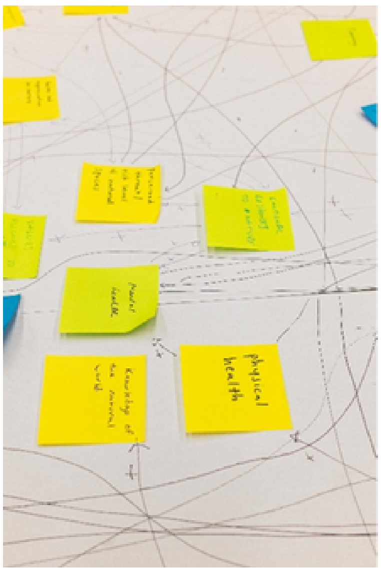
Report:

Participatory Systems Mapping Workshop

February 2023

How do children and young people connect with nature in Scotland?



MRC/CSO Social and Public Health Sciences Unit

UKRI Medical Research Council
Chief Scientist Office
University of Glasgow

Thank you.

A big thank you is due to the John Muir Trust for hosting the workshop and to the participants for your time, insight, and engagement in my ongoing research. Should you have any questions or comments, please feel welcome to get in touch.

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Report Summary

- In November 2022, a participatory systems mapping (PSM) workshop was hosted by the John Muir Trust and the University of Glasgow to explore how outdoor learning practitioners in Scotland understand the formation of nature connectedness in children and young people.

- This study is the first to use PSM to explore the formation of nature connectedness and presents a theoretical framework for future research and interventions designed to strengthen people's lasting bond with nature.

- 14 participants attended the workshop, representing different sectors of outdoor learning, including Scottish Government, Youth Awards, Youth Work, Inclusion, Teachers/Schools, Residential Centres, and Outdoor Education.

- Data were collected from participants in the form of written variables, listener reports, and four systems maps.

- During the workshop, practitioners identified and consolidated over 100 variables into 36 key variables that they considered most important. Variables that stood out as having the most connections to other variables in the system (high centrality) were "Affinity for Nature," "Child-led outdoor play," "Pleasure/Fun in Nature," "Carer respect for nature," and "Time in nature with peers."

- The PSM proved useful for quickly and collaboratively combining different types of knowledge to visualise a dynamic explanation of how nature connectedness develops as part of a complex system. However, the method struggled to distinguish between the different types of knowledge (e.g. peer-reviewed study vs. anecdotes) and fell short of fully communicating the impact of time and ageing on nature connectedness.

- The next stage of research will be to refine the map's complex systems theory through practitioner interviews and evidence triangulation. The final step will be to test its credibility against empirical data (the Children's People and Nature Survey) through the use of computational simulations, specifically agent-based modelling (ABM).

Introduction

Over the past decade, there has been a surge of interest in promoting 'nature connectedness', broadly defined as a psychological construct measuring a person's sense of their relationship with the natural world (Louv, 2013; Barrable & Booth, 2020, Hughes et al., 2019). More than just a feel-good concept, numerous studies have shown that a strong connection to nature can lead to improved health, well-being, and environmentally friendly behaviours (Whitburn et al., 2020, Barragan-Jason et al., 2022). However, despite a growing interest in the construct, we still lack a comprehensive understanding of how people develop their relationship with nature and how such connectedness can be fostered through policy and practice (Price et al., 2022). We can point to a long list of factors that may influence nature connectedness in young people, but it is not yet clear how these factors interact and which ones are most important for building lasting human-nature relationships (Lengieza and Swim, 2021). At present, few attempts have been made at building a theoretical framework that details how nature connectedness forms (Lengieza and Swim, 2021). We need to further address this knowledge gap. Recognising the value of nature connectedness as a means of promoting a healthier population and planet is of little use if we don't know how to enhance it.

Outdoor learning programmes, which are loosely described as educational activities that take place in natural settings, are one way to help people develop a stronger connection to nature (Barrable, 2019). These programmes are often targeted at children and adolescents, as positive experiences in nature during childhood have been linked to stronger nature connections later in life (Price et al., 2022, Otto and Pensini, 2017). In November 2022, the John Muir Trust in partnership with the University of Glasgow hosted a participatory systems mapping (PSM) workshop with 14 outdoor learning practitioners. The aim of developing a systems map was to explore how Scottish practitioners understand the complex formation of Nature Connectedness in children and young people, identifying variables and relationships deemed most important for enhancing and sustaining a lasting care and enjoyment of the natural world. This workshop was a preliminary step in my doctoral research, which will leverage stakeholder knowledge in building models and simulations to explore the impact of the John Muir Award on the long-term health, pro-environment behaviour, and social equity of young participants.

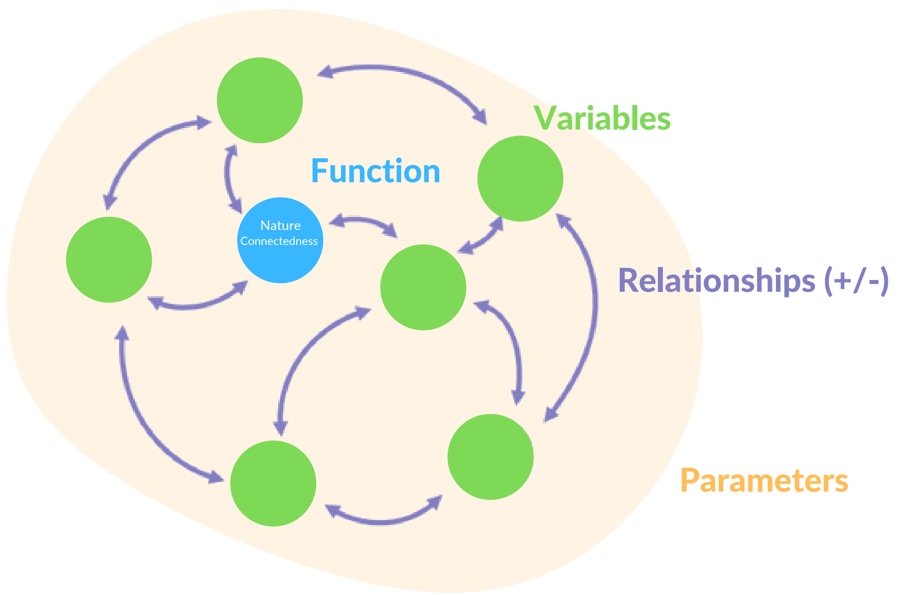
Following a brief introduction to PSM, this report is divided into three sections: 1) Research methods, which describes participant recruitment, data collection stages, and the types of data collected, 2) Results, which presents an initial structural analysis of the systems map, and 3) Discussion, which evaluates the strengths and weaknesses of the workshop design and the usefulness (and limitations) of the PSM methodology for the study of nature connectedness. The final section will outline this study's next steps for refining and building upon the findings from this workshop.

Participatory Systems Mapping

Participatory systems mapping (PSM) is a research methodology that involves engaging and collaborating with stakeholders in the process of building a causal model (aka 'mapping') to better understand a complex system or issue (Barbrook-Johnson et al., 2022). Given that nature connectedness is a multifaceted and dynamic construct that is shaped by a complex interplay of individual, social, cultural, and environmental factors, the PSM method was selected for this study to develop a more holistic understanding of the system in which outdoor learning practitioners are striving to strengthen the bond between Scotland's children and young people and the natural world.

Traditional research methods, such as surveys, experiments, and case studies, are often inadequate for understanding complex issues like the formation of nature connectedness because they tend to be focus on the impacts of and relationships between only a few choice variables (Barbrook-Johnson et al., 2022). As a result, they struggle to capture the full complexity of a system that is characterized by a high degree of interdependence and interconnectedness. While PSM is not without its own limitations, it is explicitly designed to provide a more comprehensive understanding of the system by actively involving stakeholders in the research process—combining local knowledge, perspectives, and experiences with existing evidence (Barbrook-Johnson et al., 2022). An added benefit of PSM is that by allowing practitioners to lead in the creation of the systems map, they are given a sense of agency and ownership over the research. This may lead to more meaningful and impactful research outcomes, as the insights and recommendations that emerge from the process are more likely to be accepted as relevant and useful to the research subjects themselves (Barbrook-Johnson et al., 2022). I discuss the specific affordances and limitations of PCM for this study in a later section of this report.

Figure 1: Components of a Systems Map



Research Methods

In this section, I describe the methods and procedures used to conduct a PSM workshop that explores the causal mechanisms of nature connectedness in children and young people in Scotland. This section will cover the recruitment of workshop participants, the stages of data collection, as well as the types of data collected.

Recruiting participants:

Outdoor learning practitioners within the John Muir Trust network were recruited to participate in a systems mapping workshop to define the causal mechanisms of Nature Connectedness in children and young people in Scotland. Participants were selected under the following guidelines (Penn and Babrook-Johnson, 2019):

- A participant is an adult stakeholder, 18 years or older.
- A participant affects the "system" (the network of determinants of nature connectedness).
- A participant is or has been involved in the provision of outdoor learning.
- Participants will be invited from different sectors of outdoor learning (such as Government, Schools, Youth Work, Family, Residentials, Environmental organisations, Inclusion, Outdoor Education) to provide a diverse range of knowledge and experience.
- Participants who are likely to challenge established narratives and/or belong to underrepresented ('inclusion') groups will also be invited.

In October 2022, I prepared an invitation that was forwarded by staff at the John Muir Trust to the selected stakeholders (N=28) within the Trust network. The quota group size was determined by room capacity (a maximum of 17 including note-takers and facilitator) and a desire to keep the group small enough to encourage every participant to contribute to the discussions (Penn and Babrook-Johnson, 2019). Of the 28 stakeholders invited, 14 accepted.

The professional sectors represented by the participants included Scottish Government, Youth Awards, Youth Work, Inclusion, Teachers/Schools, Residential Centres, and Outdoor Education. Relevant sectors that were not explicitly represented at the workshop were Family Practitioners and Park Rangers — this gap will be mitigated with one-on-one interviews at a later stage. Note that many of these categories are fluid as participants may identify with multiple sectors simultaneously and/or have worked in different sectors over the course of their careers.

Data collection stages:

This section of the report details the steps taken to gather information from participants and create a systems map of development of Nature Connectedness in children and young people in Scotland. See Barbrook-Johnson & Penn (2019) for a more detailed guide on the PCM process.

1) Identifying important variables: Ahead of the in-person workshop, participants were asked to create an initial list of variables (also referred to as factors, components, and determinants) that they considered important in the development of a child's long-term relationship with nature, including both barriers to and facilitators of Nature Connectedness. This was done to save time at the in-person workshop and ensure that the initial content and structure of the systems map were stakeholder-driven. Participants followed a hyperlink to an open-access list-maker (Listmoz.com). Individual contributions to the list were anonymous. This initial list consisted of 52 variables. Ahead of the workshop, I reviewed the list to remove duplicates and rewrite any factors that were not clearly written as variables, i.e., things that have a measurable quality or quantity (Penn and Babrook-Johnson, 2019). I then selected 20 variables to help jumpstart the mapping process. At the workshop, these variables were written on post-it notes and placed on three separate tables (20 per table).

2) Setting system parameters: To help focus the discussion, participants were given some guiding parameters, though the overall prompt was left intentionally broad. Participants were asked to focus on and map the system in which children and young people (ages 0-16) in present-day (time) Scotland (geographic boundary) develop Nature Connectedness.

3) Grouping the variables: Following a presentation outlining the research topic and the systems mapping method, participants at each of the three tables (4-5 people per table) were invited to discuss and organise the variables into themes/system levels to consolidate their group's ideas. The participants were encouraged to rewrite, add, or discard any variables as they saw fit.

4) Linking the variables: Participants discussed and drew relationships between the variables (also referred to as connections, links, or edges), noting whether the relationships were positive or negative with +/- symbols. I encouraged the participants to think nonlinearly and presented examples for the identification of feedback loops (reinforcing and balancing). To guide the mapping process, I recommended that the participants develop and sense-check their respective maps by telling a chronological 'story'. The assumption being that, as a hypothetical individual ages through childhood and adolescence, the level of complexity and number of variables/relationships that may influence their nature connectedness increases. This exercise was intended to help participants to build their maps piece-by-piece as well as to encourage them to think about the influence of time and aging on an individual's relationship with nature.

5) Comparing the maps: To facilitate discussion and comparison of ideas between the three tables, each group nominated two of their members to join a neighbouring table as 'ambassadors'. Ambassadors were introduced to and discussed their neighbours' systems maps.

6) Merging the maps: Following a lunch break, participants reconvened to combine the insights of the three maps into a single 'merged map'. I facilitated the merge for the remaining duration of the workshop by drawing on a whiteboard at the front of the room. Reflecting on their respective table maps, all 14 participants discussed and selected key themes and variables they considered to have a significant influence on children and adolescents' level of nature connectedness. Causal relationships (positive or negative) were drawn between the variables. At the close of the workshop, I recounted the 'story' of the final map and asked the participants for feedback and validation.

7) Weighting the connections: Had time permitted, the final stage of the workshop was going to involve the creation of a Fuzzy Cognitive Map (FCM), asking participants to rank and define the relative degree of influence of each relationship according to a fixed Likert scale (weak, medium or strong) or numerically from -1.0 to 1.0. FCM is often used to make PSM maps semi-quantitative, allowing for as some sensitivity analysis, optimization, and running simple scenarios (Barbrook-Johnson and Penn, 2022a). Only a handful of relationships were ranked by the participants in the workshop. The degree of influence will be revisited during one-on-one interviews with the participants.

Types of data collected:

Written variables: In addition to the initial list of variables (a total of 30) collected from the participants online, all the variables that were written down on post-it notes over the course of the workshop were also collected (57 additional variables). However, most of these variables were not selected by the participants for the final merged map, which contains 36 variables.

Listener reports: To encourage participants to speak freely, the workshop was not recorded or transcribed. Instead, two designated 'listeners' or note-takers were tasked with capturing key themes, challenges, and discussions. The listeners sat with the participants at their respective tables throughout the day but did not participate in the mapping process. Both listeners submitted a written summary of their observations to support the analysis and discussion of the systems map. I also noted my own observations immediately following the workshop

Systems maps: The systems maps (3 table maps and 1 merged map) produced in the workshop were photographed. The final merged map was digitised using a purpose-built software, MentalModeler, which also facilitated a structural analysis of the systems map. See *Figure 2* and *Table 2*.

Results

This section presents the initial analysis of the merged systems map created by 14 outdoor learning practitioners on the formations of nature connectedness in children and young people in Scotland. Note that the research is ongoing, and the results presented in this section should not be considered final or comprehensive. This map is intended as a tool to guide further discussions and data collection at later stages of the research. Additionally, the data in this report is based on a small sample of participants.

The participatory systems mapping (PSM) workshop resulted in a map that consisted of five variable groups: Macro, Social, Education, Place, and Individual. Each group represented a different aspect of the system being studied and contained a number of variables (or "nodes") that were relevant to that aspect of the system.

In total, the merged map consisted of 36 variables and 103 relationships between these variables. See *Table 1* on the next page.

The average number of connections per variable was 2.86. This resulted in a density value of 0.08, which indicates that the variables in the map have relatively few connections to one another. Given the high level of nuance and complexity of the in-workshop discussions, the map's low density may indicate that there are still connections between variables that are missing, i.e., the map is likely incomplete. This comes a no surprise given that this workshop was only intended to be an initial step in ongoing research.

Centrality is a measure of how connected a variable is to other variables in the system (Caldarelli and Catanzaro, 2012). In a PSM map, variables with high centrality are those that have a large number of connections to other variables in the map. This suggests that these variables are important hubs or bridges within the system, and that they play a significant role in connecting other variables together. Variables with low centrality, on the other hand, have fewer connections to other variables in the map, and are likely less important in terms of their connections to the rest of the system (Caldarelli and Catanzaro, 2012).

In our map, the variables that stood out as having the most connections to other variables in the system (high centrality) were "Affinity for Nature" (5.36), "Child-led outdoor play" (4.71), "Pleasure/Fun in Nature" (4.15), "Carer respect for nature" (3.92) and "Time in nature with peers" (3.90). These variables were identified by participants as key factors that play a significant role in the development of nature connectedness in children and young people in Scotland (Caldarelli & Catanzaro, 2012).

Table 1: Variables that influence Nature Connectedness in children and adolescents in present-day Scotland according to outdoor learning practitioners

Pre-Workshop (via online list)

1. Time spent in nature
2. Parental respect for nature
3. Frequency of positive experiences in nature
4. Relatable role models
5. Proximity to natural spaces
6. Encouragement of outdoor play/creativity
7. Shared value of nature among peers
8. Outdoor play with peers
9. Use of green spaces at/with school
10. Knowledge of the natural world
11. Adventure experiences in nature
12. Screen time/digital distraction
13. Fun experiences indoors
14. Availability of outdoor clothing/equipment
15. Physical Health
16. Faith led appreciation for nature
17. Perceived threat/risk level
18. Perceived ability to influence spaces
19. Opportunity to attend an outdoor residential
20. Affordability of transport to natural spaces
21. Safety of transport to natural spaces
22. Participation in youth work
23. Environmental volunteer opportunities
24. Outdoor play in early years
25. Non-directive outdoor play
26. Parental/guardian respect for nature
27. Opportunity for positive nature experiences
28. Watching nature documentaries
29. Accessibility of green jobs/skills
30. Empathy for nature

Variables selected by each table

Table A

1. Employment and training opportunities for underrepresented communities in the sector
2. Creative methods of engagement for people with disabilities (poetry, dance, etc)
3. Cultural storytelling
4. Neurodiversity
5. Feeling unsafe because of protected characteristics (gender, race, disability, sexuality)
6. Structural barriers/ opportunities for ethnic minorities (EM)
7. Financial resources
8. Outdoor experiences as part of the Curriculum
9. Clubs/activities in nature
10. Pro-Nature social media signposting
11. Nature adverse family
12. Relatable role models
13. Perception of safety
14. Shocks – world events
15. Government influence

Table B

1. Education about nature
2. Education for nature
3. Education in nature
4. Experiences with animals, pets, wildlife
5. Pro-nature school culture
6. Training of teachers
7. Green skills/careers
8. Enjoyment/fun being outdoors
9. Emotional responses to nature
10. Digital distraction
11. Pro-nature screen time
12. Policy Drivers (child's Rights)
13. Climate emergency
14. Individual personal world view
15. Values aligned to nature
16. Access and inequality
17. Resources (finance/clothing) SIMD
18. Disability
19. Cultural representation of nature
20. Gender
21. Class
22. Age (different ages have different needs)
23. Mental health

Table C

1. Lack of places to connect with nature
2. Leisure time
3. Child independence
4. Child-led time outdoors
5. Time spent outdoors with family/significant others
6. Fun/enjoyment/pleasure in nature
7. Contact with nature
8. Proximity to high quality (high biodiverse) natural/wild spaces
9. Existing health and wellbeing barriers
10. School experiences
11. Media (popular culture TV)
12. Emotional connection
13. Meaning making
14. Experience with nature with a significant adult as a young child
15. Mental health
16. Pro-nature policy (shared national local/agendas)
17. National drivers
18. Enabling policy
19. Egocentric societal values

Merged Map

Macro Level:
1. System shocks
2. Pro-Nature Social Norms
3. Enabling Policy (National/Local)
4. Inclusive Policy

Social Group:
5. Pro-Nature Philosophy
6. Carer Respect for nature
7. Carer Resilience to threats
8. Carer leisure time
9. Access to resources
10. Supervised outdoor play
11. Child-led outdoor play
12. Time in nature with peers
13. Relatable role models

Place/Setting Group:
14. Pets/indoor plants
15. Accessible travel
16. Close proximity to child-friendly nature
17. Biodiversity
18. Bad weather
19. Lack of natural places
20. Sensory contact with nature

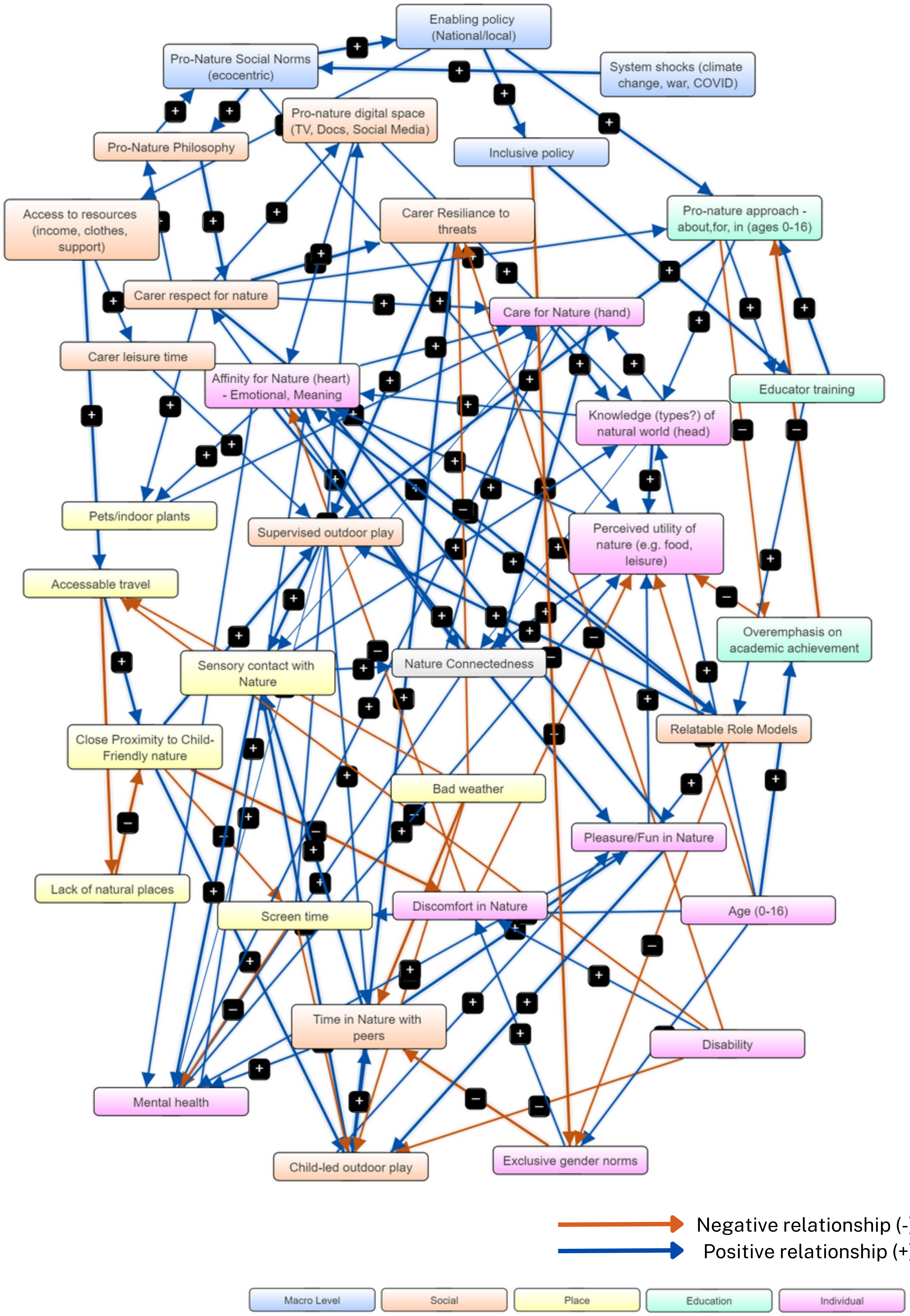
Education Group:
21. Pro-Nature approach
22. Educator training
23. Overemphasis on academic achievement

Individual Group:
24. Care for nature
25. Knowledge of natural world
26. Affinity for nature
27. Perceived utility of nature
28. Discomfort in Nature
29. Pleasure/fun in nature
30. Age
31. Disability
32. Exclusive gender norms
33. Mental health

Table 2: Summary of Merged systems map structural analysis

System Statistics	**Value**
Number of groups	5
Number of variable (nodes)	36
Number of relationships (edges)	103
Density	0.08
Average connections per variable	2.86
Number of drivers	4
Number of receivers (sinks)	0
Variables with High Centrality	**Centrality Score**
Affinity for nature	5.36
Child-led outdoor play	4.71
Pleasure/Fun in nature	4.15
Carer respect for nature	3.92
Time in nature with peers	3.90

Figure 2: Systems Map of the Formation of Nature Connectedness in Scottish Children & Adolescents in Scotland (Draft: November 2022)



Discussion

In this section, I reflect upon the strengths and weaknesses of the workshop design and the affordances of PSM for the study of Nature Connectedness.

Workshop design:

PSM workshops do not have a standardised design because the complexity of the systems being studied and the diversity and availability of stakeholders involved can vary greatly (Barbrook-Johnson and Penn, 2021). A PSM on the subject of Nature connectedness in Scotland has, to my knowledge, never been done before. It is therefore a worthwhile exercise to reflect upon the procedural decisions made, both useful and inhibiting, to inform best (or at least better) practice moving forward.

Inevitably, there were some participants who were more engaged than others (Barbrook-Johnson and Penn, 2022b). To mitigate the risk of only mapping the perspectives and opinions of a vocal few, I started the workshop by splitting the 14 participants into three tables. Smaller groups of 4-5 people provided greater opportunities for everyone to contribute to the discussion. When the maps were ready to be merged and discussed as one large group, every participant had had the opportunity to voice their perspective.

Another benefit of dividing the group into three was the creation of three distinct systems maps. Having three initial maps to reference and eventually merge arguably increased the surface area and depth of the overall workshop. This benefit was highlighted when each table sent two 'ambassadors' to learn about their neighbour's progress. Likewise, the process of merging the 3 maps began by asking each table to publicly suggest groups and variables they felt belonged on the final map provided further opportunities for participants to ask each other questions and affirm or challenge assumptions. As seen in Table 2, while each table of participants listed many overlapping and duplicate variables (though often phrased differently), there were also variables and discussions that were unique to each group, such as "Creative methods of engagement" or "Time outdoors with significant others". The structure and organization of each map also varied considerably, which speaks to the complexity of the topic as well as the variation that may occur when mappers have different areas of interest and choose different starting points (Barbrook-Johnson and Penn, 2022b).

The downside of splitting the participants into groups was that there was only one workshop facilitator. Three tables meant it was unfeasible for me to give bespoke guidance to each table whenever confusion arose around the mapping process.

One solution might have been to give participants less freedom in selecting variables and groups, making it easier for me to generalise my guidance. However, giving participants fewer choices would have been at odds with ensuring that all stakeholders are engaged and able to design a map that accurately reflects their perspectives as outdoor learning practitioners. My priority was for the workshop to be participant-driven; I chose not to prescribe variables or systems structures prior to the workshop to allow for the emergence of new and underrepresented perspectives (Barbrook-Johnson and Penn, 2022b).

Other solutions might have been to recruit more facilitators and/or allot more time to instruct the participants on the mapping procedure. This could have made the table maps a more fruitful exercise and reduced the potential for frustration and mental fatigue among the participants. Asking participants to decide upon categories/groups for their variables before dividing the room into three tables may have helped to give each table more uniformity without compromising the workshop being participant-driven.

Perhaps the most significant challenge was to design a workshop that was long enough to create a compelling systems map, but short enough to ensure that the invitees would be able to attend and stay engaged throughout the process. The workshop was conducted over a single day (10 am – 3:30 pm), including two 15 min breaks and 1 hour for lunch. This proved long enough to introduce the PCM methods and build a plausible systems map consisting of significant variables and their interrelationships. Developing a Fuzzy Cognitive Map (FCM), which would have involved asking participants to weigh the degree of influence of each relationship, was postponed to the next stage of research.

Limited time is not unique to this workshop, and it is common practice for researchers, either before or after engaging with stakeholders, to use their own knowledge of current evidence to set a basic map structure and/or fill in lingering gaps and incomplete causal loops (Penn et al., 2013). To ensure that stakeholders are still involved, feedback and validation can be requested every time the map is substantially changed.

An unforeseen challenge was convincing participants that the map is intended to be iterative. Many practitioners seemed hesitant to write down what could be later criticised or viewed as too simplistic. Each table of participants chose to draw the connections between variables in pencil instead of coloured marker. This hesitancy among participants was somewhat mitigated during the merging process when I facilitated the discussion by drawing participants' mapping decisions on a whiteboard. However, the workshop would have benefited from regular reminders that the mapping process is intended to be a rough draft and would be refined over time (Penn and Babrook-Johnson, 2019).

Affordances of PCM for the study of Nature Connectedness:

Combining knowledge

At the very least, the merged systems map (Figure 1) makes a compelling visual argument for understanding an individual's relationship with nature to be the result of a highly complex system. With an average of nearly 3 connections (arrows) per each of the 36 variables, the map's first iteration already resembles alien spaghetti. Untangling this spaghetti of dynamic causation will require more than the next decade of traditional research methods can manage. To some extent, this evident complexity reaffirms the value of using novel participatory methods to establish a more holistic understanding of how human-nature relationships form. That said, traditional approaches should be viewed as complementary to systems mapping because they serve to identify and evidence key variables an.d relationships (Barbrook-Johnson and Penn, 2021). Indeed, many of the participants referenced the findings of various case studies and surveys, particularly studies done by the University of Derby's Nature Connectedness Research Group, when building portions of their maps.

The driving purpose of a systems map is not merely to point fingers at the inadequacies of traditional research, but to be clarifying and useful. Systems mapping shines when used to quickly combine different kinds of knowledge and evidence to establish a more holistic understanding of a system (Barbrook-Johnson et al., 2022). In this workshop, designated listeners noted that the participants referenced peer-reviewed research alongside grey literature, professional opinions, personal experience, and intuition. A downside of PSM's ability to quickly blend stakeholders' varied understanding of an issue is the lack of clear distinction between these different types of knowledge sources when mapped. This is why PSM is often characterised as 'gateway' research and needs to be critically examined and benchmarked against current evidence and later studies (Barbrook-Johnson et al., 2022).

Identifying and clarifying variables

Another affordance of the systems mapping process is that it provided an opportunity for practitioners to collaboratively hone their understanding of how nature connectedness forms. Not only did the workshop result in a long list of variables that practitioners believed to influence the nature connectedness of Scotland's children and youth, but the process helped practitioners to consolidate and clarify the variables they considered most important — from over 100 variables, down to 36 (see Table 1). Variables like "Structural barriers/opportunities for ethnic minorities" and "Financial resources" were replaced with the broader "Access to resources", which may include clothes, money, opportunities, and support. Similarly, "Faith-led appreciation of nature," "Individual personal worldview", and "Values aligned to nature" were combined and clarified as "Pro-nature philosophy" to suggest that individuals need not ascribe to explicit religious or spiritual beliefs in order to view nature as a universal good.

There are likely multiple reasons for why participants chose to omit variables from the final map. In addition to participants feeling that some variables were not influential enough or they could be better articulated by broader, more clarifying terminology, it is also probable that some variables were neglected simply due to time constraints or because there was a high level of disagreement or nuance around the use of certain variables. Next stage of research will help to tease out why certain variables were included or excluded by the participants.

Capturing the influence of time and aging:

Participatory Systems Mapping (PSM) is a useful tool for better understanding and visualising what stakeholders consider to be the key mechanisms of a complex system, but it fell short when it came to addressing this study's interest in long-term change, specifically how nature connectedness develops as children age. PSM produces a static map, intended only to capture a snapshot of a system at a specific point in time (Barbrook-Johnson et al., 2022). For this reason, workshop participants were asked to consider a 'present day' system, rather than how they think the system has functioned or will function in the future. The resulting map (Figure 1) gives a snapshot of present-day Scotland in which children aged 0-16 are developing nature connectedness. Because nature connectedness has been found to be highly associated with age (Barrable and Booth, 2022, Keith et al., 2021, Price et al., 2022), such a broad map risks confusing distinctions between how different age groups develop and maintain their relationship with nature.

While still acknowledging the PSM's temporal limitations, storytelling was used to help stretch the PSM methodology to incorporate some discussion on how the development of nature connectedness varies according to age. The merged map was built by first identifying variables/relationships that the participants considered to be most influential for a young child (aged 0-5). As the hypothetical child aged, variables/relationships were added to the map piece-by-piece. The variable "age" was also included in the map as a placeholder for later discussion. Participants noted a negative relationship, generalising that an individual's nature connectedness tends to decrease as they age into adolescence (Keith et al., 2021).

Now digitised, the systems map can be flexibly reorganised and broken into parts of interest—all while keeping in mind the system as a whole. The flexibility that the map affords can help to further explore and clarify practitioner views on the development of nature connectedness over time. This study plans to convert the merged systems map into multiple maps, each corresponding to a specific age group. While these maps will still be static explanations of a system and will lack temporal resolution, they can be viewed side-by-side to give generalised glimpses of how practitioners understand nature connectedness to develop throughout childhood. As discussed in the following section, these maps will be used to inform computational simulations that are better suited to exploring system change over time, namely agent-based modelling (ABM) (Frerichs et al., 2020).

Next Steps

The PSM workshop proved useful for quickly capturing outdoor learning practitioners' understanding of the formation of nature connectedness in children and young people. However, it had limitations for conveying the impact of time/ageing and differentiating between knowledge types. The next stage of research will seek to refine the map's complex systems theory through practitioner interviews and evidence triangulation, and finally, test its credibility against empirical data through the use of computational simulations.

1) Practitioner Interviews:

Throughout February - May 2023, I will invite outdoor learning practitioners to participate in interviews designed to address gaps and ambiguities in the merged systems map. These hour-long conversations will be structured along the following goals: Revisit the merged systems map to consider missing variables and relationships (if any); Identify the variables practitioners think are most impactful on nature connectedness; Identify variables and causal mechanisms that are specific to certain age groups; Identify the variables considered to be directly influenced by participation in the John Muir Award.

2) Triangulating Evidence:

A key step — though it is more of an iterative process — will be to critique different sources of information against one another. It is unlikely that the perspectives of stakeholders, grey literature, and the findings of peer-reviewed studies will all seamlessly align — in fact, there may be significant contradictions in how nature connectedness is believed to develop. It falls upon the researcher to analyse areas of discord, weighing the strengths and limitations of each source towards developing a balanced and testable theory.

3) Agent Based Modelling (ABM)

The process of consulting stakeholders and triagulating evidence will lead to a more accurate theory of nature connectedness formation and its impact on outdoor learning. However, due to the complexity of the topic, the information will always be imperfect. Since this project does not have the time nor budget to conduct a longitudinal study to trace the development of nature connectedness, the theory will be tested by using Agent Based Modelling (ABM) against empirical data. ABM simulates the actions of agents (e.g. children, parents, schools) over time to explain complex phenomena, and will be informed by the causal assumptions from the systems map, stakeholder interviews, and current evidence. If the ABM can reproduce real-world trends (data from the Children's People and Nature Survey (C-PANS), it will lend further credibility to the theory of nature connectedness formation and, in turn, enable us to further explore the long-term impact of outdoor learning interventions, specifically the John Muir Award.

References

BADHAM, J., CHATTOE-BROWN, E., GILBERT, N., CHALABI, Z., KEE, F. & HUNTER, R. F. 2018. Developing agent-based models of complex health behaviour. Health & place, 54, 170-177.

BARBROOK-JOHNSON, P. & PENN, A. 2021. Participatory systems mapping for complex energy policy evaluation. Evaluation (London, England. 1995), 27, 57-79.

BARBROOK-JOHNSON, P. & PENN, A. S. 2022a. Fuzzy Cognitive Mapping. Systems Mapping: How to build and use causal models of systems. Cham: Springer International Publishing.

BARBROOK-JOHNSON, P. & PENN, A. S. 2022b. Running Systems Mapping Workshops. Systems Mapping: How to build and use causal models of systems. Cham: Springer International Publishing.

BARBROOK-JOHNSON, P., PENN, A. S. & SPRINGERLINK 2022. Systems Mapping: How to build and use causal models of systems, Cham, Springer International Publishing.

BARRABLE, A. 2019. Refocusing Environmental Education in the Early Years: A Brief Introduction to a Pedagogy for Connection. Education sciences, 9, 61.

BARRABLE, A. & BOOTH, D. 2022. Disconnected: What Can We Learn from Individuals with Very Low Nature Connection? International journal of environmental research and public health, 19, 8021.

BARRAGAN-JASON, G., DE MAZANCOURT, C., PARMESAN, C., SINGER, M. C. & LOREAU, M. 2022. Human–nature connectedness as a pathway to sustainability: A global meta-analysis. Conservation letters, 15, e12852-n/a.

CALDARELLI, G. & CATANZARO, M. 2012. Networks: A Very Short Introduction, Oxford University Press.

CAPALDI, C. A., DOPKO, R. L. & ZELENSKI, J. M. 2014. The relationship between nature connectedness and happiness: a meta-analysis. Frontiers in psychology, 5, 976.

FRERICHS, L., SMITH, N., KUHLBERG, J. A., MASON, G., JACKSON-DIOP, D., STITH, D., CORBIE-SMITH, G. & LICH, K. H. 2020. Novel participatory methods for co-building an agent-based model of physical activity with youth. PloS one, 15, e0241108-e0241108.

HUGHES, J., ROGERSON, M., BARTON, J. & BRAGG, R. 2019. Age and connection to nature: when is engagement critical? Frontiers in ecology and the environment, 17, 265-269.

KEITH, R. J., GIVEN, L. M., MARTIN, J. M. & HOCHULI, D. F. 2021. Urban children's connections to nature and environmental behaviors differ with age and gender. PloS one, 16, e0255421.

LENGIEZA, M. L. & SWIM, J. K. 2021. The Paths to Connectedness: A Review of the Antecedents of Connectedness to Nature. Frontiers in psychology, 12, 763231-763231.

LOUV, R. 2013. Last child in the woods: saving our children from nature-deficit disorder, New York;Boca Raton;, Atlantic Books Ltd.

OTTO, S. & PENSINI, P. 2017. Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. Global environmental change, 47, 88-94.

PENN, A. & BABROOK-JOHNSON, P. 2019. Participatory Systems Mapping: A practical guide. CECAN toolkit.

PENN, A. S., KNIGHT, C. J. K., LLOYD, D. J. B., AVITABILE, D., KOK, K., SCHILLER, F., WOODWARD, A., CKMAN, A. & BASSON, L. 2013. Participatory Development and Analysis of a Fuzzy Cognitive Map of the Establishment of a Bio-Based Economy in the Humber Region. PloS one, 8, e78319-e78319.

PRICE, E., MAGUIRE, S., FIRTH, C., LUMBER, R., RICHARDSON, M. & YOUNG, R. 2022. Factors associated with nature connectedness in school-aged children. Current Research in Ecological and Social Psychology, 3, 100037.

WHITBURN, J., LINKLATER, W. & ABRAHAMSE, W. 2020. Meta-analysis of human connection to nature and proenvironmental behavior. Conservation biology, 34, 180-193.