI's ArcGIS (https://www.esri.com/en-us/arcgis/about-arcgis/overview).

There are three options currently available for collecting outdoor play behavior data in the field: 1) a fully paper-based method, 2) a fully digital method, or 3) a paper-digital hybrid. Each of these three field collection systems has advantages and disadvantages. Selecting which system will work best for a given project depends on the budget of the project, the degree of access to specialized equipment, the expertise of data collectors, as well as access to appropriate software and technicians.

2.1 Paper-Based Method

A strictly paper-based method, in which data collectors take both paper maps and paper-based data collection tables into the field, is the most economical method and requires the least amount of observer training. However, it requires that all data collected in the field be eventually transcribed into a GIS. For a paper-based protocol, each data collector will need a large clipboard and a pen to record observations on the paper map and table. It is recommended that researchers use large but manageable paper sheets; an 11" x 17" format is ideal. For each play event observed, the observer locates the child being observed by placing a dot on the paper map, and numbering the dot. That number is placed on a row in the table, and attribute data for the play event is hand-written across that row for that observation. Once field collection is complete, the data from the paper-based maps and tables are entered into a GIS for analysis and display.

2.2 Digital Method

A second option is to develop a completely digital system for collecting field data in outdoor play spaces. For this approach, observers take a computer tablet out to the field and collect both the location and variable data directly into the tablet. The equipment, software and additional training required for this option makes this the most expensive approach. However, it generally results in less data entry and processing, which has the advantage of saving time and minimizing the opportunity for data entry errors. When selecting software for collecting field data, it is important to consider how accurately the software records locations. With some software the mapped location of the observation may be incorrect. Knowing the location of an event accurate to within three meters may be appropriate for some studies, but it is not accurate enough for behavior mapping of children's play behaviors. Researchers may need to know precise locations of children in their study, such as whether they are *near* the play structure or *on* the play structure, which may not be possible with some software. Also, it is important to select a tablet that is appropriate for collecting data in the field; it is recommended that the tablet is suitable for viewing in sunlight and resilient in damp or rugged conditions.

2.3 Hybrid Method

A hybrid system combines the use of a digital storage device, such as a tablet or cell phone, to record behavioral and environmental attributes in a digital database, with a paper-based map to record the locations of observed play events. This approach can be faster than having to physically write down the attribute data on

paper, as the digitally collected data can be transferred directly to the GIS system. Digital databases can also be pre-programmed with common variable options (e.g., through pre-selected codes or pull-down menus) to speed up data recording in the field. Drawbacks to this system include the awkwardness of carrying two systems out into the field, and the eventual need to transfer the paper-based map data to a GIS.

3. Establishment of a Systematic Protocol for Collecting Field Data

A systematic protocol to collect field data using multiple observers needs to establish: the number of researchers involved in the collection of field data, the timing intervals of observation rounds, the scanning method to be used to systematically observe play events, and the integration of reliability rounds.

3.1 Number of Observers Used to Collect Data at the Site

The number of observers engaged in data collection in an outdoor play space under study should be based on the size of the site and the availability of trained data collectors. This may ultimately be determined by the research budget. It is convenient to have the same number of observers as observation zones (i.e., four observation zones, four researchers). Often outdoor play spaces have a few peak hours with high usage, so having enough observers available during these busy times is invaluable for maximizing data collection. Proper training of data collectors is critical, and ample time should be allowed to ensure observers are properly and consistently recording data from play events before official data collection commences.

3.2 Systematic Timing of Observation Rounds

To ensure that the process of data collection using behavior mapping is systematic and repeatable, an observation protocol must be agreed upon and strictly followed. For outdoor play spaces, designating a 15-minute period to perform scans in a single observation zone is a useful place to start. This time period may be shortened or lengthened based on activity at the site and size of the observation zone. If the research team has multiple observers on a single site, simultaneous scanning of zones should take place, with all observers completing scans within the same designated time period. This time block is then broken up into three 5-minute periods. At the beginning of each 5-minute period, the observer begins scanning for observable play events from the designated starting point (see Section 3.3). Observers will continue scanning and recording play events until the 5-minute period is over. Note that observers may be finished recording all play events in that zone before the 5-minute period is up, but they must wait until the next 5-minute block begins before continuing with their observations at the beginning of the zone. However, if the observer does not finish the scan within the 5 minutes, then observation continues until the zone is completely scanned, but the clock resets; in other words, the scan extends into the next time block. In this situation, once scanning of the zone has been completed, the observer immediately starts over scanning the zone from the designated starting point. Once the 15-minute period is up, observers will move to their next designated observation zone and begin the process again. A "round" is a full rotation by a single observer through all the observation zones. When multiple observers are available, they should be

spread out as evenly as possible between the observation zones to start, and then rotate through zones in the same order until they have completed a full round.

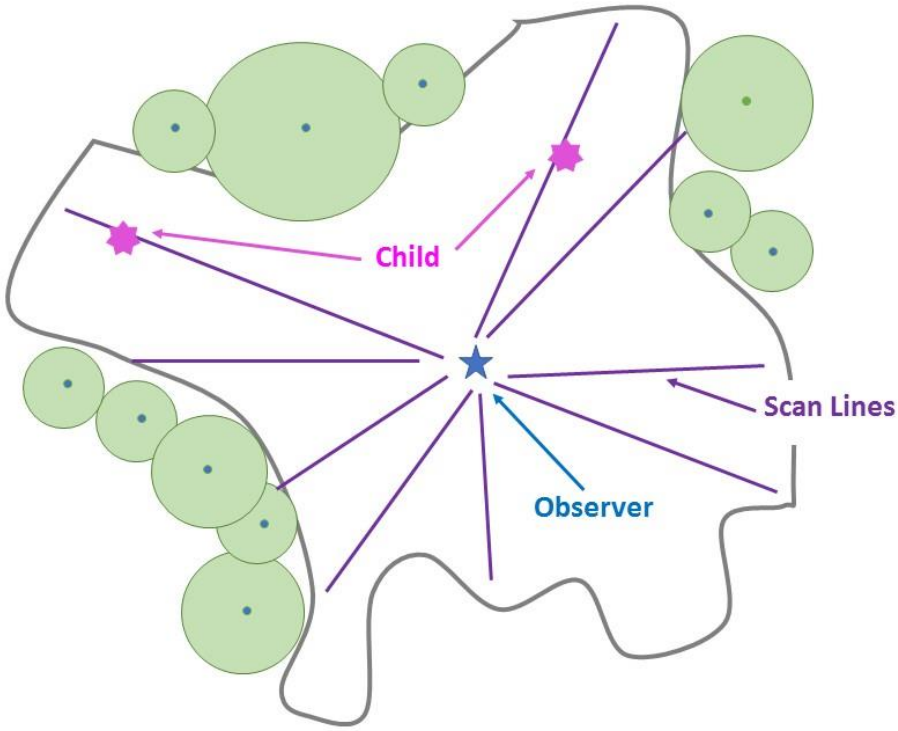
3.3 Scanning the Observation Zone

Each zone needs to be systematically "scanned" by the designated observer. An observer will start to visually scan the zone (see below for different approaches to scanning a site), until a child is observed; after observing them for 10-15 seconds, the observer then records data about that event. Shorter observation periods may be used for data collection that is easily observable, such as physical activity, however, the recommended 10-15 second interval allows the data collectors to observe other cues in the child's behavior (e.g., vocal information, peer interactions), which allows for more nuanced information to be gathered. Once the encounter is recorded, the observer moves along in their scanning pattern until the next child is encountered. A child moving quickly through the site may be missed by the observer, or a child may be encountered several times in an observation interval; this is an inherent issue in a behavior mapping approach. However, as the goal of the data collection is to evaluate the environment-behavior relationship in the play space and not an individual's behavior, this does not compromise the results. It is assumed that enough data will be collected during the field observations that anomalies will be minimized.

3.3.1 Scanning method A: Zone

For observation zones that are not linear trails or pathways, zone-based scanning is an effective approach. The observer stands in the pre-designated location within the observation zone and begins visually scanning the space. The zone is then scanned in either a clockwise or counterclockwise pattern; observers agree on a common scanning pattern before beginning. Once the observation has been recorded, the observer looks to the location of the last observation and continues scanning in the same direction until they encounter the next child engaged in play (Figure 1).

Figure 1. Example of a zone scan

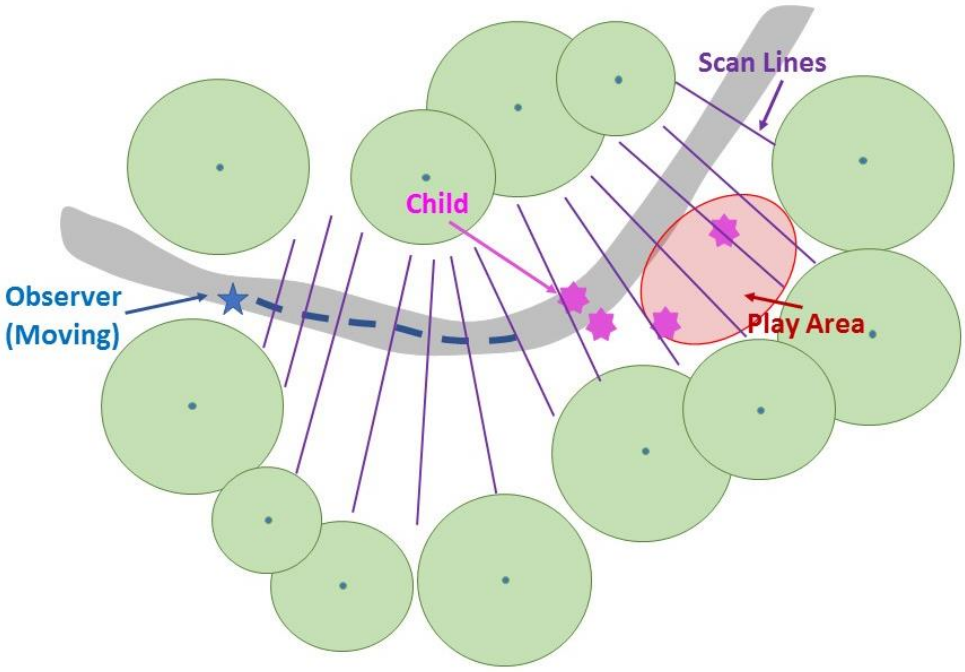


Note: During a zone scan, the observer stands in the center and rotates around the site, recording any child when observed along scan lines.

3.3.2 Scanning method B: Trail

A "trail" method of scanning was developed for observation of linear areas such as trails, greenways, and pathways (Cox, 2013). This method is similar to the "zone" scanning method above, however the observer does not remain stationary. Instead, the observer walks along the pathway from a designated starting point and determines an imaginary line at some pre-determined distance in front of the observer (e.g., 20 feet). When a child is detected along that line, the observer stops and records the location and behavior. The observer walks along the path at a steady but relatively slow pace to continue observing until reaching the end of the linear zone (Figure 2).

Figure 2. Example of a trail scan



Note: In the trail scan method, the observer walks along the pathway and scans with an imaginary line (shown in purple), recording the children observed as they are scanned along the path. Trees can often serve as natural boundaries.

3.3.3 Scanning method C: Zone and trail hybrid

Some outdoor play spaces may have a layout that requires a combination of zone and trail scanning methods. Usually, this would be a very large site that contains play opportunity zones connected by pathways. It is beneficial to scan the entire site equally to observe the broadest range of activities at the site. Figure 3 depicts an example of a large site that required a mix of these scanning methods.

Figure 3. Example of a large outdoor site that included both zone scanning areas and trail scanning areas

Note: Observers scanned in zone areas where appropriate (areas shown in pink) and scanned pathways between zones using the trail method (areas outlined in red).

3.4 Reliability Rounds

A reliability round should be regularly integrated into the data collection schedule to ensure inter-rater reliability, i.e., a high degree of consistency in the way each observer is recording the play events. During reliability round observations, all observers code a single play event together at the same time. Typically, one observer identifies a child to observe and then indicates the exact time when the observation will begin, so that all observers are capturing exactly the same play event. Observers code a series of play events independently and then compare records for consistency. In addition to comparing records informally in the field to identify and correct any common inconsistencies, reliability of observations between coders can be formally analyzed using the kappa coefficient (k) (Cohen, 1960). Typically, a k value between 0.61 and 0.80 is considered substantial agreement and a k value between 0.81 and 1.00 is considered almost perfect agreement (Landis & Koch, 1977).

4. Establishing a Set of Observable Variables to Be Collected

It is important to carefully consider the set of attributes or variables (such as user demographics, behaviors, environmental interactions, environmental conditions) that will be collected in the field. It is important to note that the more data variables collected, the more time required for each observation, and therefore fewer total observations are possible within the data collection period. Once data are loaded into a GIS, each point on the map will have a row containing all the data collected for that point. Based on the authors' experience conducting behavior mapping of children's play in outdoor or nature play spaces, we recommend collecting the following core set of attributes for each observed play event: 1) basic demographic information about the observed child, such as gender and age group; 2) primary play types; 3) peer interaction; 4) activity intensity; 5) wildlife interaction; and 6) environmental interaction.

However, it is important to note that each of these attributes is an example of static coding—that is, the team will collect data by choosing from a pre-selected set of options. It is also valuable to include a column that allows for "open coding," particularly to capture the nuances of playful interactions with the outdoor environment; this is an unstructured attribute which allows the observer to freely (but briefly) describe the observed play event, such as "2 boys climbing tree, pretending to be monkeys, vocalizing." This can help to both animate the data collected and provide a valuable source for confirming that other data has been coded correctly.

4.1 Child Demographics

Gender and age are the typical child demographic variables that are assessed during behavior mapping; other child demographic information can be difficult to observe.

Gender can be coded as "male," "female," or "unknown." Having gender information may be useful to ensure balanced play opportunities for all children. Information on the age of the observed child is also valuable, though a child's age can be difficult to estimate; the observable difference between a 7- and 8-year-old is unlikely be detectable. Instead, observing a child's age in age range groups (e.g., 0-3 years, 4-8 years, 9-12 years, and 13-18 years) is more feasible, and has resulted in higher data reliability for the authors.

4.2 Primary Play Types

Categorizing the type of play being observed in the field is a difficult but useful process. Play type categories generally describe the character of the play being observed (e.g., imaginative play), which then allows for a comparison of play behaviors within and across outdoor play spaces. There are many benefits to using a pre-defined set of play types when observing children's outdoor behaviors, including faster field recording of behaviors, which enables observers to collect more data. Another advantage of using an established set of play types is the ability to systematically compare behaviors across studies and sites. Examining the frequency and diversity of play types allows researchers and designers to understand the play affordances children perceive within the outdoor play

environment; play spaces can then be tweaked or redesigned if the space is not supporting a broad range of activities.

The "play type" scale most frequently used to date for recording observed play behaviors is the Play Observation Scale (POS) developed by Rubin (2001). It is primarily based on the cognitive classification of Piaget's stages of development, Smilansky's elaboration of that classification, and Parten's social hierarchies (Piaget, 1962; Smilansky, 1968; Parten, 1932; Rubin, 2008), and consists of four cognitive play types: Functional, Constructive, Dramatic, and Games-with-Rules. It also includes "Exploratory" behavior as one of eight non-play behaviors, many of which are not applicable to the examination of children's outdoor play environments. The scale is widely used in children's play-based research, and by researchers working in the domain of child psychology who focus on children's normative development. It is important to note, however, that this scale was developed to gauge children's play in an indoors setting with the researcher sitting close to the child and observing them for timed intervals, recording the predominant play activities observed (Rubin, 2008).

Observing play activities in outdoor settings, however, presents different challenges to the observer. For example, listening to vocal cues from children to help understand the play being observed can be more difficult outside, as the observer needs to be at some distance if they wish to remain unnoticed by the child so as not to influence their behavior. While the POS was a useful starting point, its focus on indoor, child-centered studies makes it less useful for a place-centered evaluation of outdoor play. The authors therefore recommend utilizing the adaptation of Rubin's scale shown in Table1 to capture play types while using behavior mapping in outdoor or natural environments.

Table 1. Play types scale

Play Category	Brief Summary
1. Locomotor or Functional Play	The child is using their body as the primary form of play, such as climbing a tree or running across a field
2. Play with Rules	The child is engaged with others in a game or competition, such as organized soccer
3. Imaginative	The child is engaging in dramatic or imaginative play
4. Constructive	The child is building or making something, such as forts, dams, or mud pies
5. Exploratory	The child is engaged with an object or objects in the environment and receiving information through contact or exploration with the objects, such as holding and examining a pinecone
6. Restorative	The child is engaged in quieter, restorative activities such as resting, reading, or writing
7. Non-play	The primary activity is not considered play, such as eating or self-care

Note: adapted from Rubin (2008)

4.3 Activity Intensity

Collecting information on the physical intensity of children's activity during play can be advantageous. One of the advantages of outdoor activities is the opportunity for increased physical activity levels (Gray et al., 2015; Larouche, Garriguet, & Tremblay, 2016; Stone & Faulkner, 2014). Knowing which outside play areas and components provide opportunities for varied levels of activity intensity can aid in developing sites that promote physically active play. One of the statistically valid instruments utilized to observe physically active play behaviors is the Children's Activity Rating Scale (CARS) (Puhl, Greaves, Hoyt, & Baranowski, 1990). The CARS tool assesses the intensity of physical activity during an observed play event through a 5-point scale: a score of 1 means the child is stationary or motionless; a score of 5 is recorded when the child's movement is very fast or hard (Puhl et al., 1990). Thus, as the physical exertion required for the activity increases, the CARS score increases. This scale can be easily integrated within a behavior mapping protocol to capture the physical intensity level of children's outdoor play.

4.4 Wildlife Interactions

Humans seem to have an affinity towards wildlife, and often express fascination while observing animals (Schänzel & McIntosh, 2000). Potential encounters with wildlife are a particularly unique aspect of children's play in outdoor spaces. Children's wildlife encounters can include, for example, digging for grubs, capturing caterpillars, poking sticks at polliwogs, listening to birds, and/or viewing turtles, birds and mammals.

In a recent study that examined children's connection to nature, concern for living creatures, together with personal enjoyment of nature and a positive attitude toward human-nature interdependence, explained 50 percent of the variance in children's perceived connection to nature (Cheng & Monroe, 2012). This is significant, as the connection to nature can strongly influence pro-environmental behaviors (Chawla, 2007). Studies on adults indicate possible psychological and spiritual benefits from connecting with wildlife (Curtin, 2009; Folmer, Haartsen & Huigen, 2018).

Children's wildlife interactions during play or in outdoor play spaces have been rarely researched (Ernst & Theimer, 2011; Kellert & Westervelt, 1984). In a previous behavior mapping study, children were primarily observed in areas with play equipment, as well as places with benches and bridges (Cox, 2013). However, an anomaly resulted when children encountered wildlife; they would intentionally stop in other areas to observe and interact with turtles, caterpillars, and polliwogs.

In order to document children's exposure to and interaction with wildlife in outdoor play spaces, the authors created a preliminary scale of wildlife interactions that can occur outdoors and in nature. The scale is currently being refined; additional details on this scale will be published elsewhere, but the categories shown in Table 2 provide a core set of potential wildlife interactions that can be recorded during behavior mapping exercises.

Table 2. Preliminary scale for observing children's wildlife interactions

Behavior Mapping Code	Details
1. No wildlife interaction	No wildlife interaction observed
2. Observing	The child is observing: a. Captive wildlife b. Non-captive wildlife
3. Handling	The child is handling: a. Captive wildlife b. Non-captive wildlife
4. Searching for	The child may be digging in mulch, looking under a rock, etc. Verbal cues or the use of butterfly nets or collecting jars may indicate searching to an observer
5. Rescuing/Caring for	The child may be attempting to "rescue" or "care for" wildlife such as moving an animal off the trail, out of the water, or "feeding" it
6. Harming	The child may be trying to harm (or kill) wildlife—usually wildlife the child fears or dislikes such as bugs or snakes
7. Talking About	When talking about wildlife, the child appears: a. Interested b. Excited c. Averse
8. Other	An open category can be included for interactions that do not fall into another category

Note: This scale is under development by the authors.

4.5 Peer Interaction

A key element to consider when observing children's outdoor activities is how the children may be interacting or engaging with their peers through play. Young children acquire and practice social skills through play activities, including learning to cooperate and share, as well as how to negotiate or consider the opinions of others (Parten, 1932; de Valk, Bekker & Eggen, 2015). Observing how and where children interact with their peers during play can help us to understand both these developmental interactions and the environmental features or conditions that can support various types of social play.

The work of numerous scholars around social participation provides a number of scales that can be integrated within a behavior mapping framework to record observed peer interactions during outdoor play. Parten (1932) set out categories of "social participation" for pre-school children, dividing social interactions into unoccupied play, onlooker behavior, solitary play, parallel play, associative play and cooperative play. Coding in terms of this diverse set of interactions allows an observer to not only capture nuances in the types of solo play (solitary and parallel play) and group play (associative and cooperative play) in which children engage, but also to identify when a child is not actively focused on a particular play activity (unoccupied play) or when they are observing others playing without actively engaging in the play activity themselves (onlooking). These distinctions can help

observers to evaluate the broad range of social play opportunities afforded by a given environment, across a diverse group of child users.

While various peer interaction scales could be used as part of a behavior mapping approach to record social engagement occurring during outdoor play, the authors have generally used an adapted version of Parten's scale, categorizing children's outdoor play into solitary, onlooking, parallel, cooperative, and conflict (Table 3). The largest difference is the collapse of Parten's associative and cooperative play categories, as the distinction can sometimes be hard to observe in the field. The authors have also added the category of "conflict" so as to be able to record the play activities or environments that may lead to unnecessary conflict between children and their social peers. While some conflict may be beneficial for children's development of negotiation skills, site managers may wish to re-evaluate environmental conflict zones.

Table 3. Adapted Parten Scale (1932) for observing peer interactions

Behavior Mapping Code	Details
1. Solitary Play	The child is playing on their own, either at a distance from other children or occupied in play that is distinct from nearby children
2. Parallel Play	The child is playing on their own, but in close proximity to other children engaged in similar play activities
3. Cooperative Play	The child is engaged in a common play activity with one or more children
4. Onlooking	The child is actively observing the play of others (often from a distance) but not actively engaging in the play activity themselves
5. Unoccupied Play	The child is not actively focused on a particular play activity
6. Conflict	The child is involved in some type of conflict with one or more other children

4.6 Environmental Interaction

As discussed earlier, one of the great advantages of behavior mapping is the ability to record not only children's play behaviors, but also how specific affordances in the play environment are involved in or support the observed play event. It is therefore extremely valuable to collect data on environmental elements that may be integral to the play (e.g., a child is using a found stick as a "wand" in a Harry Potter-inspired game), as well as specific environmental conditions (e.g., shade or topography) at the time and location of the observed event.

Understanding how children may be using the features available in that environment (e.g., loose, found objects or fixed elements such as trees or benches) to inspire or support their play activities is also critical information for those involved in the design or provision of outdoor play spaces. A simple set of

"environmental interaction" data to collect, such as the coding suggested in Table 4, would take note of whether the child used any fixed features or loose parts in the observed play event. This set of codes could also be expanded to note whether these fixed or loose features are natural (e.g., sticks, sand, tree stumps) or manufactured (e.g., sand shovel, bucket, toy car).

Table 4. Sample set for coding environmental interactions

Behavior Mapping Code	Details
FM - Fixed Manufactured	The play activity directly involves a fixed manufactured element (e.g., play structure, fence)
FN - Fixed Natural	The play activity directly involves a fixed natural element (e.g., tree, boulder)
LM - Loose Manufactured	The play activity directly involves a loose manufactured element (e.g., shovel, toy car)
LN - Loose Natural	The play activity directly involves a loose natural element (e.g., stick, sand, water)
Open	Specific details of the elements involved and/or interaction are recorded (e.g., using shovel to put sand into a pail)

An even more detailed environmental interaction scale can be utilized if a research team is trying to capture very specific data around the use of the environment for play. For environmental interactions, an associated open-coded attribute that records the specific fixed or loose elements involved (e.g. bucket, spoon, sand, or pinecone) can be extremely helpful to analyses.

Beyond the environmental elements that may be involved in a play event, it may also be helpful to record information about the environmental context or conditions at the time of and in the specific location of observed play, such as:

- Shade conditions: full shade, partial shade, no shade, not applicable
- Topography: flat, rolling, slope, uneven, other
- Ground surface type: asphalt/concrete, rubber, gravel/stone, grass, mulch, sand, other

5. Strategies for Analyzing Data from Behavior Mapping

Using a GIS to display field data on a site map is instrumental to data analysis and our understanding of the patterns of children's outdoor play. Data can be visually analyzed to examine site usage levels and to look for patterns in behavior within individual play settings; for example, behavioral data points can easily be sorted by gender and displayed accordingly on the site map. Patterns that are not identifiable *in situ* can also be more easily noticed when projected on a site map. Many analyses will be based on specific research questions, but interesting insights can also be revealed through an iterative, visual exploration of data maps.

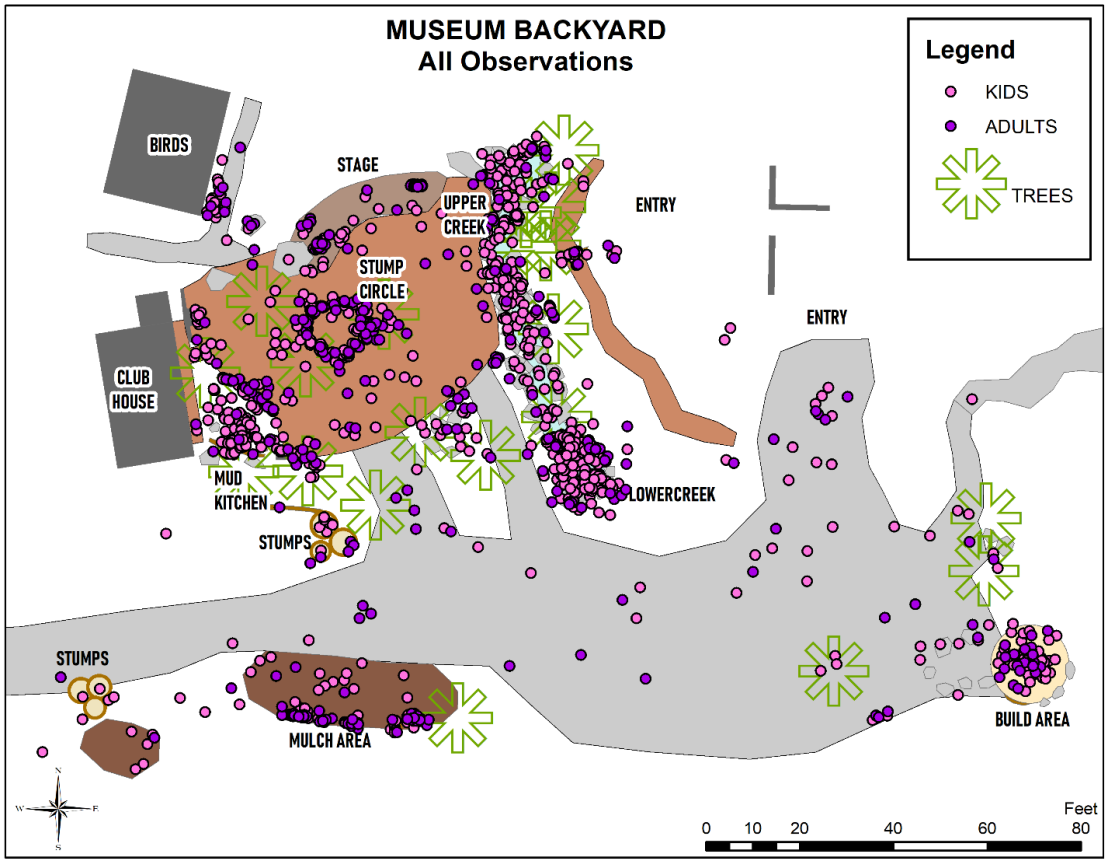
Pilot studies are a helpful and efficient way to evaluate and refine research tools and action plans (van Teijlingen & Hundley, 2001). The authors recommend that researchers spend time collecting pilot data at the study site and practicing observing children playing *in situ* before official behavior mapping data is collected. This strategy allows researchers to refine base maps, confirm observation zones, and refine the data collection protocol.

Behavior Mapping Case Study: The "Backyard" at the Santa Barbara Natural History Museum

This case study is meant to provide a glimpse into the rich data that can be captured in outdoor or nature play spaces through this customized behavior mapping protocol. The authors utilized this framework to study the outdoor nature play area (the "Backyard") at the Santa Barbara Museum of Natural History. Data were collected by three observers over a seven-day period in the summer of 2017. The facility was interested in capturing both the behavior of children playing in the outdoor space, as well as the activities and locations of adults such as parents and staff. A total of 826 observations of children and 317 observations of adults were collected during play activities on five weekdays and two weekend days, for a total of 1143 data points.

A look at a general map of all observations illustrates which areas are the most popular in the play space (Figure 4). The map shows children's activities heavily concentrated in the mud kitchen and along the water-fed creek area. Conversely, adults are most concentrated in areas where there are seating opportunities (i.e., benches, a log in the mud kitchen, and the stump circle).

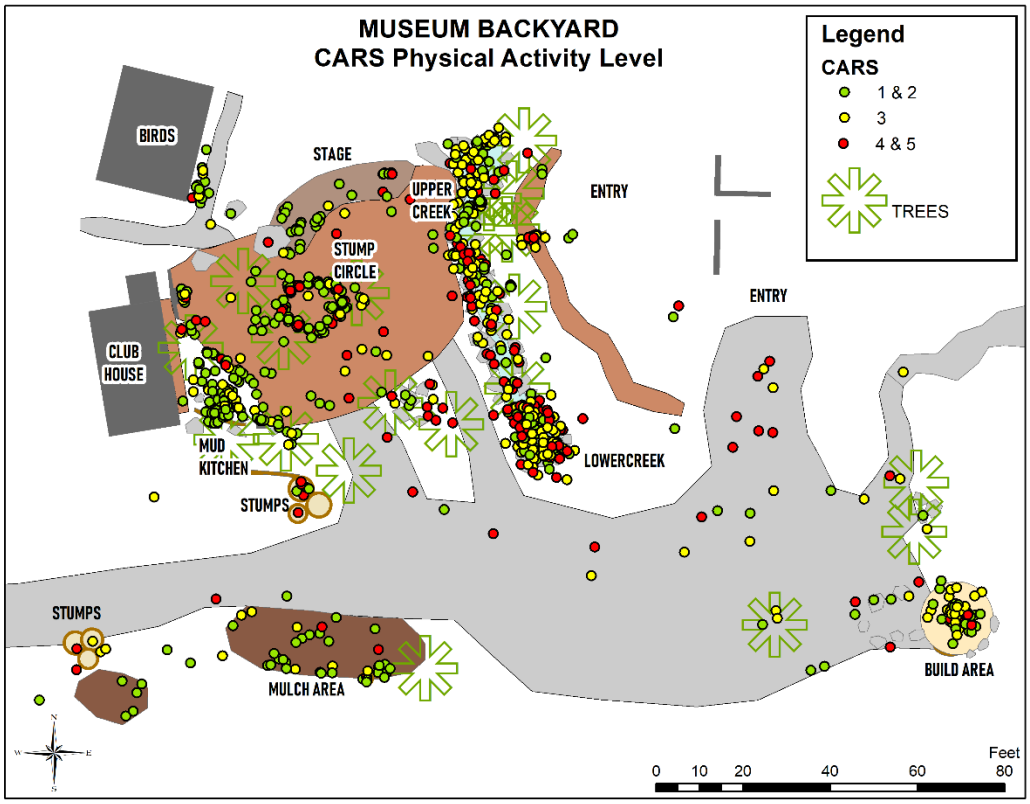
Figure 4. Map showing the overall layout of the Museum Backyard and the locations of all observations



Note: Benches were located on the stage and at the back of the mulch pile, which increased the concentration of adult observations at those locations. Observations of children were heavily concentrated along the creek, in the build area, and in the mud kitchen.

Figure 5 maps the children's play activities in the space according to the recorded level of physical activity. The highest levels of physical activity (moderate and vigorous, corresponding to a CARS score of 4 or 5, designated by red dots) are not clustered in a single area, but spread throughout the site (Figure 5). Mapping revealed there is a higher proportion of moderate and vigorous play activity along the gravel entryway, where a somewhat steep slope invites children to run down the hill as they enter the site. The boulders along the upper creek and lower creek and the trees in the rock and trees area encouraged climbing. Behavior mapping helped us to confirm that the environmental features in these areas supported opportunities for more physically active play.

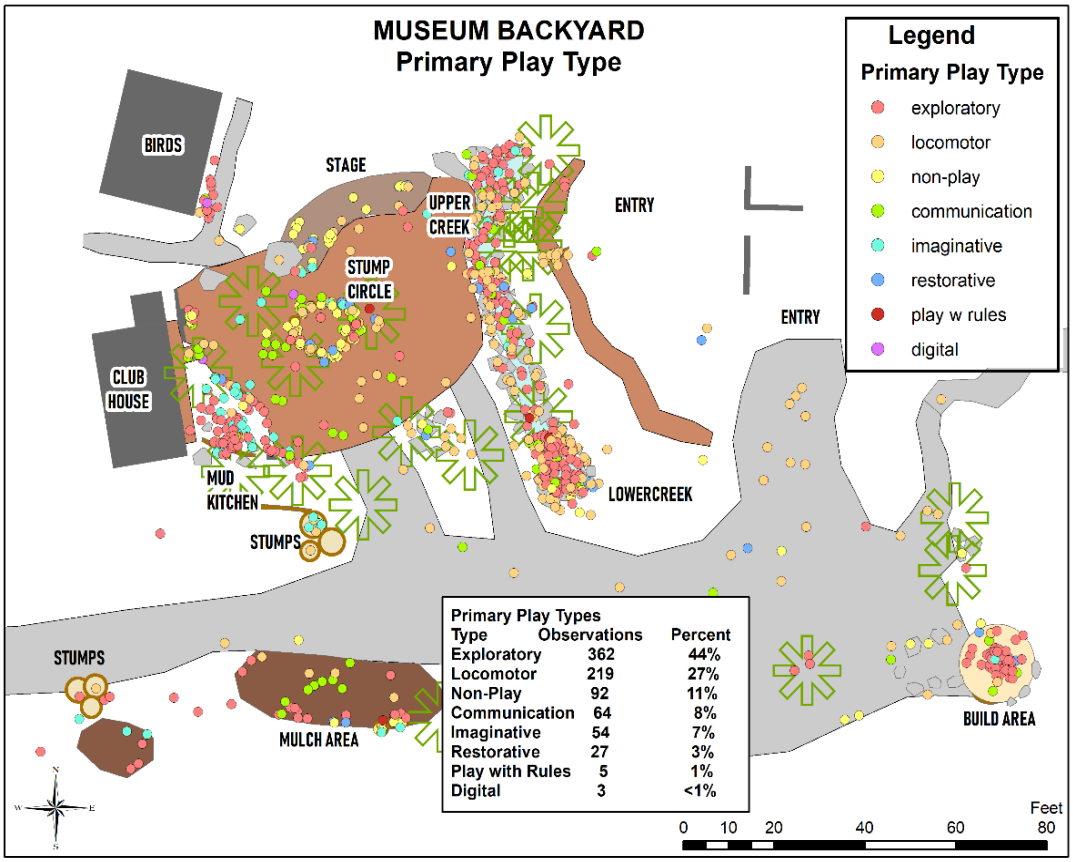
Figure 5. Map showing physical activity levels at the site



Note: The red dots indicate the highest levels of physical activity observed at the site. The boulders, frequently used for climbing, as well as the pathways supported the highest levels of physical activity.

Play types at the site were also recorded and mapped (Figure 6). Exploratory play was the most frequently observed play activity, accounting for 44 percent of the primary play activities, followed by locomotor play (27 percent). The vast majority (82 percent) of observations of exploratory play involved interaction with loose parts (see Figure 7). In contrast, locomotor play (see Figure 8) only involved loose part interaction in 37 percent of the observations. This suggests that the availability of loose parts may be particularly valuable for supporting imaginative play in outdoor play spaces.

Figure 6. Play types observed at the site



Note: The new play type scale the authors are developing has eight hierarchical types, with 27 sub-types. This map is limited to the top eight types in the hierarchy for ease of display.

Figure 7. Exploratory Play behaviors were associated with loose parts in 82 percent of observations, indicating that exploratory play may rely heavily on the availability of moveable loose parts in the environment

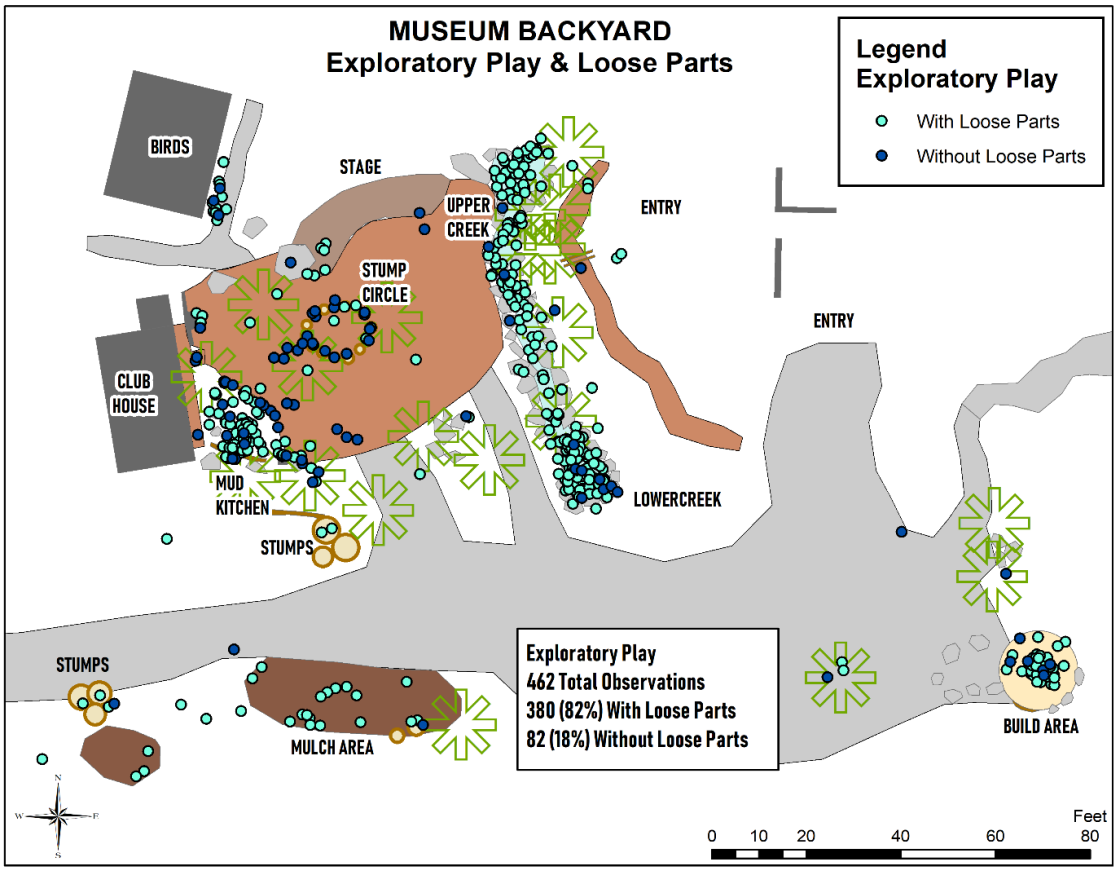
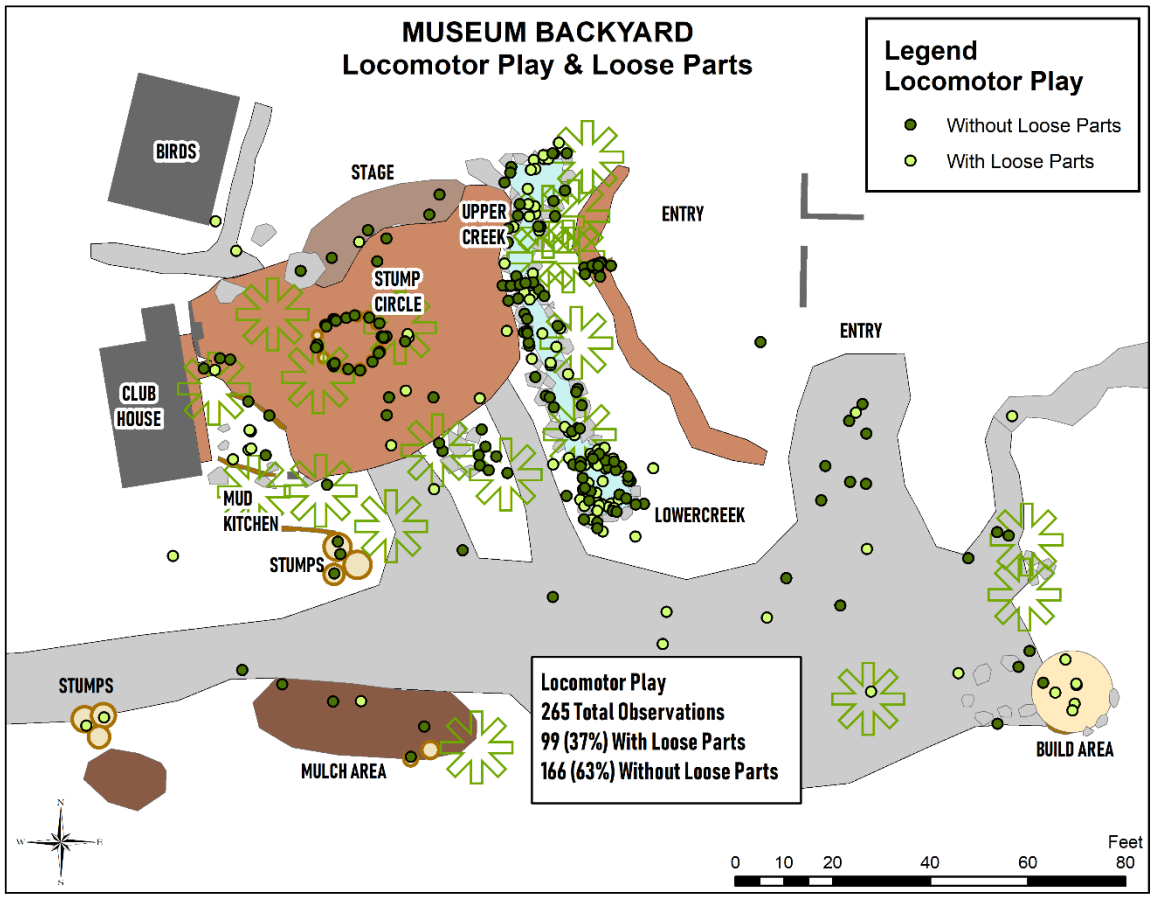


Figure 8. Locomotor activity was combined with loose parts in only 37 percent of observations, as compared to 82 percent of observations of exploratory play



As part of an effort to increase accessibility, the museum is undertaking a renovation of the Backyard play and learning space. This behavior mapping project is part of an ongoing study to help the museum understand how children and families are accessing and utilizing the site for nature play and exploration, to inform changes to the Backyard's design and programming. The data presented here are only a sample of the analyses being utilized by the museum, but provide an idea of the types of investigations in outdoor and natural play spaces that can be supported by this behavior mapping protocol.

Conclusion

Behavior mapping is a valuable approach for capturing children's play behaviors and environmental interactions in outdoor or natural play spaces. Although behavior mapping as a tool for recording environment-behavior interactions has existed for a number of decades, the framework outlined in this paper has been specifically tailored to address the unique conditions and challenges of capturing children's play behaviors in outdoor play spaces. Our recommended protocol

provides a flexible method that can be adapted to document children's diverse play activities in a wide range of outdoor spaces and accommodate a diverse set of inquiries. This method is also useful for collecting the rich details inherent in the nature play milieu.

Outdoor free play in natural environments has the potential to positively impact the healthy development of children. With an increase in the number of children living in urban areas, and decreasing opportunities for children to experience nature, well-designed nature play spaces can afford children opportunities that support their health and facilitate their development across a range of domains, as well as build positive relationships with nature.

Consistent use of this customized behavior mapping protocol across a broad range of outdoor play environments will allow researchers to compare and contrast children's outdoor play behaviors across differing environmental conditions. Understanding the components and conditions that create safe and challenging nature play spaces can help inform recommendations for the design and programming of outdoor play spaces for children to grow and thrive. Additional behavior mapping studies that address changes in children's behavior in outdoor play environments by season or over time would also be valuable contributions to this growing body of research.

Adina Cox *currently works at the University of Kentucky as a post-doctoral scholar in the Department of Landscape Architecture. She earned her Ph.D. in Design under the direction of Robin Moore at North Carolina State University (NCSU). She holds a master's in Natural Resource Management and GIS from NCSU and a bachelor's in Landscape Architecture from Cal Poly Pomona. Her research interests include children's outdoor play environments, independent mobility, children's wildlife encounters, pedestrian environments, and greenways. She emphatically believes it is important to find ways to increase children's daily exposure to outdoor natural environments and opportunities for play.*

Dr. Janet Loebach *is an environmental design researcher and consultant based in Ontario, Canada, and the principal consultant for Thrive Design Consulting. She currently holds a post-doctoral fellowship at the CAMH Institute for Mental Health Policy Research. Her research and practice focus on children's perception and use of their everyday environments, and the socio-environmental factors that influence children's behavior and well-being. Her areas of expertise include assessment and design of natural and built play and learning environments for children, as well as participatory, child-led and community-based planning processes. Dr. Loebach currently serves as Vice President of the International Play Association (Canada) and as co-chair of the Children & Youth Environments Network of the Environmental Design Research Association (EDRA).*

Sarah Little *is an Assistant Professor of Landscape Architecture at the University of Oklahoma and a registered landscape architect in the state of North Carolina where she practiced for 12 years. Her professional practice primarily consisted of high-end*

residential, children's environments, and park master plans. As a researcher, Dr. Little works to understand the influence of the physical environment on human development. Her current interests involve the relationship between children and nature, autonomous exploration of the physical environment, behavior mapping, and evidence-based design.

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