

University of Denver

Digital Commons @ DU

Electronic Theses and Dissertations

Graduate Studies

2022

Exploring Youth Relationships with Nature Using Qualitative GIS

Corey J. Martz

University of Denver

Follow this and additional works at: <https://digitalcommons.du.edu/etd>



Part of the [Geographic Information Sciences Commons](#), and the [Other Geography Commons](#)

Recommended Citation

Martz, Corey J., "Exploring Youth Relationships with Nature Using Qualitative GIS" (2022). *Electronic Theses and Dissertations*. 2138.

<https://digitalcommons.du.edu/etd/2138>

This Dissertation is brought to you for free and open access by the Graduate Studies at Digital Commons @ DU. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of Digital Commons @ DU. For more information, please contact jennifer.cox@du.edu, dig-commons@du.edu.

Exploring Youth Relationships with Nature Using Qualitative GIS

Abstract

Understanding youth relationships with nature—what nature is, where nature is located, and why nature is meaningful—is important for a range of contemporary issues, from promoting health and well-being to advancing a sustainable future. Relationships with nature are profoundly influenced by the lived experiences of youth, as they form social connections, have fun, learn, and go about their lives across an array of places—residences, schools, trip destinations, and places in between. One key to exploring youth relationships with nature, therefore, is engaging youth to document their experiences of nature in relation to specific places and developing methods that support them to do so. This dissertation aims to explore youth relationships with nature by expanding qualitative GIS methods to engage youth in research to document personal accounts of their experiences of nature and linking them to the locations of specific places. We partnered with a community organization, Nature Kids / Jóvenes de la Naturaleza (NKJN), in part to contribute to the ongoing efforts of NKJN to evaluate their environmental education (EE) programming for youth and families in Lafayette, Colorado (United States). We asked 55 youth to create story maps using existing web applications—combining images, descriptions, and drawings of areas on a map where specific nature places are meaningful in their lives. Our analysis of story maps explored impacts of different life experiences, including abrupt changes such as the COVID-19 lockdowns and differing exposure to EE programming, on how and where youth relate with nature and conceptualize what nature is. We integrated qualitative data and analysis with GIS and developed a codebook to interpret meanings embedded in the participant drawings of nature place areas on a map. We found that youth with different life experiences conceptualized and related with nature in different ways. Such differences would not have emerged without considering personal accounts in relation to specific locations as well as interpretations of participants' drawings of areas on a map. Our qualitative GIS approach for analyzing participant-created story maps demonstrates the importance of engaging youth and their voices through familiar web-based technologies as well as documenting experiences of nature linked to geographic information about locations of specific places. Our analysis of participant-drawn areas on a map highlights untapped potential of qualitative GIS for gaining more nuanced understandings of the lived experiences of youth.

Document Type

Dissertation

Degree Name

Ph.D.

Department

Geography

First Advisor

Rebecca L. Powell

Second Advisor

Eric Boschmann

Third Advisor

Helen Hazen

Keywords

Children's geographies, COVID-19 lockdowns, Environmental education, Nature, Qualitative GIS, Story maps

Subject Categories

Geographic Information Sciences | Geography | Other Geography

Publication Statement

Copyright is held by the author. User is responsible for all copyright compliance.

Exploring Youth Relationships with Nature Using Qualitative GIS

A Dissertation

Presented to

the Faculty of the College of Natural Sciences and Mathematics

University of Denver

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

Corey J. Martz

August 2022

Advisor: Dr. Rebecca L. Powell

©Copyright by Corey J. Martz 2022

All Rights Reserved

Author: Corey J. Martz
Title: Exploring Youth Relationships with Nature Using Qualitative GIS
Advisor: Dr. Rebecca L. Powell
Degree Date: August 2022

Abstract

Understanding youth relationships with nature—what nature is, where nature is located, and why nature is meaningful—is important for a range of contemporary issues, from promoting health and well-being to advancing a sustainable future. Relationships with nature are profoundly influenced by the lived experiences of youth, as they form social connections, have fun, learn, and go about their lives across an array of places—residences, schools, trip destinations, and places in between. One key to exploring youth relationships with nature, therefore, is engaging youth to document their experiences of nature in relation to specific places and developing methods that support them to do so. This dissertation aims to explore youth relationships with nature by expanding qualitative GIS methods to engage youth in research to document personal accounts of their experiences of nature and linking them to the locations of specific places. We partnered with a community organization, Nature Kids / Jóvenes de la Naturaleza (NKJN), in part to contribute to the ongoing efforts of NKJN to evaluate their environmental education (EE) programming for youth and families in Lafayette, Colorado (United States). We asked 55 youth to create story maps using existing web applications—combining images, descriptions, and drawings of areas on a map where specific nature places are meaningful in their lives. Our analysis of story maps explored impacts of different life experiences, including abrupt changes such as the COVID-19 lockdowns and differing exposure to EE programming, on how and where youth relate with nature and conceptualize what nature is. We integrated qualitative data and analysis with GIS and developed a codebook to

interpret meanings embedded in the participant drawings of nature place areas on a map. We found that youth with different life experiences conceptualized and related with nature in different ways. Such differences would not have emerged without considering personal accounts in relation to specific locations as well as interpretations of participants' drawings of areas on a map. Our qualitative GIS approach for analyzing participant-created story maps demonstrates the importance of engaging youth and their voices through familiar web-based technologies as well as documenting experiences of nature linked to geographic information about locations of specific places. Our analysis of participant-drawn areas on a map highlights untapped potential of qualitative GIS for gaining more nuanced understandings of the lived experiences of youth.

Acknowledgements

I am sincerely grateful to the youth who participated in the study and for all the contributions of Nature Kids / Jóvenes de la Naturaleza (NKJN), the manager of NKJN, Angela Myers, and NKJN program leaders who collaborated on this work.

This work would not have been possible without Becky Powell, whose constant support, countless iterations of critical feedback, and valuable intellectual contributions pushed this work forward. Sincerely, thank you, Becky. I am also grateful for the support and intellectual contributions of Bryan Wee. Bryan, thank you for sharing your invaluable expertise. And, I owe a big thanks to Helen Hazen and Eric Boschmann for all your contributions, feedback, and support in this work, as well as Tom Romero, for serving as Oral Defense Committee Chair. I cannot thank you all enough for everything.

I would like to thank my friends and family, my Mom and Dad for talking me down when I needed it, and my grandparents, who instilled my value of education.

I am thankful for funding from the Rocky Mountain URISA Scholarship as well as at the University of Denver, from the Center for Community Engagement to advance Scholarship and Learning Scholar Shop Mini-Grant, Grand Challenges Advancing Community Engagement Student Scholarship Grant, and Department of Geography & the Environment Laurance C. Herold Fund for Student Field Research.

Last, but certainly not least, I could not have done this without my wife, Brittney (and our cat, Luna). Brittney, you got to deal with my personal, day-to-day struggles to keep at it. Thanks for all the support. And, thanks for catching my messed-up map symbology in Figure 2, Chapter 4.

Table of Contents

Chapter One: Introduction	1
Motivation.....	1
Objectives	8
Research Context	8
Participants.....	11
Data Collection	13
Summary of Chapters	15
 Chapter Two: The Impact of COVID-19 Lockdowns on Youth Relationships with Nature: A Socio-Spatial Perspective.....	 18
 Chapter Three: Evaluating Environmental Education Programs Using a Qualitative Geographic Information Systems Approach.....	 53
 Chapter Four: Understanding Conceptualizations of Nature by Asking Youth to Draw Areas on a Map	 71
 Chapter Five: Summary and Conclusions.....	 116
Summary of Research.....	116
Broader Community Impacts	118
Community-Partnered Research	120
Geoprivacy in Qualitative GIS Research with Youth.....	121
Protecting Geoprivacy in a Publicly Available Story Map.....	125
Future Directions	127
References.....	129

List of Tables

Chapter One.....	1
Table 1. Summary of Participants.....	12
Chapter Two.....	18
Table 1. Summary of Study Participants.....	27
Table 2. Summary of Relationships with Nature and Emergent Themes.....	33
Chapter Three.....	53
Table 1. NKJN Program Outcome Descriptions.....	56
Chapter Four.....	71
Table 1. Codebook to Interpret Nature Conceptualizations from Participant-Drawn Map Areas.....	85
Table 2. Codebook Examples of Nature Conceptualizations Interpreted from Participant-Drawn Map Areas.....	91

List of Figures

Chapter One.....	1
Figure 1. Scenes of Nature Places in and around Lafayette	10
Chapter Two.....	18
Figure 1. Representative Story Map.....	24
Figure 2. Nature Place Locations.....	31
Figure 3. Differences in Key Emergent Themes by Mapped Locations (Near vs. Away from Lafayette).....	39
Figure 4. Self-Reported Frequency of Time Spent in Nature	40
Chapter Three.....	53
Figure 1. Example Story Map.....	58
Figure 2. Spatial Patterns of Health and Wellness (HW).....	61
Figure 3. Comparing Outcomes Between Groups by Spatial Extent.....	64
Chapter Four.....	71
Figure 1. Example of Drawing an Area on the Map.....	82
Figure 2. Conceptualizations by Prevalence in Individual Participants' Story Maps.....	93
Figure 3. Spatial Patterns of Nature Conceptualizations.....	94
Figure 4. Between-Group Comparison by Prevalence in Individual Participants' Story Maps.....	96

Chapter One: Introduction

Motivation

Documenting the lived experiences of youth—learning, having fun, and going about their lives—matters for including youth perspectives in the many decision-making, planning, education, and other processes that impact them (Aitken, 2018; Aitken et al., 2007; Holloway, 2014). Accordingly, who is better to document the lived experiences of youth than youth themselves? To engage youth in documenting their lived experiences, it is important to use research methods that deliberately support youth and their voices in the documentation process *through* familiar, web-based technologies (Martz et al., 2020). Yet, lived experiences are not straightforward to document. The lived experiences of youth are not only social, embedded in a societal context; youth lived experiences are also spatial, grounded in an array of places where they live, go to school, hang out, travel, and pass through places in between (Aitken, 2018; Aitken et al., 2007; Martz et al., 2022). Therefore, methods should also deliberately approach the lived experiences of youth as socio-spatial processes. Accordingly, *qualitative GIS* methods seek ways to integrate qualitative social meanings with the digital spatial data structures embedded in a Geographic Information System, or GIS, to produce stronger insights about socio-spatial processes than if these data were treated separately (Cope & Elwood, 2009; Jung & Elwood, 2010). The primary motivation of this dissertation is to better understand the

socio-spatial lived experiences of youth by expanding location-based, qualitative GIS methods in research with youth to document and explore their lived experiences.

Specifically, this dissertation aims to understand the lived experiences of youth relevant to their relationships with nature—what nature is, where nature is located, and why nature is meaningful (Castree, 2014; Kellert, 2002; Wee, 2020). Understanding youth relationships with nature is important to addressing a range of contemporary challenges, such as promoting health and well-being (Chawla, 2015; Mygind et al., 2019) and fostering dispositions towards nature that advance a sustainable future (Chawla, 2020; Giusti et al., 2018; Ives et al., 2017). Youth relationships with nature are mediated by physical interactions with nature, while youth also interact with, make sense of, and learn about the concept of nature through representations—words, images, feelings, beliefs, and ideas—from different forms of media and in everyday conversations (Aaron & Witt, 2011; Kellert, 2002; Wee, 2020). Representations of nature are (re)produced by representatives that range from parents, teachers, and peers to government officials, scientists, and journalists to artists, authors, and filmmakers (Castree, 2014). In turn, the concept of nature with which youth relate is rooted in a social context (Demeritt, 2001; Proctor, 1998)—a context that is not neutral. Representations of nature, to some degree, bare the underlying goals, values, and preferences of those who have (re)produced the representations individually and collectively over time (Castree, 2014).

In the United States, representations of nature have been predominantly shaped by Americans of Western-European descent, reflecting values and ideas such as the romantic sublime, the American frontier (Cronon, 1996), transcendental spirituality, and business environmentalism (Taylor, 2016). The idea of nature as sublime emerged from

romanticism in the 1800s and emphasized emotion as the source of aesthetic experience, influencing representations of nature as beautiful and pristine landscapes, without people, eliciting feelings of power, awe, and the presence of God (Cronon, 1996; Taylor, 2016). The national myth of the American frontier imbued the concept of nature with a nostalgia for vast lands already occupied by Native Americans that were increasingly settled by Americans of Western-European descent by the late-1800s. This nostalgia reinforced many core tenets of American identity, such as primitive living, rugged individualism, nation building, and democracy (Cosgrove, 1995; Cronon, 1996). Transcendentalism embedded wilderness landscapes with a spiritual presence, while business interests benefited from protected areas bringing in profits from tourists, recreationists, and the equipment they needed to access and use these areas (Taylor, 2016).

Such ideas and values continue to influence the ways that youth in the United States make sense of nature, regardless of ethnic or national origin or affiliation. In this dissertation, we use the word “nature” in our investigation of youth relationships with nature because dominant representations of nature in the United States are pervasive and provided us a common understanding with youth regarding to what the concept of nature refers (Castree, 2014). At the same time, we aim to acknowledge and explore how the concept of nature—and the places commonly associated with nature—may include and/or exclude youth of varying backgrounds and life experiences.

Seldom have the social and spatial aspects of lived experiences relevant to youth relationships with nature been more in focus than during the initial surge of COVID-19 cases in 2020 and corresponding lockdowns to slow the spread of the virus. COVID-19 lockdowns spatially restricted in-person interactions with people and places, abruptly

changing the lived experiences of youth that, in turn, profoundly influence how youth make sense of and relate with nature. Youth relationships with nature were potentially impacted by the changing contexts of the people with whom youth socially interact, and how, as well as the places where youth interact with nature. Therefore, important to understanding the impact of spatially restrictive COVID-19 lockdowns on youth relationships with nature is to understand the geographic locations of places where relationships with nature manifest, as well as why youth relate with nature in these places (Beery & Wolf-Watz, 2014; Castree, 2014; Cronon, 1996; Taylor, 2011).

But the social and spatial aspects of lived experiences relevant to youth relationships with nature are important to consider in more than just extreme circumstances; these aspects also come into focus under normal circumstances, such as in many environmental education (EE) contexts. EE programs commonly emphasize participants' experiences of the place(s) where a program is located. Evaluating the success of EE programs commonly emphasizes the outcomes of program experiences, such as the growth of participants' knowledge, skills, behaviors, and dispositions in their relationships with nature that lead to positive environmental and social change (Ardoin et al., 2015; Ardoin et al., 2018; Ladwig, 2010; Zint, 2013). EE outcomes are also spatial, intertwined with the locations of places where participants demonstrate outcomes, whether during and/or after program experiences. While usually not the emphasis of evaluation, an important component to enhancing EE outcome measurement is the inclusion of geographic locations as places where participants demonstrate outcomes, leading to a better understanding of whether, why, how, and especially where EE programs have impacts.

To explore the social and spatial aspects of youth relationships with nature, we need to use methods that are attentive to the social context of their lived experiences as well as the spatial context of places where their lived experiences are located. In qualitative GIS methods, *qualitative* refers to the descriptive and/or interpretive forms of data and how they are represented, along with the ways of analyzing these data inductively with a focus on social meaning (Jung & Elwood, 2019). *GIS* commonly refers to both the systems for storing, managing, analyzing, and representing geographic data, as well as the practices of collecting, representing, analyzing, and visualizing geographic data to produce spatial knowledge (Cope & Elwood, 2009). Qualitative GIS methods aim to integrate qualitative data collection and analysis with that of geographic data collection and analysis in a GIS. Additionally, for youth to document their relationships with nature, it is important to engage youth in research through methods that include their voices in the documentation process (Martz et al., 2020). Qualitative GIS is rooted in critical engagements with GIS as a tool that can include diverse users in research to represent their unique lived experiences (Elwood, 2006; Kwan, 2002; Sheppard, 2005). In turn, qualitative GIS approaches such as *story maps* include youth in the documentation process through familiar, web-enabled devices and applications (Martz et al., 2020), and through a medium to create rich location-based, qualitative accounts of their lived experiences in the form of multimedia content (e.g., photographs, text) integrated with a GIS (Jung & Elwood, 2019; Kerski, 2015).

An ongoing challenge in qualitative GIS is to reconcile views of space as produced by social relationships and lived experiences with that of the spatial representational model of a GIS, which views space as a geometric grid tied to the

Earth's surface (Caquard, 2013; Pavlovskaya, 2009). A specific challenge is how to formalize links between spatial objects represented in a GIS and the many ways of experiencing and describing the world (Schuurman, 2006). GIS objects—points, lines, polygons—represent locations in geographic space and are often associated with attributes, which are usually quantitative but can also be qualitative, such as written narratives, interview excerpts, and photographs (Pavlovskaya, 2009). In addition to representing locations, GIS objects can be symbolized (e.g., color, size) based on their attributes to further reflect the meaning of an attribute. One way to formalize links between GIS objects and lived experiences is for researchers to inductively analyze qualitative attributes of a GIS object to interpret themes, then incorporate the themes as another attribute of the object that can be symbolized. By symbolizing GIS objects based on the meanings of qualitative themes (Cieri, 2003; Kwan & Ding, 2008; Lowery & Morse, 2013), researchers can explore spatial patterns of specific themes. Furthermore, when spatial objects are created by participants, the objects can be considered qualitative data in and of themselves that reflect the meanings of those who create them (Jung, 2009; Jung & Elwood, 2019; Kwan, 2002). Less explored are ways of inductively analyzing the participant-created GIS object itself to further symbolize and explore spatial patterns in the meanings associated with GIS objects.

We propose, therefore, that another way to formalize links between GIS objects and lived experiences is through inductive analysis of the GIS object itself. While point objects represent dimensionless locations in geographic space, line and polygon objects represent locations and other attributes in space. For polygon objects in particular, these other attributes—extent, shape, feature(s) on a base map within a polygon—reflect

meanings, interpretations, and intentions of the participant who created the polygon object (Lowery & Morse, 2013). A key to tapping into meanings embedded in participant-created polygon objects is the development of analysis approaches that consider these other attributes. Accordingly, we develop a new analysis approach to expand how a GIS object can be interpreted and symbolized to spatially explore the lived experiences of participants. In doing so, we aim to advance the formalization of links between GIS objects and lived experiences (Schuurman, 2006).

In this dissertation, we asked youth to identify specific places where nature is meaningful in their lives and create a story map documenting images, descriptions, and locations of the places. As part of the process, youth drew a polygon on a web-based map covering the specific area of places where nature is meaningful to them. To analyze story maps, we explore two, related qualitative GIS approaches, with the aim of advancing understandings of youth relationships with nature. The first integrates spatial analysis of GIS polygon (centroid) locations with qualitative analysis of image and description attributes of polygons. The objective was to explore the value of location for understanding relationships with nature for youth with different life experiences, such as different access to people and places before or during COVID-19 lockdowns, or different exposure to more or less EE programming. The second develops a new approach, a codebook for analyzing qualitative and quantitative attributes of participant-drawn GIS polygons themselves, enhanced by both qualitative analysis of associated images and descriptions and spatial analysis of polygon (centroid) locations. The objective was to explore the value of analyzing participant-drawn areas on a map to extract meaning that helps us understand how youth conceptualize nature and, in turn, relate with nature.

Objectives

The two main objectives of this dissertation are:

- *Objective 1: Explore the value of location for understanding how and where different life experiences impact youth relationships with nature.*
 - *Case Study 1: Explore impacts of COVID-19 lockdowns on how and where youth relate with nature.*
 - *Case Study 2: Explore impacts of exposure to environmental education programming on how and where youth relate with nature.*
- *Objective 2: Explore the value of analyzing participant-drawn areas on a map for understanding how and where youth conceptualize nature.*
 - *Method Development: Develop codebook for inductive analysis of participant-drawn areas on a map to interpret how youth conceptualize nature.*
 - *Case Study: Explore impacts of COVID-19 lockdowns on how and where youth conceptualize nature.*

Research Context

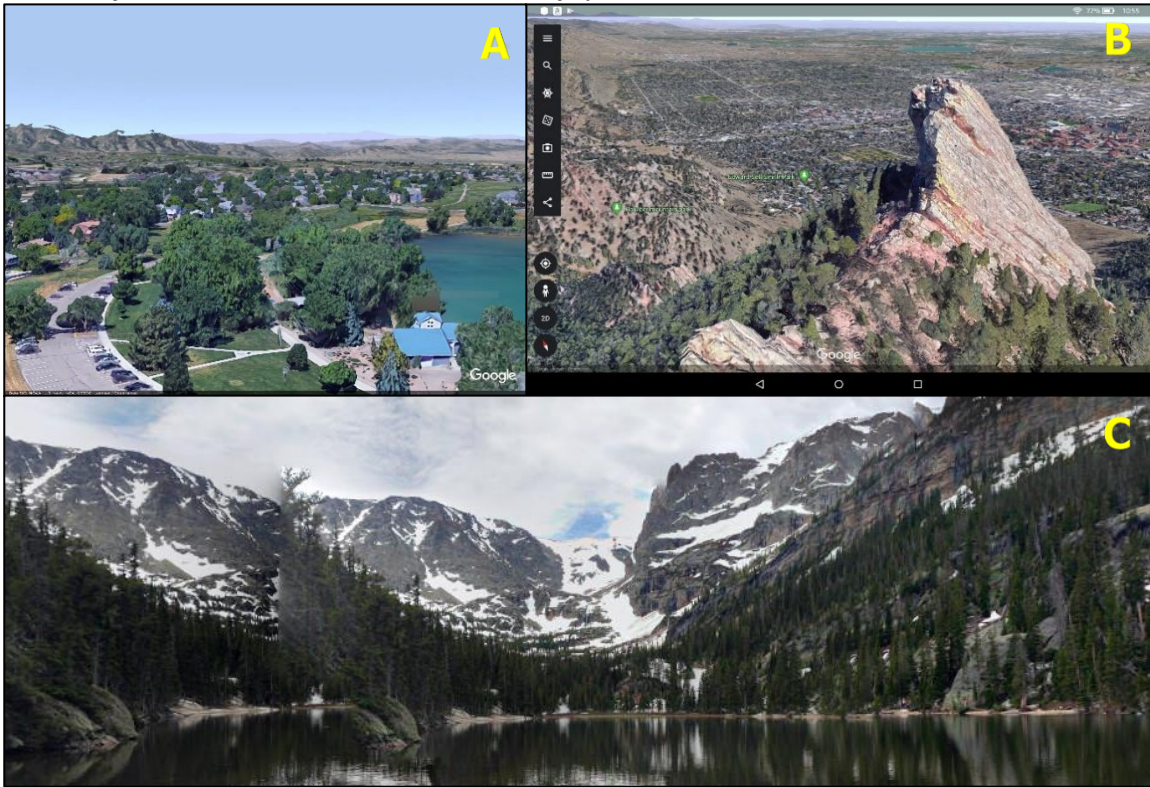
This dissertation was carried out in partnership with a community organization in Lafayette, Colorado: Nature Kids / Jóvenes de la Naturaleza (NKJN). NKJN is a collective of non-profit, government, pre-K-12 education, and academic organizations that partner with the aim of improving access to nature for youth and families. As part of their mission, NKJN coordinates construction of parks and trails in Lafayette and provides environmental education and outdoor recreation programming, both in the vicinity of Lafayette and in regional mountain areas beyond. Our goals in community-partnered research were to conduct academic research that advances qualitative GIS

methods and understandings of youth relationships with nature as well as to provide benefits to NKJN’s ongoing program evaluation efforts and, in turn, the Lafayette community in which NKJN provides programming. This involved seeking and incorporating input from NKJN organization and program leaders throughout the research process (Jacquez et al., 2013).

The City of Lafayette is located in a suburban setting of Boulder County, Colorado, 20 miles northwest of Denver. Originally founded as a coal mining town in 1888, Lafayette’s economy shifted to agricultural, commercial, and manufacturing industries by the 1970s and 1980s due to the growth of neighboring Denver and Boulder (Hutchinson, 1990). As of 2020, the population of Lafayette was over 30,000: B
70.9% white, 18.5% Latinx, 4.2% Asian, 1.1% Black, 0.3% American Indian or Alaska Native, and 5.0% some other race/ethnicity (U.S. Census Bureau, 2020). While the median household income in Lafayette is over \$85,000 (Boulder County: over \$87,000), 5.4% of the population live below the poverty level (Boulder County: 9.5%) (U.S. Census Bureau, 2020). Industrial zones at Lafayette’s city center are mixed with lower-income residential neighborhoods of rental, manufactured, and older housing that stand in contrast to newer single-family housing and higher-income areas of Lafayette and surrounding Boulder County. Residents living in and around Lafayette are in close proximity to local city parks, nearby foothills, and, for those who have a car, Rocky Mountain National Park in the mountains west of Lafayette (Figure 1).

Figure 1

Scenes of Nature Places in and around Lafayette



Note. Common nature places in Lafayette (Panel A), nearby (Panel B), and in the mountains beyond (Panel C), documented by participants in this study.

Before introducing the NKJN youth participants of this study, as the author of the dissertation who led and conducted the research process, I would like to share my relationship with nature that influenced my interest in this work. I am a white male in my early 30s who grew up in a suburban middle-income family. In my childhood, I enjoyed camping, hiking, and other activities in Boy Scout programming and on family trips located in wilderness areas, state, and national parks. These are activities and locations that I continue to enjoy as an adult. My background shaped my own ideas about how and where to relate with nature as well as my continued desire to do so. During my

upbringing, I learned from family, in school, and through different forms of media (e.g., books and movies) that nature is pristine, without many people, beautiful, awe-inspiring, and provides a change of pace from (sub)urban life. The meanings that I associated with nature influenced the locations where I interacted with nature in childhood, and now in adulthood, in places such as parks and open spaces in and around Denver, wilderness areas across Colorado, and in Rocky Mountain National Park. Moreover, I have a car, a bit of discretionary income, and free time to access nature. Because of my meanings and unique lived experiences of nature, as well as my shared background with Americans of Western-European descent who inordinately impacted the dominant representations of nature in the United States, I aimed to remain open throughout the research process to the different ways that youth in this study related with nature, rooted in their own varying backgrounds and unique lived experiences. Furthermore, I note here that while I led and conducted the entire research process, this community-partnered research involved the NKJN youth participants, NKJN organization and program leaders, and university-based collaborators. Accordingly, I wrote this dissertation using first-person plural pronouns (we/us/our) to reflect the many individuals that contributed to this work.

Participants

NKJN was a specifically suitable community partner to work with youth and ask them about their relationships with nature because NKJN offers their programming to youth in Lafayette at no charge. As a result, NKJN youth participants were not biased by their resources, or lack thereof, to access nature outside of NKJN programming. We worked with NKJN organization leadership to identify multiple programs in which to recruit study participants—between the ages of 12-18—who could offer a range of

perspectives from varying backgrounds and different lived experiences of nature. We worked with leaders of the respective NKJN programs to ask their program participants to participate in the study and to collect signed parent/guardian permission and youth assent forms from those who agreed to participate. Fifty-five NKJN youth participants of varying age, gender, family income, and race/ethnic backgrounds participated in the study (Table 1). Relative to the broader population of Lafayette, the higher proportion of participants from lower income or ethnic minority backgrounds reflects NKJN’s aims to engage lower-income and Latinx communities of Lafayette with programming.

Table 1
Summary of Participants

	% participants (n=55)
Age	
12 – 13	33
14 – 15	36
≥ 16	26
Preferred not to or did not answer	5
Gender	
Female	53
Male	45
Preferred not to or did not answer	2
Family Income^a	
Higher	53
Lower	25
Preferred not to or did not answer	22
Race/Ethnicity^b	
Asian	4
Hispanic, Latino, and/or Spanish	35
White	42
Multiple (American Indian or Alaska Native, Asian, Black, Hispanic, Latino, Spanish, and/or White)	13
Preferred not to or did not answer	6
Data Contributed	
Story Maps	n=56 ^c
Interviews	n=23

Note. ^a Reported by parents/guardians in relative terms, based on a standard NKJN question: “Does your family receive or qualify for any government assistance?”

^b Categories derived from a standard NKJN demographic question.

^c One participant created two story maps.

Data Collection

Participants created story maps in workshops that were embedded in multiple NKJN programs between June 2019 and May 2020. In 2019, we facilitated in-person workshops with 39 participants across 4 NKJN programs, including an initial pilot workshop through which we refined the story map process. Workshops typically lasted approximately 2.5 hours across one or multiple days, depending on the given program’s schedule. In each workshop, we provided a tablet or laptop, access to ArcGIS StoryMaps (Esri, 2019a), ArcGIS Survey123 (Esri, 2019b), and Google Earth, as well as a printed story map guide that explained how to use the software and prompted what types of information to include. To start each workshop, we introduced the story map activity and IRB information, then addressed questions and technical issues throughout the workshop. A subset of participants in 2019 agreed to do a follow-up interview about their story map.

In 2020, we adapted the in-person workshop to a virtual school setting amidst lockdowns that resulted from the initial surge of COVID-19 cases in Colorado. We facilitated a series of online story map activities with 17 participants across two NKJN programs (including 1 participant who had also created a story map in 2019). The series of activities lasted approximately 2.5 hours, spread across two weeks of daily activities. Participants completed the activities on personal or school-issued devices, using the same software, guided by videos and written instructions embedded within the activities that

explained how to use the software and prompted what types of information to include. We introduced the story map activities at the beginning of the series in a live video chat meeting with all participants in each program, respectively. Then, participants worked on the activities each day on their own time.

The story map process included the following steps: (1) We prompted participants to title their story map with a phrase or sentence that best described what nature is to them. The title gave a sense of how a participant made sense of the concept of nature in general and got them thinking about their personal meaning they attach to nature. (2) Next, we asked participants to think of up to five places where nature is special to them, whether they had ever visited the place or not, anywhere in the world. We used the term “special” to focus participants on thinking about places where they personally imagine nature and consider nature meaningful in their lives. A focus on meaningful nature places also aligned with a standard NKJN evaluation question about what nature means in the context of participants’ lives. Additionally, we limited the number of places to five so that they had enough time to add the places to their story map. (3) Adding a place involved three steps: (a) Participants found the place in Google Earth/Images to capture a screenshot or select an image that showed what nature looks like there. By including a generic image, participants were not limited to places for which they had personal photographs and did not need to come prepared before—or spend time during—the workshop to find personal photographs. (b) They located the place on a web map and drew the specific area of the place where nature is meaningful to them. (c) They wrote a description of what distinguishes the place as nature and why the place is meaningful to them. The web-based mapping software made it possible to keep core steps of creating a

story map consistent between the in-person workshops and virtual activities, even if the sequencing and timing of steps varied.

Summary of Chapters

Chapter 2 explores the value of location for understanding how and where different life experiences impact youth relationships with nature. Specifically, we asked: How and where were youth relationships with nature impacted by COVID-19 lockdowns? We used a qualitative GIS approach that integrates the spatial analysis of GIS polygon (centroid) locations with the qualitative analysis of associated image and description attributes to explore the impact of COVID-19 lockdowns on youth relationships with nature. Youth relationships with nature are profoundly impacted by in-person interactions with people and places that were abruptly changed by COVID-19 lockdowns. Because data collection began under normal (pre-COVID-19) circumstances, and continued during the lockdown, we compared story maps created by one group of participants before and another group during the lockdown. We conducted a (nonspatial) qualitative analysis of story map images and descriptions to identify emergent themes of relationships with nature. Then, we mapped specific themes based on the centroids of story map polygons linked to the images and/or descriptions in which specific themes were identified. To explore impacts of COVID-19 lockdowns, we focused on differences in *how* and *where* youth related with nature before and during the lockdown. Chapter 2 is a paper that has been published in *Children, Youth and Environments*, co-authored by Rebecca Powell and Bryan Wee.

Chapter 3 also explores the value of location for understanding how and where different life experiences impact youth relationships with nature. In this case, we asked:

How does exposure to environmental education programming impact how and where youth relate with nature? Specifically, we used a qualitative GIS approach that integrates the spatial analysis of GIS polygon (centroid) locations with the qualitative analysis of associated image and description attributes to investigate how exposure to NKJN programming affects locations where participants demonstrate outcomes. While EE programs commonly emphasize experiencing the place(s) where a program is located, location information is seldom included in assessments of whether, why, how, and where EE programs have impacts. We compared story maps created by a different subset of NKJN participants, all who created a story map before the COVID-19 lockdown: one group with higher exposure to NKJN programming and another group with lower exposure. We identified NKJN's targeted program outcomes—*nature connection* and *health and wellness*—described by participants in story map descriptions and follow-up interviews. Then, we mapped specific outcomes based on the centroids of story map polygons linked to the descriptions and/or interviews in which specific outcomes were identified. To explore the value of integrating location into program evaluation, we considered what insights were revealed by comparing how different exposure to NKJN programming affects locations where participants demonstrate outcomes. Chapter 3 is a paper accepted to be published in *Children, Youth and Environments*, co-authored by Rebecca Powell, Bryan Wee, and Angela Myers, manager of NKJN.

Chapter 4 explores the value of analyzing participant-drawn areas on a map for understanding how and where youth conceptualize nature. Specifically, we developed a codebook for inductive analysis of participant-drawn areas on a map to interpret how youth conceptualize nature, part of a qualitative GIS approach that integrated codebook

analysis with spatial analysis of GIS polygon (centroid) locations. Understanding how and where youth conceptualize nature offers insights into youth relationships with nature, towards supporting individual health and well-being and a collective sustainable future. Individual youth develop their own conceptualization of nature with which they relate through interactions with places. In turn, it is important to understand youth conceptualizations of nature—their meanings of what nature is, where nature is, and why they relate with nature—in relation to specific places. We asked youth to share their meanings of nature by drawing on a map the specific area of places where nature is meaningful to them. To interpret meanings that youth embedded in the areas *through* the act of drawing them, we developed a codebook of spatial, geometric, and qualitative attributes of participant-drawn areas. We applied the codebook to data from different subsets of participants to explore the value of analyzing participant-drawn areas on a map as a qualitative GIS approach and for understanding how youth conceptualize nature. First, we explored youth conceptualizations of nature based on story maps created by participants independent of COVID-19 lockdowns. Second, we revisited the Chapter 2 case to explore youth conceptualizations of nature based on different life experiences. Chapter 4 is a manuscript in preparation to be submitted to a GIS-focused journal such as *Cartographica* or *International Journal of Geographical Information Science*.

Chapter 5 summarizes findings of this dissertation research and offers recommendations for future directions of research on youth relationships with nature and qualitative GIS approaches in research with youth about their lived geographies.

Chapter Two: The Impact of COVID-19 Lockdowns on Youth Relationships with Nature: A Socio-Spatial Perspective

Abstract

Youth relationships with nature are profoundly influenced by their day-to-day interactions with people and places. Here, we explored whether abrupt spatial restrictions imposed by COVID-19 lockdowns impacted how/where youth relate with nature. We compared “story maps” created by two groups of youth—before and during lockdown—which combined geographically referenced locations, images, and descriptions about relationships with nature, supplemented by follow-up surveys. Our findings indicate that youth relationships with nature are dynamic, responding to changing circumstances, environments, and needs. Specifically, during lockdown youth were more likely to find fulfillment and respite in nature, value lasting associations, and notice nature near where they live.

Keywords: children’s geographies, COVID-19 lockdowns, nature, qualitative GIS, story maps

Introduction

Youth relationships with nature—what nature is, where nature is found, and why nature is meaningful—are profoundly influenced by the contexts of their lived experiences (Castree, 2014; Kellert, 2002; Wee, 2020). The COVID-19 pandemic abruptly changed the lived experiences of youth, limiting their access to in-person

interactions with people and places. The initial surge of COVID-19 cases in the western U.S. state of Colorado between March and May of 2020 prompted state and local governments to slow the spread of the virus by implementing lockdown measures. These measures included stay-at-home orders that required people to remain at their place of residence whenever possible (Polis, 2020; Zayach, 2020). Corresponding school closures, activity cancellations, social distancing requirements, and other spatial restrictions resulting from lockdowns disrupted with whom youth socially interacted, and how, as well as where they interacted with nature.

While youth relationships with nature are mediated by their physical interactions with the natural world, youth also vicariously interact with, make sense of, and receive explanations about nature through representations, for example, in common vernacular, photographs, print, and other media (Aaron & Witt, 2011; Kellert, 2002; Wee, 2020). Vicarious encounters with representations of nature may bring to mind concepts of locations, whether general settings or specific places on a map, nearby or faraway (Castree, 2014; Cronon, 1996; Taylor, 2011). In contrast, physical interactions with nature always occur somewhere specific (Beery & Wolf-Watz, 2014). Severe spatial restrictions imposed by COVID-19 lockdowns limited the locations where youth could physically interact with nature and, in turn, potentially limited their conceptions of the places where they might encounter nature vicariously. With this in mind, we sought to explore the impact of COVID-19 lockdowns on youth relationships with nature.

To do this, we documented specific locations where youth physically and/or vicariously interacted with nature, before and during the lockdown, asking: *how and where were youth relationships with nature impacted by COVID-19 lockdowns?* The

question emerged because COVID-19 lockdowns occurred during an ongoing study by the authors, in which initial data collection had begun under normal (pre-COVID-19) circumstances. We therefore compared data shared by two similar groups of study participants, one before and one during the lockdown.

Youth Relationships with Nature

There is wide-ranging research that explores relationships between people and nature to understand human-nature connections (Ives et al., 2017). These include quantitative indices of “connection to nature” (e.g., Cheng & Monroe, 2012), mixed-methods studies of “nature connectedness” (e.g., Freeman et al., 2015), and qualitative, place-based explorations of subjective nature “place attachments” (e.g., Derr, 2002). We draw on the work of Ives et al. (2017; 2018) to explore human-nature connectedness as a multifaceted concept comprising multiple types of connections, or relationships, with nature. These are: *experiential* (i.e., interactions with nature), *emotional* (i.e., attachments to nature), *cognitive* (i.e., knowledge about nature), *philosophical* (i.e., worldviews of nature in relation to humans), and *material* (i.e., use of goods provided by nature). These five types of relationships are distinct but related; for example, experiential interactions could foster cognitive knowledge. While these relationships are based on research conducted predominantly with adults, we propose that there is value in using them to (broadly) guide our interpretations of youth relationships with nature.

Importantly for our study, relationships with nature begin in childhood (Chawla, 2020; Giusti et al., 2018; Ives et al., 2017). Hence, we further draw on the child-nature-connectedness framework proposed by Giusti et al. (2018) to situate each of the types of relationships within a youth context. The framework identifies “qualities of significant

nature situations” (p. 4), related to youth “abilities of human-nature connection” (p. 6). Through situations involving creative play, sensory engagement, and other activities, youth develop abilities to connect with nature, such as feeling comfortable in nature (experiential relationship), or being curious about nature (cognitive relationship). We refer to *youth* as adolescents from ages 12-18, after middle childhood, which includes ages 6-11 (Chawla, 1992). In the following paragraphs, we contextualize each type of relationship with nature with situations, abilities, and other aspects relevant to youth.

Experiential relationships involve interacting with nature. Previous research has explored how youth experience nature, particularly in specific places, in ways that involve or lead to exploration, creative expression (Chawla, 1992; Derr, 2002; Kong, 2000), social connection (Freeman et al., 2015; Hordyk et al., 2015; Koller & Farley, 2019), fear and/or security (Aaron & Witt, 2011; Malone, 2016; Milligan & Bingley, 2007), and mental and physical restoration (Collado et al., 2016; Korpela et al., 2001; Morgan, 2010). For youth, diverse interactions with nature range from social to personal, from entertainment to restoration. In the process, youth have opportunities to engage in activities and to develop greater comfort with/in nature (Giusti et al., 2018).

Emotional relationships with nature are shaped by memories and feelings of attachment or empathy. For youth, their affinity for nature may form through social ties (Derr, 2002) or experiential interactions, for example, restorative experiences (Korpela et al., 2001) or memorable explorations (Chawla, 1992; Morgan, 2010). Youth develop emotional relationships based on the amount and frequency of time they spend in nature (Giusti et al., 2018; Kals et al., 1999), particularly in specific places (Lewicka, 2011; Morgan, 2010; Twigger-Ross & Uzzell, 1996).

Cognitive relationships include knowledge or awareness of, attitudes towards, and values related to nature. While the word “nature” may trigger different concepts for different people (Adams & Savahl, 2017), youth of varied ages and cultural contexts tend to describe nature similarly: living organisms such as forests, trees, plants, grass, and wildlife; non-living things such as water and rocks (Aaron & Witt, 2011; Freeman et al., 2015); water features such as rivers and lakes; and land features such as beaches and mountains (Adams & Savahl, 2017; Collado et al., 2016). According to Giusti et al. (2018), youth may develop curiosity and knowledge about nature in situations with a range of qualities, from sensory engagement to self/peer-guided exploration.

Philosophical relationships are informed by worldviews of what nature is in relation to humans and associated ethics of humans existing in/with nature. Youth often describe their views of nature as outdoors (Aaron & Witt, 2011; Adams & Savahl, 2017), clean, fresh (Freeman et al., 2015; Milligan & Bingley, 2007), not human-made, and/or inclusive of everything (Aaron & Witt, 2011; Collado et al., 2016; Freeman et al., 2015). Philosophically, youth tend to draw on “Western cultural, vernacular, representations” of an idealized, “pure” nature separated from the presence of humans (Taylor, 2011, p. 423; Wee, 2020), while their physical encounters with the more-than-human world underscore views and experiences that are embedded in, not separate from, nature (Malone, 2016). Philosophical relationships may form in situations that involve thought-provocation and/or mentorship, in which youth learn to read nature spaces for different features and possibilities, or develop a sense of being one with nature (Giusti et al., 2018).

Material relationships with nature involve the extraction and consumption of goods, flows of material and energy (Dorninger et al., 2017), and the relational

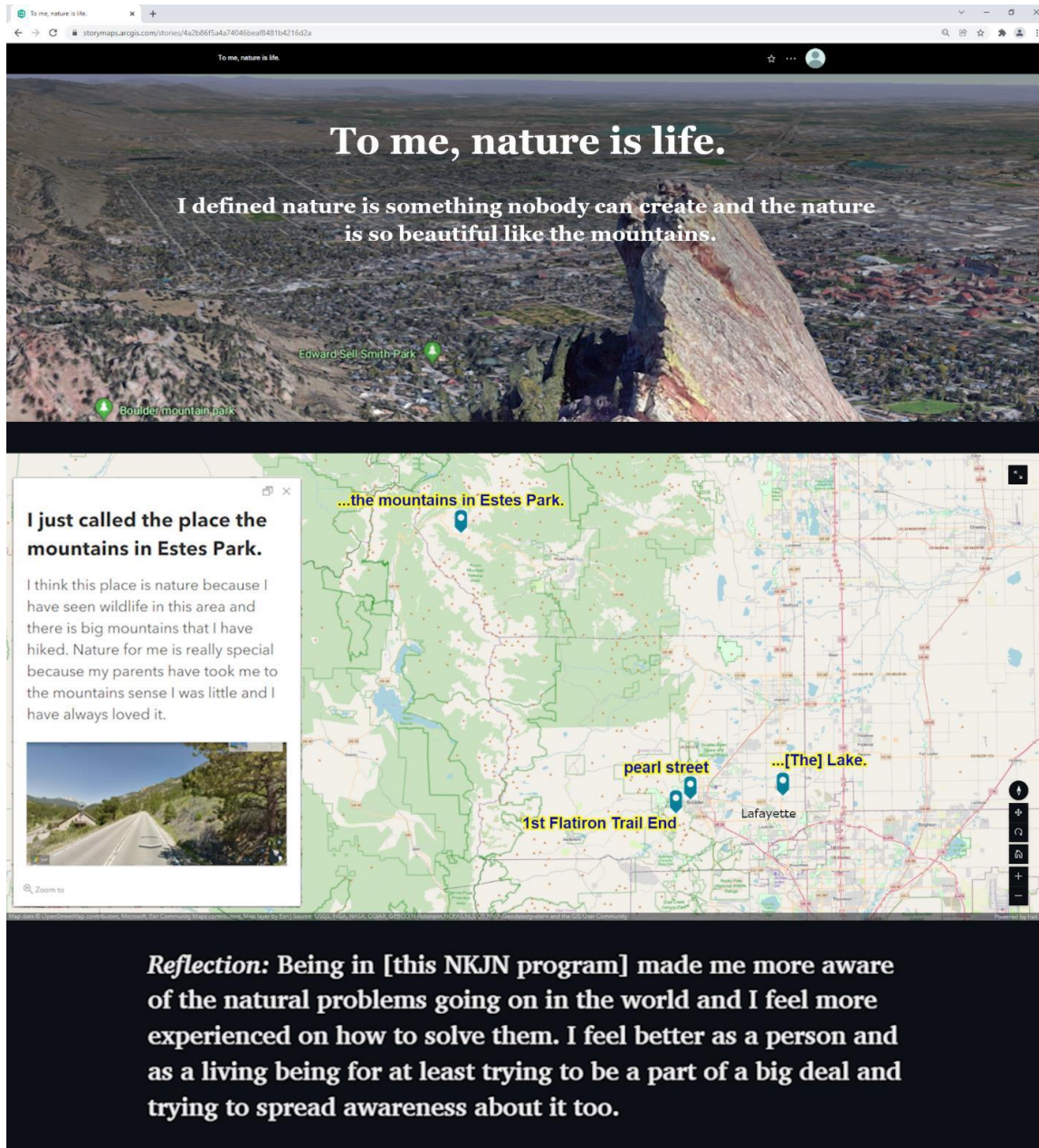
“materiality of child bodies and the bodies of other nonhuman entities” (Malone, 2016, p. 52). Youth are also conscious of their material relationships with nature because of human impacts, such as deforestation (Wee, 2020), and resources provided by nature, for example, food, water, air (Derr, 2002; Freeman et al., 2015), goods (Aaron & Witt, 2011), and life in general (Cheng & Monroe, 2012; Collado et al., 2016; Freeman et al., 2015). Youth may learn about material relationships in structured situations such as school that foster abilities to care about and/or take care of nature (Giusti et al., 2018).

Methods

To explore youth relationships with nature, we asked a group of youth to create *story maps* (Figure 1), a qualitative geographic information system (GIS) that integrates multimedia content (e.g., images, text) and locations (e.g., points on a map) in a web application to tell location-based “stories” (Jung & Elwood, 2019; Kerski, 2015; Kwan & Ding, 2008). Before introducing the study participants, we note our positionalities as adults and outsiders in youth spaces; specifically, the first author who implemented story maps, a white male from a suburban, middle-income background. To focus on the perspectives of youth, we employed open-ended story map protocols and an inductive data analysis (Corbin & Strauss, 2015).

Figure 1

Representative Story Map



Note. Representative story map that combines elements of multiple participants' individual story maps; locations and other potentially sensitive information have been altered to protect participant privacy.

A story map is effectively a website (with settings to maintain privacy) that combines multimedia content linked to specific locations. Each participant adds (1) a title and cover image to their story map; (2) a map of locations, each with associated name, description, and image; and (3) additional narrative text. We have previously found the process of creating story maps to be inclusive and engaging, eliciting youth to voice location-specific meanings of places, while providing the ability to include locations anywhere in the world (Martz et al., 2020). In this study, story maps provided a medium for youth, working indoors—whether in a classroom before, or at home during, the lockdown—to assemble locations, images, and descriptions that help us understand *what*, *why*, and *where* the youth relate with nature. Participants were able to select places located anywhere in the world; importantly, they were not restricted to locations that they had visited in person.

Study Participants and Context

Study participants were between the ages of 12-18; all were program participants in Nature Kids / Jóvenes de la Naturaleza (NKJN). NKJN is a community-based organization that provides nature programming for youth and families who live in and around Lafayette, Colorado, a suburban municipality in Boulder County with a 2020 population of approximately 30,000 (U.S. Census Bureau, 2020). The cover image (Figure 1) provides a sense of Lafayette's setting, located on the plains just east of the Rocky Mountains, with a variety of local parks and surrounding open spaces. Residents with a car also have driving access to regional mountain areas such as Rocky Mountain National Park. NKJN funding provides outdoor programming free for all participants, regardless of prior interaction with or resources to access nature. We partnered with

NKJN to better understand the situated perspectives of NKJN youth who had interacted with nature; this allowed us to utilize story maps as a component of NKJN's ongoing program evaluation efforts. As a result, NKJN helped us to recruit study participants and to request signed parent/guardian permission and child assent forms for human subjects research (IRB) approval. A group of 17 participants, hereafter referred to as the *Before* group (BG), created story maps in 2019, before the onset of the COVID-19 pandemic. A comparable group of 17 participants (Table 1), hereafter referred to as the *During* group (DG), were also recruited prior to the pandemic but created story maps in April and May of 2020, during COVID-19 stay-at-home orders. Lockdowns in the United States varied widely in length and severity. Colorado issued stay-at-home orders in March and April of 2020—extended into May by Boulder County (Zayach, 2020)—that required residents to stay at home except to work at essential jobs, to obtain food, to give/receive care, or to exercise nearby (Polis, 2020).

Table 1*Summary of Study Participants*

	Before Group (BG) n = 17	During Group (DG) n = 17
Age		
12 – 13	10	4
14 – 15	5	10
≥ 16	2	3
Gender		
Female	8	6
Male	9	10
Preferred not to or did not answer	0	1
Family Income^a		
Higher	6	11
Lower	4	4
Preferred not to or did not answer	7	2
Race/Ethnicity		
Asian	1	1
Asian and White	2	0
Hispanic, Latino, and/or Spanish	9	6
Hispanic and White	0	1
Spanish and White	1	0
White	4	9
Preferred not to or did not answer	0	0
Data Contributed		
Story Maps	17	17
Surveys	17	15
Additional Lockdown Questions	0	13

Note. One participant created two story maps, one as a part of each group. All but five participants were younger than 16 during the study (i.e., below legal driving age) and likely dependent on others to some extent for access to nature places.

^a Reported by parents/guardians in relative terms, based on a standard NKJN question: “Does your family receive or qualify for any government assistance?”

Creating Story Maps

The BG created story maps during a school-based, in-person workshop, lasting approximately 2.5 hours across 4 days of NKJN programming. A total of 17 participants joined in one of two workshops (11 and 6 participants, respectively). The first author facilitated both workshops by introducing the story map project and IRB information, providing a tablet or laptop and a written project guide, answering questions, and offering technical assistance. Participants created story maps using existing mapping software, including Google Earth, ArcGIS StoryMaps (Esri, 2019a), and ArcGIS Survey123 (Esri, 2019b).

For the DG, the in-person workshop was adapted to the COVID-19-induced virtual, primarily asynchronous, school setting. The first author worked with a total of 17 participants in two different cohorts (10 and 7 participants, respectively) to introduce the story map project in a synchronous video chat meeting with each cohort and to facilitate a series of asynchronous story map activities. The virtual series was approximately 2.5 hours, spread across nine daily activities over approximately two weeks. Each activity covered a specific component of the story map; that is, introductions to the project/software and adding each story map element. Lacking real-time opportunities to answer questions or offer technical assistance, we provided supplementary videos and directions that demonstrated how to use the software for each activity. Methodologically, web-based mapping software allowed us to keep core steps consistent between the in-person and virtual formats, even if the timing and sequencing varied.

The core steps proceeded as follows: (1) Participants titled their story map with a phrase or sentence that best described what nature is to them. (2) They were prompted to

think of (no more than five) places where nature is special to them, that is, places that are important or significant to them and their life. These could be places they had gone to physically or only vicariously, nearby or faraway. (3) For each nature place, participants (a) virtually visited the place in Google Earth/Images to capture a screenshot or found an image from another source online that showed what nature looks like there; they selected one of these as the cover image, (b) located the place on a web map, and (c) wrote a description of what identifies the place as nature and why the place is meaningful to them. The products of each step coalesced in a story map (see Figure 1 for an example).

After concluding their story map, all participants were asked to complete a survey that included demographic and other questions, for example, how frequently they spend time in nature (response: BG, 100%; DG, 88%; Table 1). Additionally, DG participants were asked about nature places they visited during the lockdown, whether in their story map or elsewhere (response: 76%). For each of these lockdown places, DG participants described what identifies the place as nature, why the place is meaningful to them, and reported how frequently they visited the place before and during the lockdown.

Analyzing Story Maps

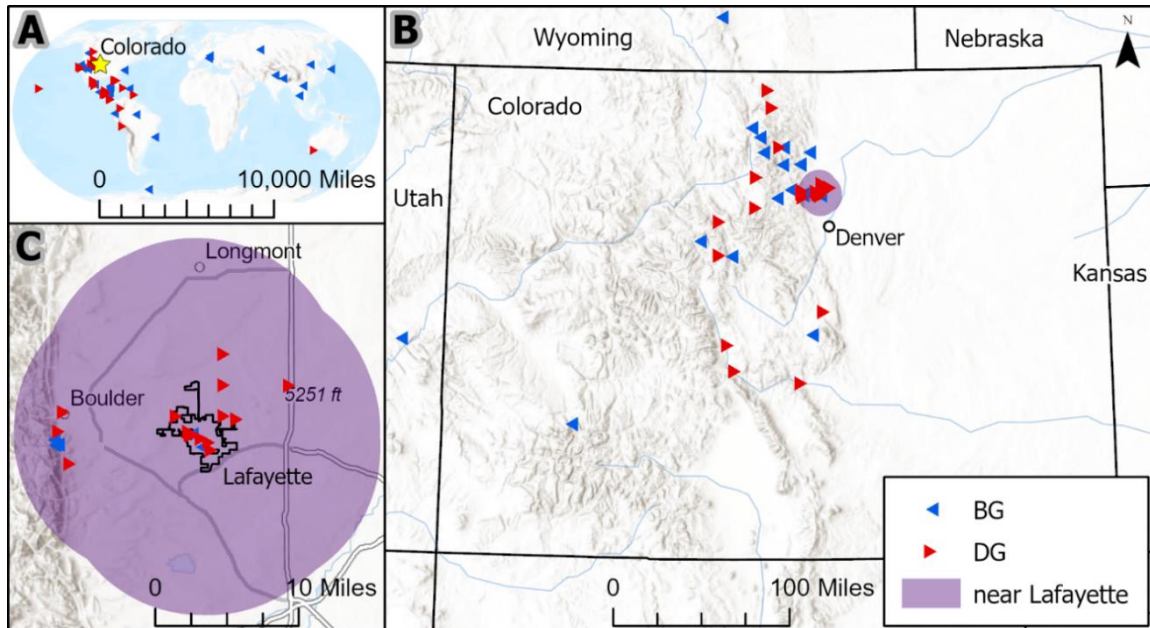
The goal of our qualitative GIS analysis, primarily implemented by the first author, was to approach youth relationships with nature as socio-spatial phenomena (Jung & Elwood, 2019). We drew from the work of Knigge and Cope (2006; 2009) to inform an inductive and iterative back-and-forth between (1) qualitative open coding to develop emergent themes of *what* nature is and *why* nature is meaningful to participants and (2) exploring spatial patterns of *where* emergent themes were located on a map. The five types of relationships with nature described earlier were not used as pre-determined

categories; rather, they provided a framework later in the analytical process to further refine emergent themes and discern differences between the groups. Qualitative open coding involved going image-by-image, line-by-line, to notice, reflect on, and code pieces of data in images and associated descriptions with main ideas or concepts, as well as comparing, adding, and condensing codes, verifying interpretations, and developing emergent themes (Corbin & Strauss, 2015). Next, we drew links between (a) emergent themes in images and descriptions and (b) corresponding map locations. For example, the map location of "...the mountains in Estes Park" (Figure 1) was linked to emergent themes identified in the associated image and place description. We identified themes such as *flora* in the image. In the description, themes emerged from the text, such as *fauna* from "I have seen wildlife in this area," *lasting association* from "sense [sic] I was little," and *fulfillment* from "I have always loved it."

We explored spatial patterns by plotting locations corresponding to a specific emergent theme on a map. For example, the map of locations associated with *fulfillment* included "...the mountains in Estes Park." To support this process, we used QDA Miner software (Provalis Research, 2020), which integrates the capabilities of computer-aided qualitative data analysis software (CAQDAS) and GIS (Jung & Elwood, 2010; Kwan & Ding, 2008). To identify spatial patterns, we visually interpreted mapped locations to delineate the highest density cluster, regardless of group (Figure 2); our interpretation was supported by a GIS distance-based density tool. This high-density cluster served as a reference for comparing differences in spatial patterns of emergent themes between the groups.

Figure 2

Nature Place Locations



Note. Panel A shows all nature place locations identified by both groups, Panel B displays locations in and around Colorado, and Panel C presents locations near Lafayette. The highest density of map locations across both groups occurred within an approximately 10-mile buffer from the Lafayette municipal boundary. Not all places are visible here due to overlap and/or proximity of map symbols. Some locations have been randomly shifted to protect participant privacy.

Data analysis thus far focused on inductively developing common emergent themes and exploring spatial patterns of emergent themes *across* both groups. Next, we sensitized our analytical focus to discern similarities and differences *between* the groups by assigning each unique emergent theme to one of the five types of relationships with nature. This involved selecting a single relationship that best captured the meaning of each emergent theme. Most emergent themes had a clear fit; for example, participants commonly shared their experiences of *fulfillment* in nature places, reflecting an

experiential relationship. Some themes were less clear, but still demonstrated a particular relationship that enabled us to assign a best fit. For example, *respite* (i.e., a break and sense of relief), while emotional, was interpreted to be a fundamental part of participants' experiential relationships because the emotion of relief was an outcome of experiencing a break. Still, experiencing respite could lead to an attachment to nature and an emotional relationship, illustrating how relationships and emergent themes were closely related and influenced one another.

To analyze the additional questions asked of the DG participants, we used the same process to identify emergent themes in the nature places they visited during the lockdown in terms of what identified the places as nature, why the places were meaningful to them, and where the places were located.

Findings

Qualitative Similarities in Emergent Themes

Overall, participants across both groups expressed similar emergent themes in images and descriptions of what nature is and why nature is meaningful in their nature places. We expected this result, due in part to the consistent research design before and during the lockdown, comparable demographics across both groups, and the relatively brief timespan of the lockdown in the scope of DG participants' lives. In what follows, we describe emergent themes, each of which we assigned to a type of relationship with nature (Table 2).

Table 2***Summary of Relationships with Nature and Emergent Themes***

Relationship	Emergent Themes	BG	DG	BG	DG
		<i>% participants</i>		<i>#/participant</i>	
<i>EXPERIENTIAL</i>	doing activities fulfillment respite	100	100	2.8	3.1
<i>EMOTIONAL</i>	developing association lasting association social ties affinity significant experience interesting belonging	100	100	3.4	3.3
<i>COGNITIVE</i>	land features water features flora fauna abiotic factors	100	100	2.6	3.2
<i>PHILOSOPHICAL</i>	pristine built-up one with nature	64.7	52.9	1.2	0.8
<i>MATERIAL</i>	nature as resource nature as life human impacts	29.4	17.6	0.6	0.2

Note. % participants refers to the percent of participants in each group who indicated the relationship in their description of at least one place in their story map; #/participant refers to the average number of unique places where participants described the relationship type.

Experiential

All participants across both groups interacted with their nature places, whether physically or vicariously. Participants had visited most of their collective 119 nature places in person (~82% of all places); all but three participants had visited at least one—and more commonly, all—of their nature places. In contrast, participants had interacted only vicariously with a smaller number of places included in their story maps (~18% of

all places). Estimates are approximate because of some unclear descriptions regarding whether the participant had actually visited the place. A participant may have connected with a place vicariously because they learned about it in school (e.g., “Mount Everest”) or from family (e.g., “Grand Canyon”). Participants described their experiential relationships with nature mostly in terms of doing activities, feeling fulfillment, and, less often, finding respite (Table 2).

Participants experienced a range of activities, from hiking to playing to skiing, in their nature places. Participants felt fulfilled most often by enjoying themselves, sensing wonder, and sometimes socially connecting with family and friends. Some also found respite where they had a break to sense peace, feel relief, or pass time. One participant described activities, fulfillment, and respite associated with a single place:

[The] Park is nature because it’s a mountain you can hike and look at a breathtaking/amazing view...Nature is special to me because whenever I’m stressed, angry, or sad I always take a walk in nature and it clears my head. Nature has a calming tone to it that really helps me. I also love going on hikes with my family.

Emotional

All participants across both groups described attachments to nature, most often in terms of developing or lasting associations (Table 2). For example, developing associations were reflected by a short-term visit (e.g., a family trip to “Yellowstone”) or a desire to visit a new place (e.g., “Machu Picchu”). In contrast, participants indicated lasting associations when they described spending extensive or frequent time in a place (e.g., “I have been skiing here all my life” or “I go there a lot”), living in immediate

proximity (e.g., “I lived very close to there”), and/or spending enough time there to have multiple memories (e.g., “I have many memories there”). Emotional relationships with nature also arose through social ties (e.g., “I go with my family and friends”), affinity (e.g., “one of my favorite places”), significant experience (e.g., “I did something extreme for the first time”), historical interest (e.g., “it has an interesting history”), famous interest (e.g., “it is the most visited beach”), and belonging (e.g., “home”).

Cognitive

All participants across both groups described their knowledge or awareness of nature environments, including land and water features, flora, fauna, and abiotic factors (Table 2). Participants most often described wildlife, mountains, forests, trees, and water features generally; these were also the most common features that participants represented in images (except wildlife, which are not displayed on Google Earth). For example, one participant described “[The] Lake” (Figure 1), “there are many trees around the lake,” reflecting evidence of their cognitive relationship with nature there.

Philosophical

A majority of participants in both groups expressed their views of nature in relation to humans. This was done most often when participants drew on their cognitive awareness of nature features to describe them in pristine terms (Table 2), for example, “untouched,” “outside,” “not man-made,” and, as one participant described a rock formation in their story map, “It is in a protected forest, shielded from development.” Some participants also described nature in built-up places, for example, a participant explaining how “pearl street [sic]” (Figure 1) in downtown Boulder, Colorado, “...has the mix between nature and man-made structures.” In images, participants also included

built-up aspects in the form of human-made features, for example, the building in the image of “...the mountains in Estes Park” (Figure 1). Participants also commonly represented pristine nature in images without many (or any) human-made features. In doing so, participants across both groups alluded to a dichotomy between nature and the presence or absence of humans and human influences in their views of nature. Some participants further described being “one with nature” in pristine nature places, reinforcing how their philosophical relationship shaped their experiential relationship with nature.

Material

Few participants in either group described an awareness of their material relationship and dependence on goods provided by nature. Those who did described nature as a resource in their nature places (Table 2)—for food, water, air, biodiversity, and tourism—or defined nature as “life,” as one participant did in their story map title (Figure 1). This participant further described one of their places as special, “because without nature I could not live.” A few participants were conscious of material human impacts on nature, for example, noting a “lake without contamination,” again reflecting a philosophical view of nature as uncontaminated and pristine.

Spatial Differences in Emergent Themes

Participants collectively mapped 119 unique nature places across the world (Figure 2); the BG participants collectively included 60 unique places, the DG participants, 59 places. The highest density of map locations across both groups occurred near Lafayette, within an approximately 10-mile buffer from the Lafayette municipal boundary. Using this buffer as reference, we identified differences in the mapped

locations between the groups by comparing places *near Lafayette* versus *away from Lafayette*, beyond the 10-mile buffer. More DG participants than BG participants mapped at least one place near Lafayette, and collectively DG participants mapped more places within the 10-mile buffer (Figure 3). In the following paragraphs, we describe differences between the groups in terms of the locations participants associated with specific emergent themes.

Experiential

Nearly all participants, regardless of group, described *fulfillment* in nature places located away from Lafayette. Many DG participants also experienced fulfillment in places located near Lafayette; in contrast, few BG participants expressed the theme of fulfillment in places nearby (Figure 3).

Emotional

Regardless of group, places identified with *developing associations* were mostly located away from Lafayette. More BG participants than DG participants described a developing association with at least one of their nature places; BG participants also collectively identified a greater number of such places. Many participants across both groups also identified places where they held *lasting associations*. In this case, more DG participants than BG participants identified lasting associations with at least one of their places, and collectively, in a greater number of places, in locations clustered near Lafayette (Figure 3).

Cognitive

Overall, more DG participants than BG participants described *trees*—a subset of the emergent theme, *flora*—in their nature places, particularly in locations near Lafayette

(Figure 3). There, more DG participants than BG participants described trees in at least one place, and collectively, in more places. Additionally, DG participants more commonly included images of individual or smaller stands of trees, particularly in locations near Lafayette.

Conversely, BG participants more commonly included images of larger forest extents, in locations away from Lafayette. In images, DG participants also more often identified other natural features near Lafayette, including grass, birds, plants, (views of) mountains, and water features.

Philosophical

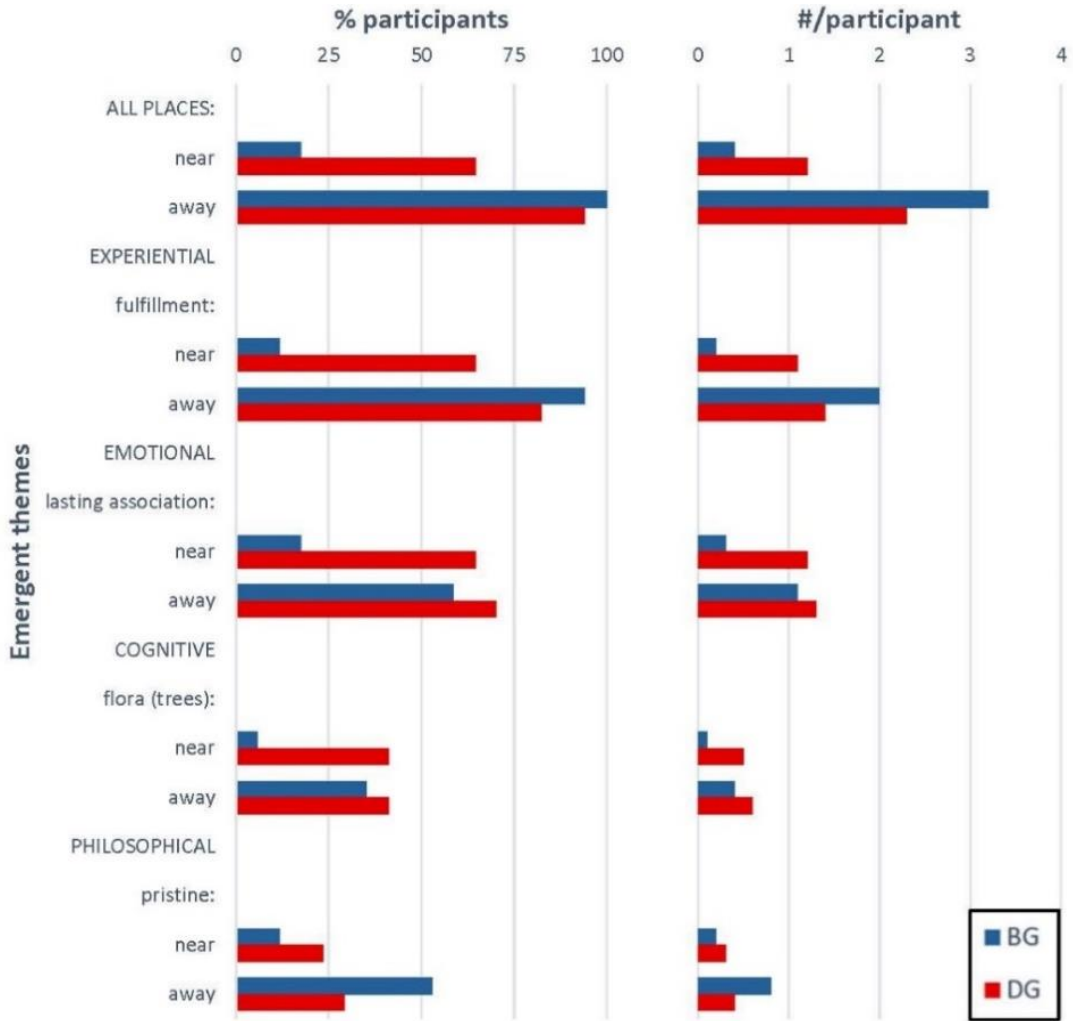
More BG participants than DG participants described *pristine* aspects of at least one nature place, and in more places on average, generally in locations away from Lafayette (Figure 3); this theme was reinforced by the images selected by BG participants. In contrast, more DG participants than BG participants selected images that included built-up features within their nature places, and in more places on average, especially in locations near Lafayette.

Material

While not prominent overall, more BG participants than DG participants described *nature as a resource* in at least one nature place, and in more places on average; all places associated with this theme were in locations away from Lafayette.

Figure 3

Differences in Key Emergent Themes by Mapped Locations (Near vs. Away from Lafayette)



Note. Left: Percent of participants in each group who indicated the emergent theme in their description of at least one place in their story map. Right: Average number of unique places per participant in which the emergent theme was indicated.

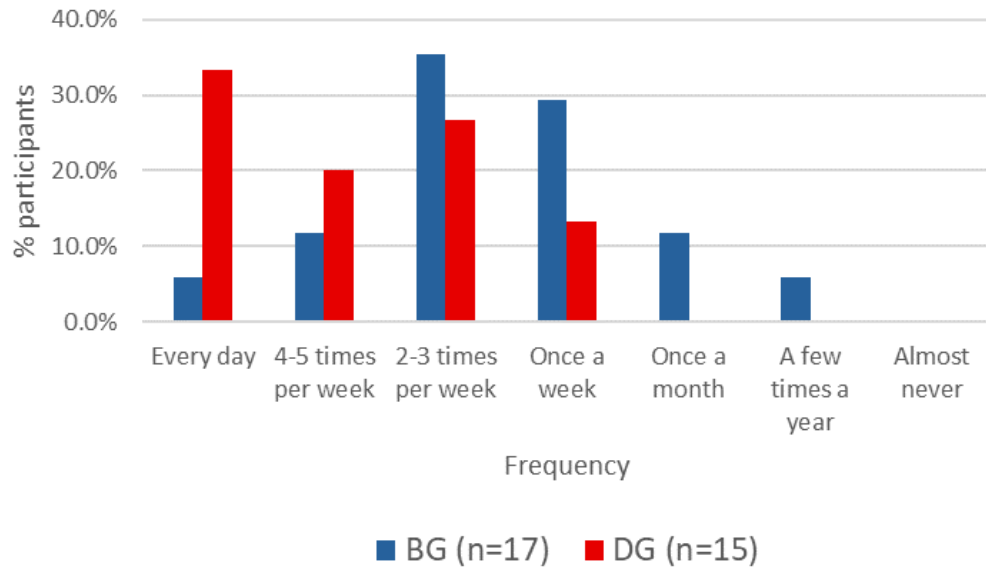
Lockdown-Specific Emergent Themes

Nearly all participants from both groups responded to the post-activity survey, including questions about how frequently they spend time in nature. Responses showed

that collectively, the DG participants’ experiential relationships with nature amidst lockdown involved more frequent time spent in nature—as measured by frequency of visits to nature—than BG participants (Figure 4).

Figure 4

Self-Reported Frequency of Time Spent in Nature



Note. Participants recorded frequency of visits to nature in response to the survey question: “How often do you and/or your family spend time in a natural or outdoor area?”

Additionally, 13 DG participants (76.5%) responded to questions about visiting nature places amidst lockdown. Collectively, they identified 21 unique lockdown nature places; based on their descriptions of these places, most (72.6%) were yards or greenspaces near Lafayette.

Among the themes respondents associated with lockdown places were respite (experiential), lasting association (emotional), and trees, plants, and water features (cognitive). Significantly, all but one of these DG respondents described respite in lockdown nature places, indicating that these places supported youth physical and mental

well-being by enabling them to get out to pass time, play, exercise, relax, and/or clear their head, whether alone or with family. One respondent described a large field down the street from their home: “I go there to clear my head or to refresh and get some fresh air and sometimes to skate.” All respondents identified lasting associations with the nature places they visited amidst lockdown. Furthermore, respondents reported visiting many lockdown nature places more frequently during than before the lockdown.

Discussion

Our findings offer evidence that the COVID-19 lockdowns impacted how and where youth relate with nature, especially experientially and emotionally. Experientially, the lockdown restricted locations where youth physically interacted with nature to find fulfillment, highlighting dynamic experiential relationships between youth and nature. The settings of places that youth associate with nature, whether trees in a remote forest or in a city park, invite and satisfy youth needs for fulfillment (Chawla, 1992; Giusti et al., 2018; Morgan, 2010). Amidst the severe spatial restrictions of lockdown, these youth seemed to seek fulfillment more often and in nature places closer to home. Our study highlights that youth experiential relationships with nature are dynamic, as youth adapt where they do activities, find fulfillment, and deem places special based on changing circumstances, environments, and needs.

The lockdown also increased the importance of respite in youth experiential relationships with nature, especially in locations near home. Nature can be restorative for youth mental and physical well-being (Collado et al., 2016; Korpela et al., 2001; Morgan, 2010). Moreover, youth value places that provide a reprieve from acute or ongoing stressors, or that satisfy physical and/or psychological needs (Scannell et al., 2017),

particularly nature places (Chatterjee, 2018; Chawla, 2014; Morgan, 2010; Scannell et al., 2016). The COVID-19 lockdown presented an acute stressor that prompted youth in this study to seek respite in nature places near home. This reprieve supported their mental and physical well-being (Chatterjee, 2018; Chawla, 2014) and demonstrated their resiliency amidst a lockdown.

Emotionally, lockdown focused participants' relationships with nature in places where they held lasting associations, and in locations near where they live. Forming lasting emotional ties to nature involves repeated physical interactions over time (Giusti et al., 2018; Kals et al., 1999) and in specific places (Lewicka, 2011; Morgan, 2010; Twigger-Ross & Uzzell, 1996).

Emotional ties to place can preserve continuity amidst disruptions to the places and routines of youth (Scannell et al., 2016; 2017). On one hand, simply that youth identified more nature places located near Lafayette likely contributed to youth describing more lasting associations, because the nearby places they identified inherently support long-term interactions, proximity, and memories. On the other hand, living with severe spatial restrictions may have increased the value youth put on their established ties to places amidst the lockdown. In turn, they identified more nature places in their story maps—and nearly all the places they visited during lockdown—where they held lasting associations. Many of these were located near Lafayette, places where they had established ties prior to the pandemic, and locations that preserved some level of continuity. Meanwhile, associations with places they visited once, or only interacted with vicariously, were relatively less important to youth amidst lockdown. The diminished value of lesser-known places, coupled with the heightened value of established places,

further suggest that youth relationships with nature, and reasons why nature places are special, fluctuate as they respond and adapt to change.

Cognitively, philosophically, and materially, the lockdown highlighted a sensitivity to the locations the youth in this study could access. Broadly speaking, how youth thought about nature (conceptually)—their knowledge, views, and material consciousness of nature—did *not* change in the relatively short lockdown period. Youth across both groups shared similar concepts of nature that they had developed throughout their lives, through physical interactions with nature as well as vicarious encounters with nature representations (Aaron & Witt, 2011; Kellert, 2002; Wee, 2020). Yet, during the lockdown, youth applied long-held concepts of nature to different locations. For DG participants, this concept of nature applied to places that were more likely to be located in tree-lined, human-populated, built-up settings *near* Lafayette. Conversely, forests, pristine landscapes, and resources were more commonly found in BG participants' nature places, which were located in less built-up settings *away* from Lafayette. In particular, the relatively low prominence of material relationships in the study might be explained by modern societies being disconnected from local environments, as material resources increasingly come from faraway places (Dorninger et al., 2017). How youth embody (physically) and express (conceptually) their relationships with nature are linked to their conceptual knowledge, views, and material consciousness of nature. These are, in turn, dependent upon physical locations youth can access. The severe spatial restrictions imposed by lockdown, therefore, impacted the contexts in which youth embodied and expressed cognitive, philosophical, and material relationships with nature.

Conclusion and Implications

As locations and access to places for youth changed following COVID-19 lockdowns, so did youth relationships with nature. This study focused on the impact of the lockdowns during a very specific period, in a specific location, on a specific group of youth. We acknowledge that our findings are also specific to the situated perspectives of NKJN youth, and not all youth. Nevertheless, we suggest several ways that our findings may offer useful insights into youth relationships with nature, while recognizing that youth of different ages and circumstances may be affected by spatial restrictions and other disruptions to their lives in different ways.

Any factors that limit spatial access, similar to COVID-19 lockdowns, potentially impact youth relationships with nature. Many youth live with various forms of spatial restrictions that limit their daily access to nature locations. These may include factors such as residential setting (i.e., rural, urban, or suburban); limited time, money and/or transportation; safety concerns; perceived discrimination of historically marginalized groups; and/or level of adult supervision, autonomy, and range from home (Byrne & Wolch, 2009; Freeman et al., 2015; Taylor, 2016).

Youth also face a myriad of other disruptions to their lives, from everyday life challenges to acute or ongoing natural disasters, conflicts, and other crises (Chatterjee, 2018; Chawla, 2014). In response to the lockdown, participants in this study further established their relationships with nature nearby, drawing on lasting associations with grassy yards and wooded greenspaces, activities that fulfilled them, and habits of respite. Indeed, the location of nature nearby was more important to youth than the type of nature (e.g., how pristine it was), at least during the lockdown. This demonstrates the broader

value of youth having access to, and building relationships with, nature nearby on which they can draw to cope with disruptions to their lives.

COVID-19 lockdowns illuminated dynamic relationships between youth and nature. As circumstances, environments, and needs changed for youth, so did their relationships with nature. Changes that shift the focus on nature closer to home can expand and also ground youth relationships with nature, especially in nearby places. While we wish to avoid generalizing the experiences of youth, we also wish to point out that most youth face spatial restrictions and other disruptions at various times in their lives. Therefore, we suggest the implications of our study are worth considering in future research exploring dynamic, socio-spatial relationships between youth and nature, particularly under ordinary circumstances, or in this “new normal” that we inhabit.

Finally, an important component of our findings was the value of including location specificity in research about youth relationships with nature (e.g., Freeman et al., 2015), that is, linking *what* and *why* nature was meaningful to youth with *where* they valued nature in their lives. The broader human-nature connection literature offers relatively limited understanding of the specific locations of individuals’ relationships with nature (Beery & Wolf-Watz, 2014; Klaniecki et al., 2018; Restall & Conrad, 2015). We suggest that our location-specific approach to exploring qualitative themes led to findings that would not have emerged from analysis of spatial or qualitative data alone (Jung & Elwood, 2010). Greater location specificity offers richer understandings of where individuals, and youth in particular, form relationships with nature, as well as understandings of how their dynamic, socio-spatial relationships may change over time.

References

- Aaron, R. F., & Witt, P. A. (2011). Urban students' definitions and perceptions of nature. *Children, Youth and Environments*, 21(2), 145-167.
<http://www.jstor.org/stable/10.7721/chilyoutenvi.21.2.0145>
- Adams, S., & Savahl, S. (2017). Children's discourses of natural spaces: Considerations for children's subjective well-being. *Child Indicators Research*, 10, 423-446.
<https://doi.org/10.1007/s12187-016-9374-2>
- Beery, T. H., & Wolf-Watz, D. (2014). Nature to place: Rethinking the environmental connectedness perspective. *Journal of Environmental Psychology*, 40, 198-205.
<https://doi.org/10.1016/j.jenvp.2014.06.006>
- Byrne, J., & Wolch, J. (2009). Nature, race, and parks: Past research and future directions for geographic research. *Progress in Human Geography*, 33(6): 743-765.
<https://doi.org/10.1177/0309132509103156>
- Castree, N. (2014). *Making sense of nature*. Routledge.
- Chatterjee, S. (2018). Children's coping, adaptation and resilience through play in situations of crisis. *Children, Youth and Environments*, 28(2), 119-145.
<https://doi.org/10.7721/chilyoutenvi.28.2.0119>
- Chawla, L. (1992). Childhood place attachments. In I. Altman & S. M. Low (Eds.), *Place attachment* (pp. 63-86). Springer. https://doi.org/10.1007/978-1-4684-8753-4_4
- Chawla, L. (2014). Children's engagement with the natural world as a ground for healing. In K. G. Tidball & M. E. Krasny (Eds.), *Greening in the red zone: Disaster, resilience and community greening* (pp. 111-124). Springer.
https://doi.org/10.1007/978-90-481-9947-1_8

- Chawla, L. (2020). Childhood nature connection and constructive hope: A review of research on connecting with nature and coping with environmental loss. *People and Nature*, 2(3), 619-642. <https://doi.org/10.1002/pan3.10128>
- Cheng, J. C. H., & Monroe, M. C. (2012). Connection to nature: Children's affective attitude toward nature. *Environment and Behavior*, 44(1), 31-49. <https://doi.org/10.1177/0013916510385082>
- Collado, S., Íñiguez-Rueda, L., & Corraliza, J. A. (2016). Experiencing nature and children's conceptualizations of the natural world. *Children's Geographies*, 14(6), 716-730. <https://doi.org/10.1080/14733285.2016.1190812>
- Corbin, J., & Strauss A. (2015). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Sage.
- Cronon, W. (1996). The trouble with wilderness: Or, getting back to the wrong nature. *Environmental History*, 1(1), 7-28. <https://www.jstor.org/stable/i382276>
- Derr, V. (2002). Children's sense of place in northern New Mexico. *Journal of Environmental Psychology*, 22(1-2), 125-137. <https://doi.org/10.1006/jevp.2002.0252>
- Dorninger, C., Abson, D. J., Fischer, J., & von Wehrden, H. (2017). Assessing sustainable biophysical human-nature connectedness at regional scales. *Environmental Research Letters*, 12(5), 055001. <https://doi.org/10.1088/1748-9326/aa68a5>
- Esri (Environmental Systems Research Institute) (2019a). *ArcGIS StoryMaps* [Computer software]. <https://storymaps.arcgis.com/>

- Esri (Environmental Systems Research Institute) (2019b). *ArcGIS Survey123* (Version 3.6.149) [Computer software]. <https://survey123.arcgis.com/>
- Freeman, C., van Heezik, Y., Hand, K., & Stein, A. (2015). Making cities more child- and nature-friendly: A child-focused study of nature connectedness in New Zealand cities. *Children, Youth and Environments*, 25(2), 176-207.
<https://doi.org/10.7721/chilyoutenvi.25.2.0176>
- Giusti, M., Svane, U., Raymond, C. M., & Beery, T. H. (2018). A framework to assess where and how children connect to nature. *Frontiers in Psychology*, 8, 2283.
<https://doi.org/10.3389/fpsyg.2017.02283>
- Hordyk, S. R., Dulude, M., & Shem, M. (2015). When nature nurtures children: Nature as a containing and holding space. *Children's Geographies*, 13(5), 571-588.
<https://doi.org/10.1080/14733285.2014.923814>
- Ives, C., Giusti, M., Fischer, J., Abson, D. J., Klaniecki, K., Dorninger, C., Laudan, J., Barthel, S., Abernethy, P., Martín-López, B., Raymond, C. M., Kendal, D., & von Wehrden, H. (2017). Human-nature connection: A multidisciplinary review. *Current Opinion in Environmental Sustainability*, 26-27, 106-113.
<https://doi.org/10.1016/j.cosust.2017.05.005>
- Ives, C., Abson, D. J., von Wehrden, H., Dorninger, C., Klaniecki, K., & Fischer, J. (2018). Reconnecting with nature for sustainability. *Sustainability Science*, 13, 1389-1397. <https://doi.org/10.1007/s11625-018-0542-9>
- Jung, J., & Elwood, S. (2010). Extending the qualitative capabilities of GIS: Computer-aided qualitative GIS. *Transactions in GIS*, 14(1), 63-87.
<https://doi.org/10.1111/j.1467-9671.2009.01182.x>

- Jung, J., & Elwood, S. (2019). Qualitative GIS and spatial research. In P. Atkinson, S. Delamont, A. Cernat, J. W. Sakshaug, & R. A. Williams (Eds.), *Sage research methods foundations*. Sage. <https://www.doi.org/10.4135/9781526421036818834>
- Kals, E., Schumacher, D., & Montada, L. (1999). Emotional affinity toward nature as a motivational basis to protect nature. *Environment and Behavior*, 31(2), 178-202. <https://doi.org/10.1177/00139169921972056>
- Kellert, S. R. (2002). Experiencing nature: Affective, cognitive, and evaluative development in children. In P. H. Kahn, Jr. & S. R. Kellert (Eds.), *Children and nature: Psychological, sociocultural and evolutionary investigations* (pp. 117-151). MIT Press. <https://doi.org/10.7551/mitpress/1807.003.0006>
- Kerski, J. J. (2015). Geo-awareness, geo-enablement, geotechnologies, citizen science, and storytelling: Geography on the world stage. *Geography Compass*, 9(1), 14-26. <https://doi.org/10.1111/gec3.12193>
- Klaniecki, K., Leventon, J., & Abson, D. J. (2018). Human-nature connectedness as a ‘treatment’ for pro-environmental behavior: Making the case for spatial considerations. *Sustainability Science*, 13, 1375-1388. <https://doi.org/10.1007/s11625-018-0578-x>
- Knigge, L., & Cope, M. (2006). Grounded visualization: Integrating the analysis of qualitative and quantitative data through grounded theory and visualization. *Environment and Planning A*, 38(11), 2021-2037. <https://doi.org/10.1068/a37327>
- Knigge, L., & Cope, M. (2009). Grounded visualization and scale: A recursive analysis of community spaces. In M. Cope & S. Elwood (Eds.), *Qualitative GIS: A mixed methods approach*. Sage. <https://dx.doi.org/10.4135/9780857024541.n6>

- Koller, D., & Farley, M. (2019). Examining elements of children's place attachment. *Children's Geographies*, 17(4), 491-500.
<https://doi.org/10.1080/14733285.2019.1574336>
- Kong, L. (2000). Nature's dangers, nature's pleasures: Urban children and the natural world. In S. Holloway & G. Valentine (Eds.), *Children's Geographies: Playing, Living, Learning* (pp. 257-271). Routledge.
- Korpela, K. M., Hartig, T., Kaiser, F. G., & Fuhrer, U. (2001). Restorative experience and self-regulation in favorite places. *Environment and Behavior*, 33(4), 572-589.
<https://doi.org/10.1177/00139160121973133>
- Kwan, M. P., & Ding, G. (2008). Geo-narrative: Extending geographic information systems for narrative analysis in qualitative and mixed-method research. *The Professional Geographer*, 60(4), 443-465.
<https://doi.org/10.1080/00330120802211752>
- Lewicka, M. (2011). Place attachment: How far have we come in the last 40 years? *Journal of Environmental Psychology*, 31(3), 207-230.
<https://doi.org/10.1016/j.jenvp.2010.10.001>
- Malone, K. (2016). Reconsidering children's encounters with nature and place using posthumanism. *Australian Journal of Environmental Education*, 32(1), 42-56.
<https://doi.org/10.1017/aee.2015.48>
- Martz, C. J., Powell, R. L., & Wee, B. (2020). Engaging children to voice their sense of place through location-based story making with photo-story maps. *Children's Geographies*, 18(2), 148-161. <https://doi.org/10.1080/14733285.2019.1685073>

- Milligan, C., & Bingley, A. (2007). Restorative places or scary spaces? The impact of woodland on the mental well-being of young adults. *Health & Place, 13*(4), 799-811. <https://doi.org/10.1016/j.healthplace.2007.01.005>
- Morgan, P. (2010). Towards a developmental theory of place attachment. *Journal of Environmental Psychology, 30*(1), 11-22. <https://doi.org/10.1016/j.jenvp.2009.07.001>
- Polis, J. (2020). *Executive order: Ordering Coloradans to stay at home due to the presence of COVID-19 in the state*. State of Colorado. <https://drive.google.com/file/d/1ppYkzwOR7wAo5Aw9PhS7PiMU4vGVcPLN/view?usp=sharing>
- Provalis Research. (2020). *QDA Miner* (Version 6.0.1) [Computer software]. <https://provalisresearch.com/products/qualitative-data-analysis-software/>
- Restall, B., & Conrad, E. (2015). A literature review of connectedness to nature and its potential for environmental management. *Journal of Environmental Management, 159*, 264-278. <https://doi.org/10.1016/j.jenvman.2015.05.022>
- Scannell, L., Cox, R. S., Fletcher, S., & Heykoop, C. (2016). “That was the last time I saw my house”: The importance of place attachment among children and youth in disaster contexts. *American Journal of Community Psychology, 58*(1-2), 158-173. <https://doi.org/10.1002/ajcp.12069>
- Scannell, L., Cox, R. S., & Fletcher, S. (2017). Place-based loss and resilience among disaster-affected youth. *Journal of Community Psychology, 45*(7), 859-876. <https://doi.org/10.1002/jcop.21897>
- Taylor, A. (2011). Reconceptualizing the “nature” of childhood. *Childhood, 18*(4), 420-433. <https://doi.org/10.1177/0907568211404951>

- Taylor, D. E. (2016). *The rise of the American conservation movement: Power, privilege, and environmental protection*. Duke University Press.
- Twigger-Ross, C. L., & Uzzell, D. L. (1996). Place and identity processes. *Journal of Environmental Psychology, 16*(3), 205-220.
<https://doi.org/10.1006/jevp.1996.0017>
- U.S. Census Bureau (2020). "2020 Decennial Census." Accessed December 4, 2021.
<https://data.census.gov/cedsci/>
- Wee, B. (2020). The nature of childhood in childhoodnature. In A. Cutter-Mackenzie, K. Malone, E. Barratt Hacking (Eds.), *Research handbook on childhoodnature: Assemblages of childhood and nature research* (pp. 1025-1042). Springer, Cham.
https://doi.org/10.1007/978-3-319-51949-4_56-1
- Zayach, J. (2020). *Notice of Boulder County Public Health order adopting and extending state stay-at-home orders*. Boulder County Public Health.
<https://assets.bouldercounty.org/wp-content/uploads/2020/04/final-bcph-adoption-extension-of-stay-at-home-order-04-23-20.pdf>

Chapter Three: Evaluating Environmental Education Programs Using a Qualitative Geographic Information Systems Approach

Abstract

Environmental education (EE) programs commonly emphasize experiencing the place(s) where a program is located. Yet, program evaluations seldom map locations *where* participants demonstrate outcomes, whether during or after program experiences. To explore the value of including location in program assessment, we pilot a qualitative, map-based analysis to complement current evaluation efforts of an organization providing EE programs aimed at improving access to nature in suburban Lafayette, Colorado. Our preliminary findings suggest that youth participants with more exposure to programming demonstrated more prominent *nature connection* and *health and wellness* outcomes, especially in locations near Lafayette, illustrating how consideration of outcome locations adds nuance to EE program evaluation.

Keywords: environmental education, program evaluation, program outcomes, qualitative GIS, story maps

Introduction

Environmental education (EE) programs commonly emphasize experiencing the place(s) where a program is located. Evaluating outcomes of EE programs interests many stakeholders—practitioners, administrators, funders, and policymakers (Ardoin et al., 2018)—for reasons such as making program improvements, meeting needs of diverse

program audiences, and demonstrating program impacts (Zint, 2013). EE evaluations commonly employ quantitative approaches such as pre- and post-program surveys; somewhat less prevalent, are qualitative and/or mixed-methods approaches that incorporate observations, interviews, and/or focus groups. Common outcomes of EE programs may include knowledge, skills, behaviors, and dispositions, as well as personal growth and social/community engagement that lead to positive environmental and social change (Ardoin et al., 2015; Ardoin et al., 2018; Ladwig, 2010; Zint, 2013). Here, we examine the *approach* used to measure program outcomes, rather than the outcomes themselves.

Evaluation approaches that focus too narrowly on measured outcomes may distort perceived program impacts, overlook why and how programs are (un)successful, or miss overall richness of program experiences (Ardoin et al., 2018). Moreover, program outcomes may resonate differently with diverse audiences (Zint, 2013). Such challenges underlie a need to expand what and how outcomes are measured (Carleton-Hug & Hug, 2010; Stern et al., 2014). The inclusion of geographic locations as places where participants demonstrate outcomes—during and/or after program experiences—may enhance outcome measurement and lead to a better understanding of whether, why, how, and *where* EE programs have impacts.

In this field report, we explore integrating location information into evaluation of EE programs. Specifically, we implement a qualitative, map-based analysis to complement the program evaluation of Nature Kids / Jóvenes de la Naturaleza (NKJN). NKJN is a collective of non-profit, government, pre-K-12, and academic organizations partnering to improve access to nature by building physical infrastructure (e.g., parks, trails) and providing EE and outdoor recreation programming for youth and families in

Lafayette, Colorado. Located 20 miles northwest of Denver, Lafayette is a suburban municipality in the urban corridor on the plains, just east of the Rocky Mountain Front Range, with a 2020 population over 30,000, including predominantly white (70.9%) and minority Latinx (18.5%) populations (U.S. Census Bureau, 2020). NKJN programs extend from “the backyard to the backcountry,” including day and after-school camps in local parks, overnight camps in regional mountain areas, field-based internships, and school courses. Roughly half of programming is located near Lafayette (51%), the remainder in more remote areas of Boulder County (20%), surrounding counties (19%), and beyond (10%).

NKJN employs a mixed-methods approach to evaluate program impacts on participants based on five outcome categories (See Table 1), representing different EE dimensions (Ardoin et al., 2018). Quantitative metrics include tracking exposure to NKJN programming (i.e., total number of hours) for each participant—whether across one or multiple programs, potentially over multiple years—and self-reported surveys, such as frequency of time spent outdoors. Qualitative data are collected via open-ended surveys, observations, interviews, and focus groups. None of the approaches explicitly record locations associated with outcomes. Here, we explore what location tells us about the impact of NKJN programming. Specifically, we ask: *How does exposure to NKJN programming affect locations where participants demonstrate outcomes?* We aim to assess *where* participants potentially transferred learning and growth from NKJN programming to places in their lives.

Table 1

NKJN Program Outcome Descriptions

Outcomes	Definitions
Access	Participants perceive nature as accessible, overcome barriers to access, and desire to repeat experiences outside of NKJN programs.
Community Engagement	Participants feel they belong in, care about, and serve their community, especially related to nature.
Health and Wellness	Participants experience mental, social-emotional, overall health and well-being, and personal development in nature.
Learning Outcomes	Participants enjoy learning, gain leadership skills, and express interest in environmental careers and/or ethics.
Nature Connection	Participants possess an environmental identity that supports their connection to the natural world.

To this end, we piloted a qualitative geographic information systems (qualitative GIS) approach as one component of program assessment. A *GIS* is a system for storing, managing, and representing location data (e.g., geographic points, areas) and associated attributes (e.g., name, description, image), along with practices of collecting, analyzing, and visualizing spatial patterns in these data on a map (Jung & Elwood, 2019).

Qualitative GIS is a mixed-methods approach that integrates collection and analysis of largely quantitative location data (e.g., geographic coordinates) with descriptive qualitative data, extracting insights not possible if these data were treated separately (Jung & Elwood, 2010). Including location allows us to identify spatial patterns in the meanings embedded in participants' descriptions of their experiences, especially youth, who may have many experiences that take place in specific locations at intimate scales, such as within the household or community (Steger et al., 2021). Specifically, we employed *story maps* as a method of multimedia data collection (Jung & Elwood, 2019). Participants integrated qualitative content with geographic locations in an existing web application (Kerski, 2015). Story maps provided a medium for participants to share

location-based stories of places and experiences, whether inside or outside NKJN programming, located anywhere globally (Martz et al., 2020). Below, we describe our use of qualitative GIS before considering its potential to add nuance and to diversify EE program evaluation.

Data Collection

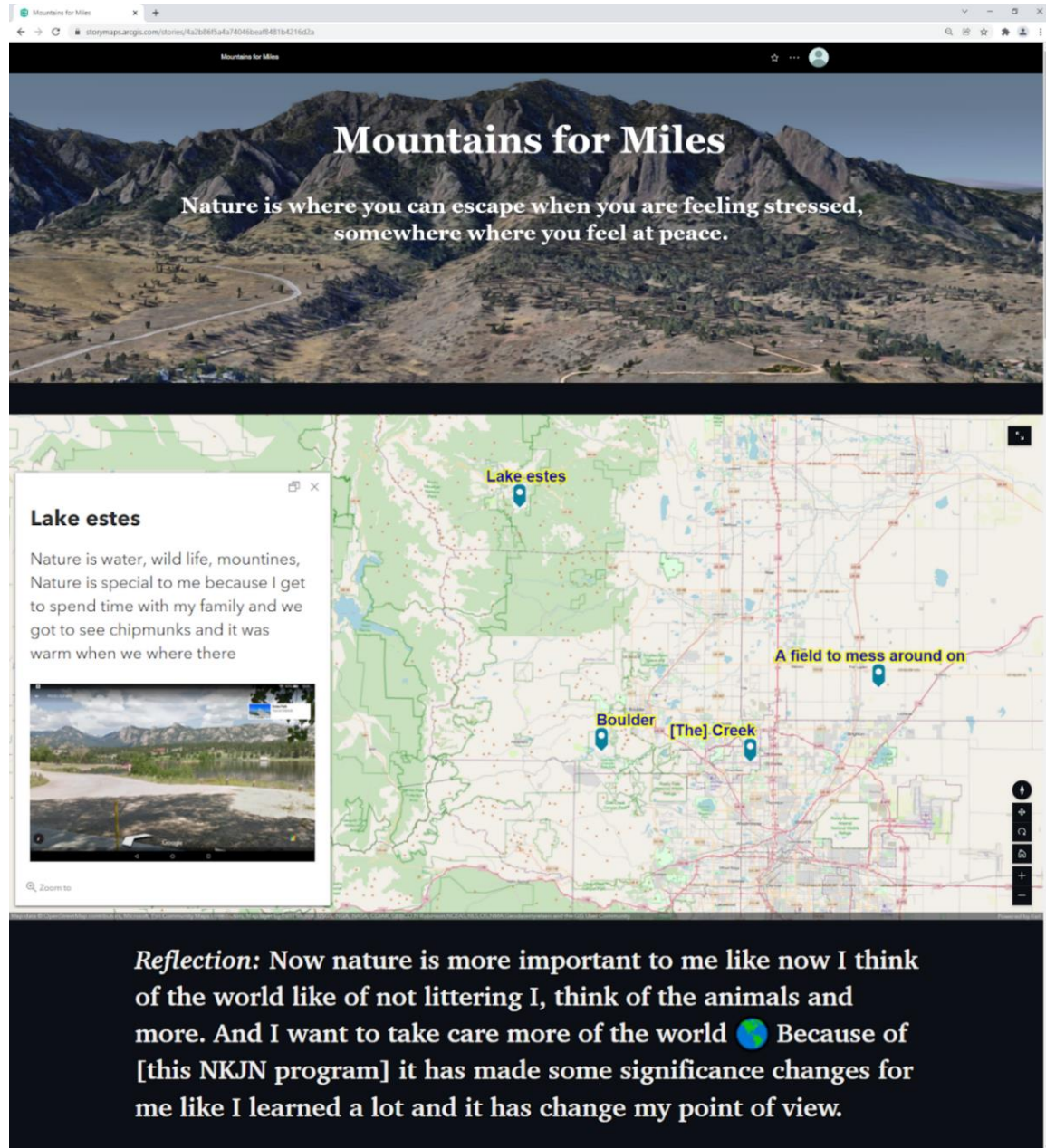
In 2019, 33 NKJN participants, ages 12-18 years, created story maps during in-person workshops led by the first author. In collaboration with program leaders, workshops were developed to support program goals and were embedded into three different NKJN programs. Each program was multiple weeks in length and took place across multiple sites; most activities were located in participants' "backyards"—local parks and open spaces near Lafayette—and at least one activity in the "backcountry" of regional mountain areas. Participants created story maps during the middle of each program as: (1) a reflection activity about what nature means to them; and, (2) a learning activity to gain GIS skills and awareness. We asked permission from participants and their parents/guardians to use story maps for exploratory research and for informing NKJN program evaluation.

Participants created a story map about why specific nature places are meaningful in their life (Figure 1), using ArcGIS StoryMaps (Esri, 2019a) and ArcGIS Survey123 (Esri, 2019b) on a tablet that we provided. *For each place* (up to 5), participants identified the location on a web map, included a corresponding image, and wrote a description about why they identify the place as nature and why it is meaningful. Their story map title described what nature is to them, and they selected one of their images as the cover image. They also wrote a reflection about why nature is meaningful to them,

specifically considering their participation in NKJN programming. A subset of participants (n=21) subsequently participated in interviews to elaborate on their story maps, sometimes describing additional place(s) to include.

Figure 1

Example Story Map



Note. Example story map, merging elements from story maps created by multiple participants (adapted from Martz et al., 2022). We altered locations and descriptions in this example to protect privacy.

Data Analysis

Our qualitative GIS analysis approach compared two groups of participants, a Higher-Exposure Group (>100 hours of exposure to NKJN programming, n=17, 11 interviewed; hereafter *HEG*) and a Lower-Exposure Group (\leq 100 hours, n=16, 10 interviewed; hereafter *LEG*). Typically, the HEG (>100 hours) had participated in at least two different multi-week NKJN programs, while the LEG (\leq 100 hours) had participated in only one. Our initial qualitative coding procedure was adopted from a process previously developed by NKJN. This involved iteratively reading each nature place description in story maps and interviews multiple times to code words, phrases, and/or sentences that reflected NKJN's program outcomes (Stuckey, 2015), based on discernable indicators specific to each outcome. For example, the *health and wellness* outcome was identified by indicators such as *social connection*, and the *nature connection* outcome, by indicators such as *attention to detail* and/or *awareness*. The primary code referred to the specific outcome, and secondary codes, to corresponding indicators. For example, in a description of "Lake estes [sic]" (Figure 1), we coded "because I get to spend time with my family" with the primary code, health and wellness, as indicated by the secondary code, social connection. We coded "and we got to see chipmunks and it was warm when we where [sic] there" with nature connection, as indicated by attention to detail. We compared the relative prominence of each outcome and corresponding indicators between groups.

Next, we compared spatial patterns between groups by mapping the locations of descriptions coded with specific outcomes. For example, codes applied to the description of “Lake estes” were linked to the geographic coordinates of that place. When we mapped the locations of all descriptions associated with the health and wellness outcome, “Lake estes” was one of the locations included on the map; we followed the same process when we mapped locations associated with nature connection. Our goal was to compare the groups in terms of *where* participants described each outcome. As a basis of comparison, we delineated two concentric zones that aligned with the spatial extents of NKJN programming: Zone 1 aligns with NKJN programs located near Lafayette (in Lafayette and within a 10-mile buffer of Lafayette’s municipal boundary); Zone 2 includes Zone 1 and is the approximate geographic area that includes most NKJN program locations (within an 80-mile buffer of Lafayette). We used QDA Miner software (Provalis Research, 2020) to integrate coding of qualitative themes and GIS analysis of locations (Jung & Elwood, 2010).

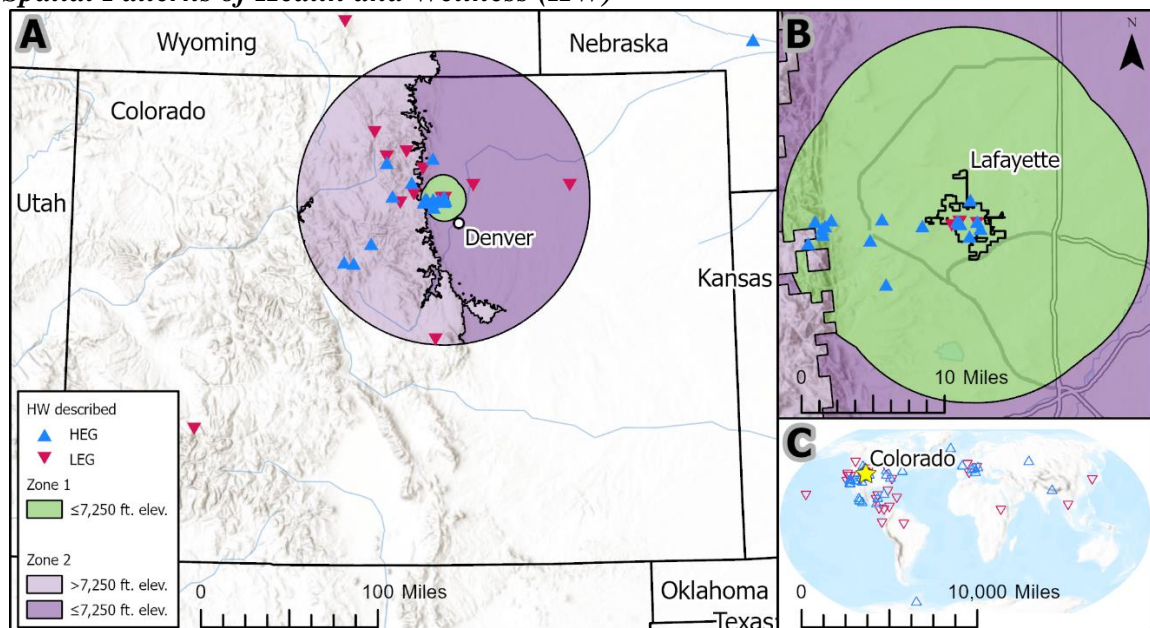
Preliminary Findings

Collectively, 17 HEG participants identified a total of 65 unique nature places, globally, while 16 LEG participants included 59 (Figure 2). Within the spatial extent of NKJN programming (Zone 2), 15 HEG participants identified 32 unique places; 13 LEG participants identified 30. Near Lafayette (Zone 1), 14 HEG participants identified 23 places; 10 LEG participants identified 13. Additionally, within Zone 2, places identified near Lafayette were all located at lower elevations ($\leq 7,250$ ft.); in contrast, places identified beyond Lafayette were almost all located at higher elevations ($> 7,250$ ft.). Across all locations, themes that emerged from nature place descriptions predominantly

reflected *nature connection* and *health and wellness* outcomes, and seldom reflected NKJN’s other outcomes. The prominence of nature connection was expected, given explicit emphasis in workshops on *why* nature places were meaningful to participants. The prominence of health and wellness was somewhat surprising because this theme was not explicit in workshops. In what follows, we compare differences between the groups in terms of *where* they identified these themes and *how* they described them.

Figure 2

Spatial Patterns of Health and Wellness (HW)



Note. Comparison of spatial patterns of health and wellness (HW) described between Higher-Exposure Group (HEG) and Lower-Exposure Group (LEG) participants, based on three spatial extents: (A) approximate extent of most NKJN program locations (i.e., Zone 2: within an 80-mile buffer of Lafayette’s municipal boundary), (B) approximate extent of NKJN programs located in the vicinity of Lafayette (i.e., Zone 1: within a 10-mile buffer of Lafayette), and (C) global extent of all nature place locations identified by all

participants (adapted from Martz et al., 2022). Some places are not visible due to overlap and/or proximity of map symbols. We altered some locations to protect privacy.

Nature Connection (NC)

Nearly all participants described at least one nature place somewhere in the world in ways that reflected NC (HEG: 100%; LEG: 93.8%), and most participants identified multiple places (on average, 3.5 places/HEG participant; 3.0 places/LEG participant; Figure 3). Within the spatial extent of NKJN programming (Zone 2), many participants in both groups described NC, generally in more than one place. The largest between-group differences manifested near Lafayette (Zone 1): a greater proportion of HEG (76.5%) than LEG participants (43.8%) described NC in at least one place, and on average, HEG participants identified a greater number of places (1.3 places/participant) than LEG participants (0.6 places/participant).

Participants from both groups commonly indicated NC in terms of *empathy* and/or *affinity* for nature and nature experiences of others (humans or nonhumans), and *attention to detail* and/or *awareness* of nature. One LEG participant showed attention to detail in Cancún, Mexico: “when looking at the ocean and walking in it I could feel and see a fond [sic] of algae and small living organisms.” Another HEG participant described affinity for nature in “Boulder” (Figure 1): “I have gone in the mountains for as long as I can remember...I love hiking this one specific area...it’s absolutely gorgeous there and it’s just one of my favorite places in the world.” Like other participants, this participant indicated NC by sharing memories and feelings that instilled a *sense of place*, appreciating the “absolutely gorgeous” *beauty*, and explaining in their interview the *interconnectedness* between “the wild and the people,” and their *wonder and amazement*

of the “big” and “vast” mountains. Especially near Lafayette, HEG participants connected with nature more prominently than LEG participants by expressing wonder and amazement and/or developing a sense of place.

Health and Wellness (HW)

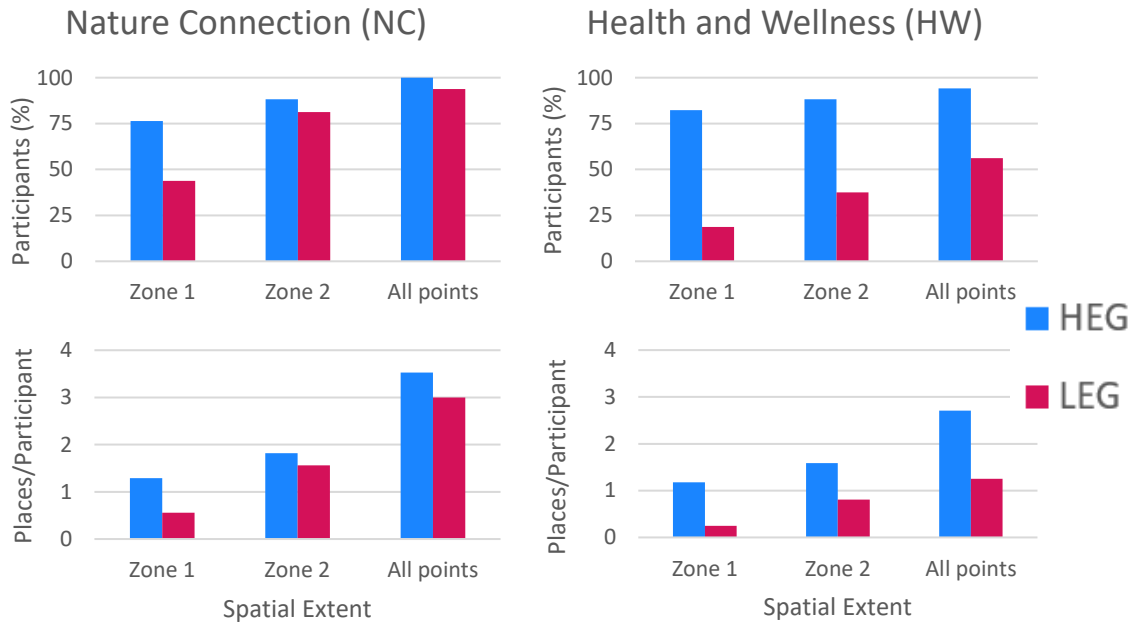
Even more striking between-group differences emerged in the expression of HW themes: 94.1% of HEG participants described HW in at least one nature place somewhere in the world, versus 56.3% of LEG participants (Figure 3). HEG participants also mentioned HW in a greater number of places on average than LEG participants (2.7 vs. 1.3 places/participant, respectively). In Zone 2, a greater proportion of HEG (88.2%) than LEG participants (37.5%) identified HW in at least one place, and in more places on average (1.6 vs. 0.8 places/participant, respectively; Figure 2). In Zone 1, a greater proportion of HEG (82.4%) than LEG participants (18.8%) described HW in at least one place, and on average, in more places (1.2 vs. 0.3 places/participant, respectively).

Participants commonly indicated HW by referring to *social connection* with family and friends, sensing *calm and peace* by finding seclusion or feeling relaxed, experiencing *joy* through having fun and/or being happy, and recognizing their *overall health* physically (e.g., exercise) and/or mentally (e.g., stress relief). One HEG participant described calm, peace, and overall health at “[The] Creek” (Figure 1): “this is a place of seclusion and stress relief” LEG participants described HW in similar terms, though not as often as HEG participants. One LEG participant described social connection and joy in a place they called “A field to mess around on” (Figure 1): “I like this place because me and my friend would always mess around in this field launch rockets ride on a four wheeler and other really fun stuff.” HEG participants more often described HW in terms

of finding calm, peace, and social connection, as well as feeling joy and overall health, particularly near Lafayette.

Figure 3

Comparing Outcomes Between Groups by Spatial Extent



Note. (Top) Percent of participants in each group who identified NC or HW outcomes in at least one place, and (Bottom) average number of unique places in which participants identified NC or HW, grouped by spatial extent.

Discussion

Through our pilot approach, we found spatial differences in the locations *where* higher-exposure participants described themes reflecting nature connection and/or health and wellness outcomes, relative to lower-exposure participants, particularly in nature places located near Lafayette. We also illuminated *how* participants with more exposure to NKJN programming demonstrated these outcomes in nearby places, e.g., by developing a sense of place or by finding calm, peace, and social connection. We

established preliminary evidence that more exposure to NKJN programming increased HEG participants' awareness and/or ability to demonstrate NC and HW, especially near Lafayette. These outcomes appeared more prominently for HEG participants, particularly near Lafayette, perhaps because exposure to more NKJN programming showed them more opportunities for connecting with nature and/or seeking health and wellness nearby. This result aligns with existing research which suggests that repeated exposure to an EE program supports outcomes, particularly those related to deepening nature connection (Chawla & Derr, 2012; Williams & Chawla, 2016).

Additionally, away from Lafayette but within the spatial extent of NKJN programming, nearly all nature places that participants identified with NC and HW were located in higher-elevation mountain areas. Perhaps this pattern reflects a common view in EE, and Western societies more broadly, that nature is associated more with remote, awe-inspiring spaces without many humans, for example, the high-country of the Rocky Mountains, rather than with suburban areas where many humans live, such as Lafayette (Malone, 2016). While we recognize NKJN programming is one of many potential influences on meanings that participants associated with nature places in their lives (e.g., personal or family interests and values, life experiences, etc.), the heightened prominence of NC and HW *locally* in the lives of HEG participants offers preliminary evidence of the impact of NKJN's programming approach. That is, NKJN seeks to engage participants in developing awareness of, and connection with, nature nearby (roughly half of programming) before exposing them to more remote areas and opportunities to deepen their nature connections. While we did not assess specific program locations, preliminary evidence warrants further exploration.

Implications

Our results demonstrate the value of qualitative GIS for evaluating EE program outcomes in three important ways. First, qualitative GIS can serve as an evaluation *and* educational tool that produces geographically referenced qualitative data, while simultaneously advancing program goals, e.g., as a reflection activity and opportunity to gain GIS skills/awareness (Ardoin et al., 2015). Story maps “feel more like a project” (NKJN program leader, personal communication, December 11, 2019), not just another survey for youth who are already regularly evaluated in schools and other programs. Second, qualitative GIS supports data analysis that combines qualitative themes with spatial patterns of specific locations, thereby generating new insights that not only include how and/or why program experiences impact participants, but also where impacts occur. Third, these new insights from the inclusion of location information demonstrate how qualitative GIS can enhance outcome measurements in EE program evaluation (Ardoin et al., 2018; Carleton-Hug & Hug, 2010; Stern et al., 2014).

We note that qualitative GIS approaches to data collection and analysis involve further considerations, particularly related to additional costs (e.g., time, skills, equipment). The process of configuring and collecting story maps was time intensive, although so are other qualitative methods. Collecting geographic data alongside qualitative data could be less demanding, however, if location(s) associated with participants’ experiences could be recorded as part of existing evaluation protocols. While no-cost software may be used to collect such data, story maps in this pilot were created with proprietary GIS software (Esri, 2019a; 2019b). We also analyzed story maps using a proprietary, computer-aided qualitative data analysis software with GIS

capabilities (Provalis Research, 2020). While a variety of such software (e.g., NVivo, ATLAS.ti, MAXQDA) support geographic data, qualitative GIS analysis need not be integrated at the software level (Jung & Elwood, 2019). Further, this pilot leveraged a community-university partnership. We recommend such partnerships to expand capacity, make qualitative GIS approaches more feasible, and bring communities and universities together in ways that are inclusive and equitable. While our pilot demonstrates the potential of qualitative GIS for evaluating EE program outcomes, we suggest that qualitative GIS approaches warrant further exploration, particularly where geographic insights could guide program locations, improve understanding of program impacts, and/or inform decisions around broader education, planning, and public health initiatives.

References

- Ardoin, N. M., Biedenweg, K., & O'Connor, K. (2015). Evaluation in residential environmental education: An applied literature review of intermediary outcomes. *Applied Environmental Education & Communication, 14*(1), 43-56.
<https://doi.org/10.1080/1533015X.2015.1013225>
- Ardoin, N. M., Bowers, A. W., Roth, N. W., & Holthuis, N. (2018). Environmental education and K-12 student outcomes: A review and analysis of research. *The Journal of Environmental Education, 49*(1), 1-17.
<https://doi.org/10.1080/00958964.2017.1366155>
- Carleton-Hug, A., & Hug, J. W. (2010). Challenges and opportunities for evaluating environmental education programs. *Evaluation and Program Planning, 33*(2), 159-164. <https://doi.org/10.1016/j.evalprogplan.2009.07.005>
- Chawla, L., & Derr, V. (2012). The development of conservation behaviors in childhood and youth. In S. D. Clayton (Eds.), *The Oxford handbook of environmental and conservation psychology*. (pp. 527-555). Oxford University Press.
<https://doi.org/10.1093/oxfordhb/9780199733026.013.0028>
- Esri (Environmental Systems Research Institute) (2019a). *ArcGIS StoryMaps* [Computer software]. <https://storymaps.arcgis.com/>
- Esri (Environmental Systems Research Institute) (2019b). *ArcGIS Survey123* (Version 3.6.149) [Computer software]. <https://survey123.arcgis.com/>
- Jung, J. K., & Elwood, S. (2019). Qualitative GIS and spatial research. In P. Atkinson, S. Delamont, A. Cernat, J. W. Sakshaug, & R. A. Williams (Eds.), *Sage research methods foundations*. Sage. <https://www.doi.org/10.4135/9781526421036818834>

- Jung, J. K., & Elwood, S. (2010). Extending the qualitative capabilities of GIS: Computer-aided qualitative GIS. *Transactions in GIS*, 14(1), 63-87.
<https://doi.org/10.1111/j.1467-9671.2009.01182.x>
- Kerski, J. J. (2015). Geo-awareness, geo-enablement, geotechnologies, citizen science, and storytelling: Geography on the world stage. *Geography Compass*, 9(1), 14-26.
<https://doi.org/10.1111/gec3.12193>
- Ladwig, J. G. (2010). Beyond academic outcomes. *Review of Research in Education*, 34(1), 113-141. <https://doi.org/10.3102/0091732X09353062>
- Malone, K. (2016). Reconsidering children's encounters with nature and place using posthumanism. *Australian Journal of Environmental Education*, 32(1), 42-56.
<https://doi.org/10.1017/aee.2015.48>
- Martz, C. J., Powell, R. L., & Wee, B. 2020. Engaging children to voice their sense of place through location-based story making with photo-story maps. *Children's Geographies*, 18(2), 148-161. <https://doi.org/10.1080/14733285.2019.1685073>
- Martz, C. J., Powell, R. L., & Wee, B. (2022). The impact of COVID-19 lockdowns on youth relationships with nature: A socio-spatial perspective. *Children, Youth and Environments*, 32(1), 128-151. <https://www.muse.jhu.edu/article/855979>
- Provalis Research. (2020). *QDA Miner* (Version 6.0.1) [Computer software].
<https://provalisresearch.com/products/qualitative-data-analysis-software/>
- Steger, A., Evans, E., & Wee, B. (2021). Emotional cartography as a window into children's well-being: Visualizing the felt geographies of place. *Emotion, Space and Society*, 39, 100772. <https://doi.org/10.1016/j.emospa.2021.100772>

- Stern, M. J., Powell, R. B., & Hill, D. (2014). Environmental education program evaluation in the new millennium: What do we measure and what have we learned? *Environmental Education Research*, 20(5), 581-611. <https://doi.org/10.1080/13504622.2013.838749>
- Stuckey, H. L. (2015). The second step in data analysis: Coding qualitative research data. *Journal of Social Health and Diabetes*, 3(1), 7-10. <https://doi.org/10.4103/2321-0656.140875>
- U.S. Census Bureau. (2020). *2020 Decennial Census*. Retrieved from <https://data.census.gov/cedsci/>
- Williams, C. C., & Chawla, L. (2016). Environmental identity formation in nonformal environmental education programs. *Environmental Education Research*, 22(7), 978-1001. <https://doi.org/10.1080/13504622.2015.1055553>
- Zint, M. (2013). Advancing environmental education program evaluation: Insights from a review of behavioral outcome evaluations. In R. B. Stephenson, M. Brody, J. Dillon, & A. Wals (Eds.), *International handbook of research in environmental education* (pp. 298-309). Routledge. <https://doi.org/10.4324/9780203813331>

Chapter Four: Understanding Conceptualizations of Nature by Asking Youth to Draw Areas on a Map

Abstract

Understanding how youth conceptualize nature offers insights into how youth relate with nature, for reasons such as promoting individual health and well-being and building a collective sustainable future. Individual youth develop their own conceptualization of nature with which they relate through interactions with places. In turn, it is important to understand youth conceptualizations of nature—their meanings of what nature is, where nature is, and why they relate with nature—in relation to specific places. We asked youth to share their meanings of nature by drawing on a map the specific area of places where nature is meaningful to them, as part of creating story maps that also documented their images and descriptions of nature places. To better understand youth conceptualizations of nature, we developed a codebook of spatial, geometric, and qualitative attributes of participant-drawn areas to interpret meanings that youth embedded in the areas *through* the act of drawing them. We applied the codebook to explore insights into how youth conceptualize nature based on different life experiences. The codebook demonstrated the value of tapping into specific contexts of individual participant-drawn areas to extract meaning, leading to better understandings of youth conceptualizations of nature.

Keywords: children's geographies, nature, qualitative GIS, sketch maps, story maps

Introduction

Understanding youth relationships with nature matters for addressing a range of contemporary challenges, from promoting individual health and well-being (Chawla, 2015; Mygind et al., 2019) to building a collective sustainable future (Chawla, 2020; Giusti et al., 2018; Ives et al., 2017). Individual youth form a relationship with nature that is mediated by their physical interactions with nature, as well as their vicarious interactions with representations of nature that they encounter in everyday conversations and through different forms of media (Aaron & Witt, 2011; Kellert, 2002; Wee, 2020). Whether physical or vicarious, interactions with nature are largely grounded in places. Physical interactions are always located in specific places (Beery & Wolf-Watz, 2014), while vicariously, youth may imagine, read about, or see images of specific places or generic place settings (Castree, 2014). Through these interactions, individual youth develop their own conceptualizations of nature with which they relate—their meanings of what nature is, where nature is, and why they relate with nature (Castree, 2014; Kellert, 2002). In turn, exploring how youth conceptualize their meanings of nature offers insights into how youth relate with nature.

A key to understanding how youth conceptualize nature is to do so in relation to places (Castree, 2014), especially specific places (Beery & Wolf-Watz, 2014). Youth often describe their conceptualizations of nature in relation to places, whether describing what nature is in relation to generic places, for example, “trees, wild animals, and things other than the city...untouched by civilization places,” or why they relate with nature in specific places, such as “a certain spot[...]where I just calmed myself down whenever I had a problem” (Aaron & Witt, 2011, 151-152). Youth may also visualize their

conceptualizations of nature in relation to places, whether by drawing illustrations of plants and animals in generic place settings (Aaron & Witt, 2011), or by capturing photographs of specific places with mountains, trees, and/or water features (Martz et al., 2022). Additionally, youth associate their conceptualizations of nature with specific places that they can locate on a map: a nearby place such as a “local park” (Freeman et al., 2015), a regional place such as “Lake Estes” (Martz et al., in press), or a vicarious place such as “Mount Everest” (Martz et al., 2022). Whether youth communicate their conceptualizations of nature in words, illustrations, photographs, locations, or some combination, the conceptualization of an idea such as nature is challenging for anyone to fully communicate.

Important to communicating additional information that is not present in words, illustrations, photographs, or even locations, is asking youth to draw on a map. Asking individuals or groups to draw points, lines, areas, and other markings on a georeferenced base map is common in *participatory mapping* and *sketch mapping* techniques that engage participants to represent on a map their location-based meanings, experiences, and local knowledge of issues relevant to their lives (Boschman & Cubbon, 2014; Elwood, 2006; Lowery & Morse, 2013). These techniques share *qualitative GIS* objectives of integrating *qualitative* meanings and experiences with the digital spatial data structures of a *GIS* (Cope & Elwood, 2009). An ongoing challenge in qualitative GIS is the formalization of links between objects—points, lines, polygons—that exist in the geographic, gridded space formalized in a GIS and the many ways that humans describe their meanings and experiences of space in more relative terms (Caquard, 2013; Pavlovskaya, 2009; Schuurman, 2006). Yet, it is nonetheless possible to formalize links

between spatial objects represented in a GIS and social meanings and experiences. Qualitative data such as written narratives, interview transcripts, and photographs can be associated with GIS objects, whether stored in an attribute table or hyperlinked in an external document (Jung & Elwood, 2010; Pavlovskaya, 2009). Researchers can inductively analyze qualitative data associated with GIS objects, linking qualitative themes to points (Cieri, 2003), lines (Kwan & Ding, 2008), or polygons (Lowery & Morse, 2013) to explore spatial patterns of qualitative themes, effectively formalizing a link between the GIS object and qualitative meanings and experiences. Yet, when created by participants, GIS objects are also qualitative data in and of themselves that reflect the meanings and experiences of those who create them (Jung, 2009; Jung & Elwood, 2019; Kwan, 2002). An important component to advancing the formalization of links between GIS objects and social meanings and experiences is inductive analysis of meanings and experiences that participants embed within the GIS object itself.

Specifically, we propose that a valuable way for youth to communicate their conceptualizations of nature is to draw the specific area on a map of places they associate with nature. While a point object in a GIS is dimensionless and only represents a geographic location in space, an area is a two-dimensional polygon object that represents a location and other attributes in geographic space, such as the spatial extent, shape, and feature(s) on a base map within an area. In turn, the attributes of the area itself hold potentially valuable insights into how youth conceptualize their meanings of nature, such as how they interpret the spatial extent of their meanings of nature associated with a place (Cacciapaglia et al., 2012; Lowery & Morse, 2013). By inductively analyzing the attributes of individual areas drawn on a map by youth, we can formalize the association

of an area (GIS object) with a conceptualization of nature. In this paper, our objectives are (1) to explore the value of participant-drawn areas on a map for understanding youth conceptualizations of nature; and (2) to develop, implement, and explore a codebook supporting the integration and analysis of spatial, geometric, and qualitative attributes of individual, participant-drawn areas on a map.

Why Ask Participants to Draw on a Map?

The fundamental purpose for asking research participants to share their perspectives—meanings, experiences, and local knowledge—by drawing on a map is rooted in critical GIS objectives to include individuals and groups in research about issues that are relevant to them (Boschmann & Cubbon, 2014; Elwood, 2006). Participant perspectives are particularly valuable related to issues that can best be understood through the perspectives of those who have encountered an issue in their lives. For example, researchers who aim to understand the issue of crime in a community could analyze the locations of reported crimes. But their analysis would lack contextual information about why crime happens in those locations, how social systems address crimes in those locations, or where unreported crimes happen in other locations. To collect and analyze such contextual information, researchers could ask those in the community who have encountered the issue firsthand to discuss and draw on a map their perspectives of crime (Curtis et al., 2019). By asking participants to draw on a map, researchers engage participants to describe their location-based meanings, experiences, and local knowledge imbued with spatial information that is georeferenced and can be integrated into a GIS for analysis. At the same time, the activity of drawing on a map can also aid primary modes of data collection—surveys, interviews, focus groups—by

enhancing dialogue and/or allowing participants to add geographic specificity to their descriptions (Boschmann & Cubbon, 2014; Brennan-Horley & Gibson, 2009; Lowery & Morse, 2013; Schoepfer & Rogers, 2014). Fundamentally, asking participants to supplement their words about places with spatial information on a map elicits more of their perspective about an issue—how, why, and specifically *where* their meanings, experiences, and local knowledge of that issue manifest.

A common motivation for asking participants to draw *areas* on a map is to understand *where an issue or idea manifests in geographic space*. Asking participants to describe an issue by drawing two-dimensional areas on a map allows participants to circumscribe locations that are significant to their meanings and experiences of that issue (Brennan-Horley & Gibson, 2009), as well as to present their interpretations of the spatial extents of that issue (Lowery & Morse, 2013). Researchers can then make connections between participant maps (e.g., about experiences of job access) and authoritative maps and data (e.g., public transit networks) (Boschmann & Cubbon, 2014). Participant maps can also challenge authoritative maps (Cieri, 2003; Schoepfer & Rogers, 2014; Wiener & Harris, 2003). Researchers can also collectively overlay the areas drawn by participants to explore aggregate spatial patterns in participant perspectives of an issue or idea. For example, Brennan-Horley and Gibson (2009) explored *creative* places in a city where creative work happens—visual arts, performing arts, and intellectual property, in formal and informal sectors—important for informing decisions around planning and economic development by including informal, not just formal, creative work. They asked creative workers to describe in interviews and mark on a map where they experience creativity. Individually, the spatial extent of an area on a map indicated the “general creative vibe”

of large areas, or the specific creative facilities marked by small areas (Brennan-Horley & Gibson, 2009, 2610). Collectively, an overlay of all areas drawn by participants revealed creative hot spots where the most areas overlapped. Researchers have used overlay analyses to explore a range of issues, including participant experiences of crime (Curtis et al., 2019); feelings of fear or safety (Boschmann & Cubbon, 2014; Curtis et al., 2014); preferences of land use or activity space (Carver et al., 2009; Huck et al., 2014; Lowery & Morse, 2013; Prener, 2021); perceptions of flood risk (Brandt et al., 2019); and local knowledge of ecosystem services (Rice et al., 2020).

A less common motivation for asking participants to draw areas on a map is to understand *how participants conceptualize an issue or idea*. A key reason to focus on how participants conceptualize an issue is to better understand how individuals or groups view or think about the issue. For an example, in a study of landowner views of forest fire management—their meanings of what fire management is, where it is appropriate, and why it relates to them—Cacciapaglia and others (2012) interviewed and asked participants to mark areas on a map that represented their meanings of forest fire management to better understand public support around management decisions. In this example, asking participants to draw areas on a map not only added geographic specificity to participants' descriptions in interviews. More importantly, participants were able to present their interpretations of the spatial extents of their meanings in relation to specific places on a map (Lowery & Morse, 2013). The spatial extents of areas on a map provide insight into how participants conceptualize the meanings they associate with a particular issue (Cacciapaglia et al., 2012). Researchers can categorize individual areas by the sizes of their spatial extents to characterize how participants conceptualize their

meanings associated with an issue, as well as to corroborate the interpretation of other data sources such as interviews or focus groups (Cacciapaglia et al., 2012; Gunderson & Watson, 2007; Lowery & Morse, 2013). For example, participants represented their meanings of forest fire management by drawing areas with spatial extents the size of entire landscapes, not specific sites. The areas provided geographically specific information about how participants conceptualized forest fire management at a landscape level, which also corroborated participants' descriptions in interviews of why management is most appropriately applied to entire landscapes. The result was a better understanding of how landowners conceptualize forest fire management by considering many interconnected factors across a landscape (Cacciapaglia et al., 2012).

In addition to varying motivations for asking participants to draw areas on maps, the ways participants draw areas on maps also vary. Some researchers ask participants to use a digital spray can tool to mark fuzzy extents and intensities of meanings associated with places, which are *fuzzy* because it is hard to define where meanings begin and end with discretely outlined areas on a map (Cacciapaglia et al., 2012; Carver et al., 2009; Huck et al., 2014). Researchers also ask participants to draw discretely outlined polygons, recognizing that the outlines are fuzzy, transitional boundaries between where is, and is not, meaningful to a participant (Lowery & Morse, 2013). Other researchers ask participants to draw sketch map markings such as circles and cross-hatches to represent their meanings (Boschmann & Cubbon, 2014; Brennan-Horley & Gibson, 2009). Further, the base map on which participants draw varies by study, in terms of cartographic scale, map features, study region, static or dynamic, digital or paper, and individual or shared by participants. The study region on the base map where participants are asked to draw

areas is typically specific and defined by the researcher, such as a village (Brandt et al., 2019) or multiple counties (Lowery & Morse, 2013). Participants either draw areas on a dynamic, digital base map in a GIS (e.g., Shoepfer & Rogers, 2014) or on a static, paper base map that is later geo-referenced and digitized in a GIS (e.g., Prener, 2021).

Rarely do studies use a dynamic, digital base map to ask participants to draw areas within a study region that is left undefined by the researcher (i.e., the entire world). Also rarely explored are other attributes of the areas drawn on a map, in addition to an area's extent (Cacciapaglia et al., 2012), that potentially provide insights into how participants conceptualize their meanings associated with an issue or idea. In a GIS, areas (polygon objects) possess inherent quantitative spatial and geometric attributes: shape, locational accuracy (i.e., relative to the location on the base map a participant intended to include in an area), and feature(s) on the base map an area circumscribes, to name a few. Simultaneously, participant-drawn areas are also inherently qualitative in that they reflect the meanings and experiences of the participants who draw them (Jung, 2009; Jung & Elwood, 2019; Kwan, 2002). Inductive analysis of the qualitative and quantitative attributes of individual, participant-drawn areas holds potential for researchers to interpret participants' conceptualizations of the meanings and experiences they associate with areas they draw. The conceptualizations interpreted from participant-drawn areas formalize a link between participants' meanings and experiences and the areas (polygon objects) they draw on a map (Pavlovskaya, 2009; Schuurman, 2006). Researchers can combine the interpreted conceptualizations with other modes of analysis to develop stronger explanations than would have been possible otherwise (Jung & Elwood, 2010).

Methods

We used a qualitative GIS approach to integrate the range of qualitative and quantitative attributes of participant-drawn areas on a map. Our aim was to integrate qualitative forms of data collection and analysis with that of quantitative forms of GIS data collection and analysis (Cope & Elwood, 2009), towards characterizing how youth conceptualize their meanings of nature in relation to specific places. In our qualitative GIS approach to data collection, we asked youth to use a GIS application to draw on a map the specific areas (polygons) of nature places that are meaningful to them, anywhere in the world, as part of creating story maps that also documented their images and descriptions of nature places. While asking youth to draw on a map is itself a qualitative GIS approach to collecting qualitative data integrated with a GIS (Boschmann & Cubbon, 2014), *story maps* are a specific multimedia qualitative GIS approach to data collection that use existing web applications to integrate multimedia content with geographic locations (Jung & Elwood, 2019; Kerski, 2015; Martz et al., 2020).

In our qualitative GIS approach to data analysis, we developed a codebook to integrate and analyze the spatial, geometric, and qualitative attributes of individual story map areas (polygons) to characterize categories of *how* youth conceptualize their meanings of nature. Then, we linked the categories to the geographic locations of story map areas (polygon centroids) to explore spatial patterns in *where* youth conceptualize their meanings of nature. Developing codes and a codebook is a common process in qualitative analysis that is specific to the context of each study. *Codes* are words or phrases assigned to represent the meanings of pieces of language-based data (e.g., interview transcripts, written narratives) or visual data (e.g., drawings, photographs). A

codebook is the collection of codes and broader categories of codes, their descriptions, and data examples (Saldaña, 2013). Codebook development is an iterative process, and can be both deductive, drawing from theory or previous empirical studies, and/or inductive, emerging from the data (Arnold & Casellas Connors, 2021; Forman & Damschroder, 2007; Saldaña, 2013). The goal of our codebook was to integrate the spatial, geometric, and qualitative attributes of participant-drawn areas on a map in an inductive way that elucidated categories of how youth conceptualize their meanings of nature. In the following sections, we describe how youth drew areas, and how we developed and implemented a codebook of area attributes to characterize youth conceptualizations of nature.

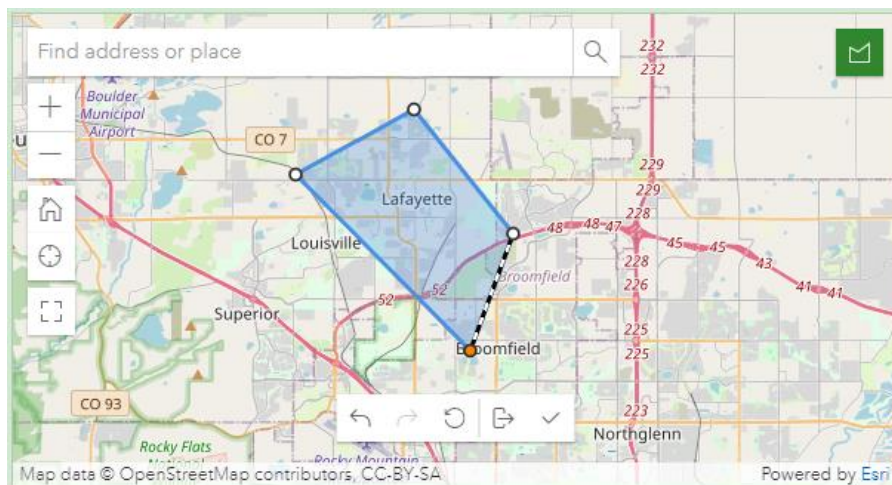
Data Collection

We asked youth to draw areas as part of a story map activity that contributed to academic research and the program evaluation efforts of our community partner, Nature Kids / Jóvenes de la Naturaleza (NKJN). NKJN is an organization that builds parks and trails, as well as provides environmental education and outdoor recreation programming for youth and families in Lafayette, Colorado. Fifty-five NKJN participants between the ages of 12-18 created story maps using ArcGIS StoryMaps (Esri, 2019a). Each participant selected up to 5 nature places anywhere in the world to include in their story map, drew a polygon using a web mapping application to circumscribe the specific area of each place that is meaningful to them, added an image of what nature looks like in each place, and wrote a description about what distinguishes each place as nature and why each nature place is meaningful. For examples of story maps and more details about the process of creating story maps, please reference Martz, Powell, and Wee (2022).

Participants drew areas on a map in response to the prompt: “Draw a shape on the map covering the specific area of this place where nature is special to you.” We used the phrase, “where nature is special to you,” to prompt participants to think about where they personally imagine nature and consider nature meaningful in a place. To give participants control to circumscribe a specific area of a place in a way that was relatively quick to learn and apply, they used an online map editing application within ArcGIS Survey123 (Esri, 2019b). The application included a dynamic base map (including roads, water bodies, formal boundaries, place names), search bar, zoom-level controls, and tool for drawing polygons (Figure 1). Following instructions that we provided, participants entered the place name into the search bar, zoomed and panned to the place, and drew a polygon by placing vertices, one at a time (as many as the participant desired), to define the specific area where nature is meaningful.

Figure 1

Example of Drawing an Area on the Map



Note. Example of the web mapping application and a participant’s drawing (replicated) of a polygon on the map covering the specific area of the place they named, “Lafayette,” where nature is meaningful to them.

Data Analysis

We analyzed the areas drawn by youth to explore youth conceptualizations of nature as well as whether different life experiences impact how youth conceptualize nature. To explore youth conceptualizations of nature, we analyzed the individual story map areas drawn by 39 participants. We explored whether different life experiences impact how youth conceptualize nature by analyzing the areas drawn by an additional group of 17 participants who created their story maps during lockdowns amidst the COVID-19 pandemic. We compared this group to a similar group of 17 (of the initial 39) participants who created story maps before COVID-19 lockdowns (note: one participant created two story maps, one as a part of each group). For additional details about creating story maps during COVID-19 lockdowns, please reference Martz, Powell, and Wee (2022). First, we developed a codebook to analyze story map areas and characterize categories of conceptualizations of nature. Second, we linked categories with the corresponding area (centroid) locations. Third, we mapped locations linked with specific categories to compare spatial patterns of youth conceptualizations of nature as well as spatial patterns of how youth conceptualize nature based on different life experiences.

To develop the codebook, we viewed the areas to identify attributes that could either be quantitatively measured or qualitatively interpreted to contribute to characterizing how a participant conceptualized their meanings of nature in specific places. As we went area by area numerous times, we inductively developed codes that represented the range of measurements or interpretations within each attribute.

First, we identified spatial, geometric, and qualitative attributes of the area itself (Table 1). Quantitative spatial and geometric attributes included *extent* and *locational*

accuracy. Within the extent attribute, we developed codes by viewing areas and distinguishing categories of areal extents (km²) that represented how an individual could view the extent in person. Within the locational accuracy attribute, codes reflected whether a participant's geographic location of an area matched the base map location of the place the participant named, described, and showed in their image. We treated *shape* and *feature(s)* as qualitative attributes, interpreting the complexity of a shape and feature(s) on the base map within an area.

Second, we identified qualitative attributes of the description and image linked to the area. We interpreted a participant's *experience* based on whether they described going in person to the place in the description, *interaction* based on what they described doing in the place, and *vision* from the view they showed of the place in the image.

Table 1***Codebook to Interpret Nature Conceptualizations from Participant-Drawn Map Areas***

nature conceptualization categories			interactively grounded visually grounded abstract
data type	attribute	code	description
polygon	extent	immediate	directly surrounding area (0-0.1 km ²)
		visible	area from unobstructed ground view (0.1-2 km ²)
		panoramic	area viewable from high point (2-20 km ²)
		landscape	area from birds-eye view (20-300 km ²)
		regional	area beyond birds-eye view (>300 km ²)
	shape	complex	detailed, with many vertices
		simple	general, without many vertices
	locational accuracy	match	location aligned (approximately) with base map location of place named, described, and shown in description and image
		mismatch	location not aligned with base map location of place named, described, and shown in description and image
	feature(s)	specific	explicit feature (e.g., a lake) on base map within area
		varied	mixed features (e.g., land and water) on base map within area
		broad	features on base map within area too generalized to identify
description	experience	physical	in-person experience of place (i.e., in person)
		vicarious	virtual experience of place (e.g., learning online or at school)
	interaction	robust	physical interaction with many regions of area
		limited	physical or vicarious interaction with narrow region of area
image	vision	narrow	view of a particular region of the area
		vista	view of a broad region of the area
		expansive	view of the area and surrounding region

Note. Attributes and associated codes of participant-drawn areas on a map, by data type.

To implement the codebook, we went area by area numerous times to reflect and (re)assign one code within each attribute of each individual area. For example, when considering an area's shape attribute, we assigned the code, *complex*, if the area was

drawn in detail with many vertices, or *simple* if the area was drawn generally without many vertices. From the combination of codes assigned to each individual area, we interpreted how the participant conceptualized their meanings of nature in relation to that particular place. To do this, we considered the area's attributes of extent, shape, locational accuracy, and feature(s) *in the context of* the area's associated description and image attributes of experience, interaction, and vision. For a given area, not all attributes necessarily contributed to interpreting how the participant conceptualized their meanings of nature in that place. Typically, the code(s) of one or more polygon attributes, contextualized by the code(s) of one or more of the area's image and description attributes, allowed us to categorize how the participant conceptualized their meanings of nature in that place as either *interactively grounded*, *visually grounded*, or *abstract*. We emphasize that this category did not characterize a participant's overall conceptualization of nature, rather their conceptualization of nature as it related to a specific place. An *interactively grounded* conceptualization reflected more intimate interaction(s) with the physical setting of the place (e.g., playing on a beach); a *visually grounded* conceptualization reflected less intimate interaction(s) with the physical setting, and more interaction with the viewable setting of the place (e.g., viewing the ocean from a beach); while an *abstract* conceptualization reflected the idea of a place, based on vicarious or only limited physical interaction (e.g., the Amazon Rainforest). If we arrange the application of codes within each attribute from top to bottom (Table 1), generally, the more codes on the top that applied to an area, such as *immediate*, *complex*, *match*, *specific*, *physical*, *robust*, and/or *narrow*, the more likely we interpreted an interactively or visually grounded conceptualization, and vis versa. Although, each area had its own

context, leading to variations within this general pattern that we consider in more detail in what follows.

In the interpretation of each area, attributes played varying primary, corroborating, and (productively) contradicting roles that further varied from area to area. An attribute played a primary role when it was the clearest indicator of a participant's conceptualization, a corroborating role when it supported the indications of other attributes, and a contradicting role when it called into question the indications of other attributes. We discuss the varying roles of each attribute in the following paragraphs.

Extent: The spatial extent of an area usually played a primary role in our interpretation of a participant's conceptualization of nature in a place. The extent offered an indication of a participant's thought process in defining the boundary where nature is meaningful to them, whether a specific site where they were immediately aware of the surroundings (Table 2, Example 1) or a broad region they knew more intangibly (Table 2, Example 2).

Shape: The shape of an area often corroborated the primary indication of the extent or other attributes by offering an indication of the level of detail with which a participant knew a place and, in turn, conceptualized their meanings of nature in that place. Complex shapes often corroborated interactively grounded conceptualizations because a participant knew the place well enough to draw a detailed boundary. Simple shapes were often associated with abstract conceptualizations because a participant demonstrated a more general knowledge of the boundary (Table 2, Example 2). Although, simple shapes also often coincided with grounded conceptualizations when considered in the context of other attributes, such as an area's immediate extent (Table 2,

Example 1). In a few cases, however, shape had a primary role. For example, a participant drew a panoramic extent of a ski resort, which may have indicated a visually grounded conceptualization (Table 2, Example 3). But their complex shape covered specific ski trails, in the context of their description of a robust interaction with the place, so we interpreted their interactively grounded conceptualization of nature in that place.

Locational accuracy: The locational accuracy of the area's location mostly played a corroborating role, offering another indication of the level of detail with which a participant knew a place and, in turn, conceptualized their meanings of nature in that place. When an area's location matched the authoritative location on the base map, the match indicated a participant knew the place well enough to find it on a map, often corroborating other attributes that indicated a grounded conceptualization (Table 2, Example 3). Conversely, when an area's location was mismatched with the authoritative location, the mismatch indicated a participant was less familiar with where the place was located, often corroborating other attributes that indicated an abstract conceptualization (Table 2, Example 2). However, sometimes the locational accuracy did not play a role in the interpretation when considered in the context of other attributes. For example, a participant's area of St. Mark's Basilica was mismatched with the authoritative location on the base map (Table 2, Example 1). But their area's immediate extent—and the varied features of land and water within the area—in the context of their vision of a vista that included land and water, one-time physical experience, and limited interaction with a narrow region of the area, all pointed to their visually grounded conceptualization of nature, regardless of where the place was located. The few cases such as St. Mark's Basilica demonstrate the value of asking participants to draw the area of a place on a

map, because even if the location is inaccurate, the area reflects other aspects (i.e., extent, shape, features) of how the participant conceptualizes the place.

Feature(s): The feature(s) on the base map within the area often played a corroborating role, offering an indication of what about the place was meaningful to the participant. Often, areas that covered specific recreation features such as ski trails (Table 2, Example 3), or varied landscape features such as a mix of land and water (Table 2, Example 3), corroborated interactively or visually grounded conceptualizations of nature. In contrast, areas that covered features that were too generalized to distinguish often corroborated a more abstract conceptualization of nature in a place (Table 2, Example 2).



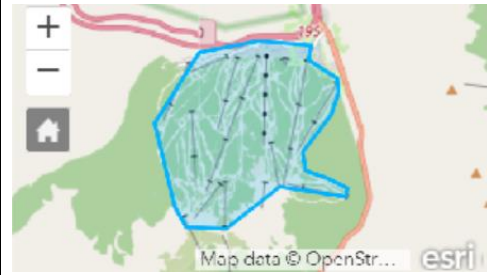

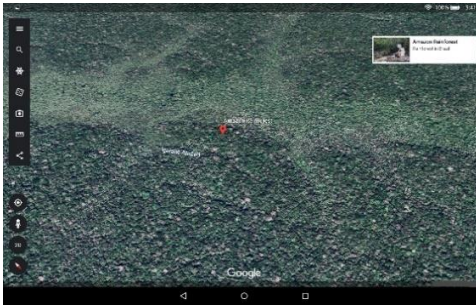

Experience, Interaction, Vision: While we focused on the indications of area-based attributes, the experience, interaction, and vision attributes derived from the description and image associated with an area provided essential context to our interpretations. Whether a participant had physically experienced a place, how they had interacted with a place, and their vision of a place in an image all provided insight into their conceptualization of nature in the place. This insight usually corroborated, and sometimes contradicted, our interpretation in important ways. For example, a participant drew an area with a landscape extent of Lafayette, with a simple shape, covering features on the map too generalized to distinguish (Figure 1), which all pointed to their more abstract conceptualization of nature in relation to Lafayette. However, their description explained, “I’ve grown up here for my whole life...and I roam around freely.” Moreover, their image showed a narrow view of a specific spot within a local Lafayette park. The description and image added important context of their narrow vision, physical

experience, and robust interaction with many regions of the area, pointing instead to their interactively grounded conceptualization of nature in Lafayette.

Once a category for each area was interpreted, the category associated with each area was linked with the area's location (polygon centroid). Then, we explored spatial patterns in the locations of specific categories to explore youth conceptualizations of nature as well as whether different life experiences impact how and where youth conceptualize nature. In what follows, we present findings from the codebook analysis as well as consider what new information was gained from analyzing participant-drawn areas in characterizing how youth conceptualize their meanings of nature.

Table 2

Codebook Examples of Nature Conceptualizations Interpreted from Participant-Drawn Map Areas

	Example 1: Venice, Italy	Example 2: Amazon Rainforest	Example 3: Copper Mountain Ski Resort
16 polygon			
codes	immediate, simple, mismatch, varied	regional, simple, mismatch, broad	panoramic, complex, match, specific
description	Excerpt: “Saint Mark's Basilica...this is one of the places that I visited when I was on a trip to europe [sic]. this was the most quiet place...It felt like true nature to me.”	Excerpt: “The Amazon...It is important for society and the world! Because it is a source of life for the people of the North America Continent since it gives us oxygen.”	Excerpt: “Copper Mountain... You can just be outside enjoying the snow or riding and walking through the dirt...I have been going there for a long time.”
codes	physical, limited	vicarious, limited	physical, robust
image			
code	vista	expansive	vista
category	visually grounded	abstract	interactively grounded

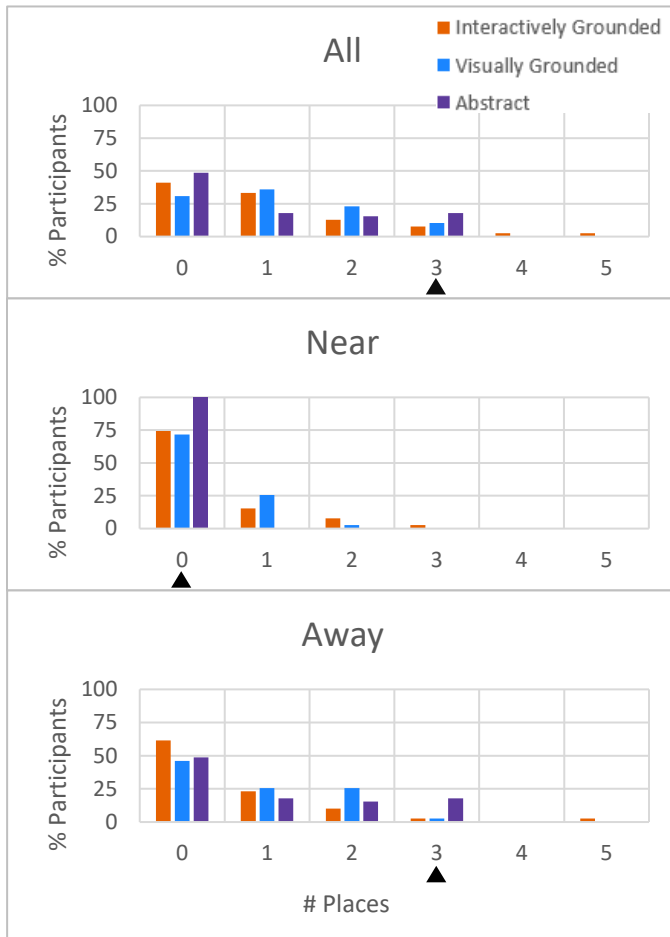
Findings

Youth Conceptualizations of Nature

The 39 participants who created story maps (independent of COVID-19 lockdowns) collectively included and drew the areas of 126 unique nature places, globally. We found that the categories of conceptualizations of nature—identified in our codebook analysis of story map areas—varied between individual participants, and often between the places that individual participants included in their story maps. Considering all participants, while some participants (35.9%) had one conceptualization of nature that applied across all the places in their story map—interactively grounded (5 participants), visually grounded (3 participants), and abstract (6 participants)—more participants (64.1%) had varied conceptualizations of nature that applied between different places in their story map. Considering all places, more participants included more nature places in their story maps where they had an interactively or visually grounded conceptualization of nature, compared to abstract (Figure 2). Most commonly, participants included 1 place in their story map where they conceptualized nature in an interactively and/or visually grounded way, sometimes 2 or 3 places, and less often, 4 or 5. Participants who conceptualized nature abstractly included 1, 2, or even 3 places in their story map.

Figure 2

Conceptualizations by Prevalence in Individual Participants' Story Maps



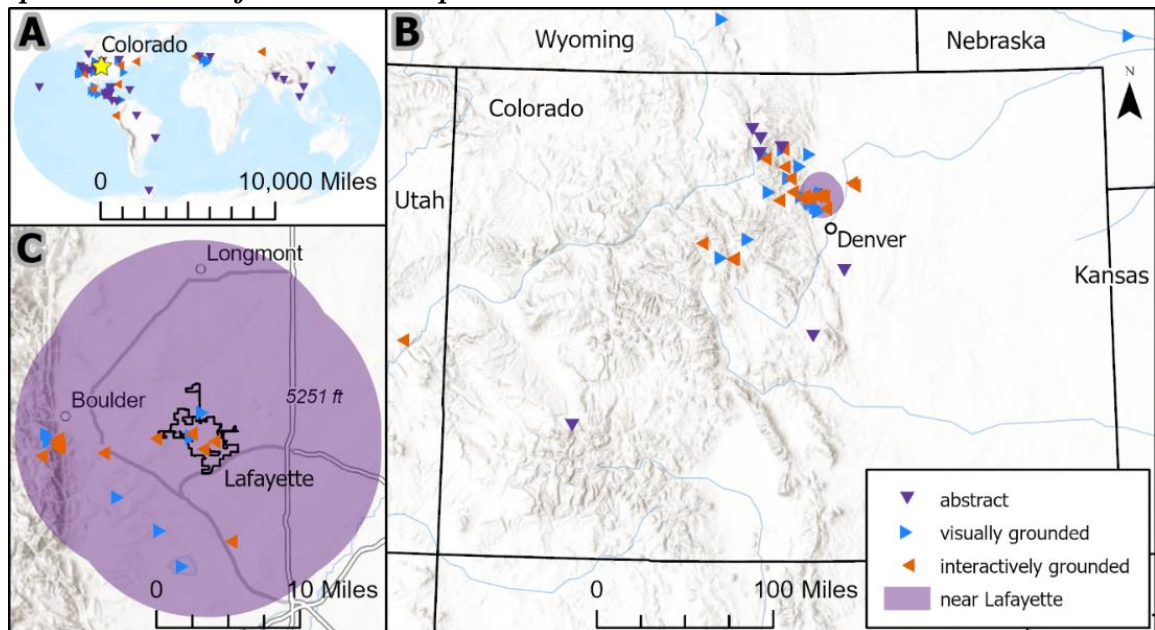
Note. Percent of participants who conceptualized nature in a way that was interactively grounded, visually grounded, or abstract—grouped by the number of places in an individual participant's story map where they conceptualized nature in that way—for all places, places near Lafayette, and places away from Lafayette. The ▲ indicates the median number of places included per story map, regardless of nature conceptualization.

When we linked the conceptualization categories to the corresponding locations of story map areas (polygon centroids), we found that the highest density of locations in general occurred near Lafayette, within an approximately 10-mile buffer of the Lafayette

municipal boundary. We used this buffer as a reference to consider where participants conceptualized nature *near Lafayette* compared to *away from Lafayette*, beyond the 10-mile buffer (Martz et al., 2022). Overall, participants' conceptualizations of nature were interactively grounded, visually grounded, and abstract in locations dispersed across the globe (Figure 3). In locations clustered near Lafayette, participants only conceptualized nature in ways that were interactively and visually grounded, and for the most part, only included 1 place in their story map (Figure 2). Away from Lafayette, participants mostly included 1 or 2 places in their story map with an interactively and/or visually grounded conceptualization of nature; participants who conceptualized nature abstractly included 1, 2, or 3 places. Participants only abstractly conceptualized nature away from Lafayette.

Figure 3

Spatial Patterns of Nature Conceptualizations



Note. All area (centroid) locations (*Panel A*), locations in and around Colorado (*Panel B*), and locations near Lafayette, within an approximately 10-mile buffer of the Lafayette municipal boundary (*Panel C*). Some places are not visible due to overlap and/or

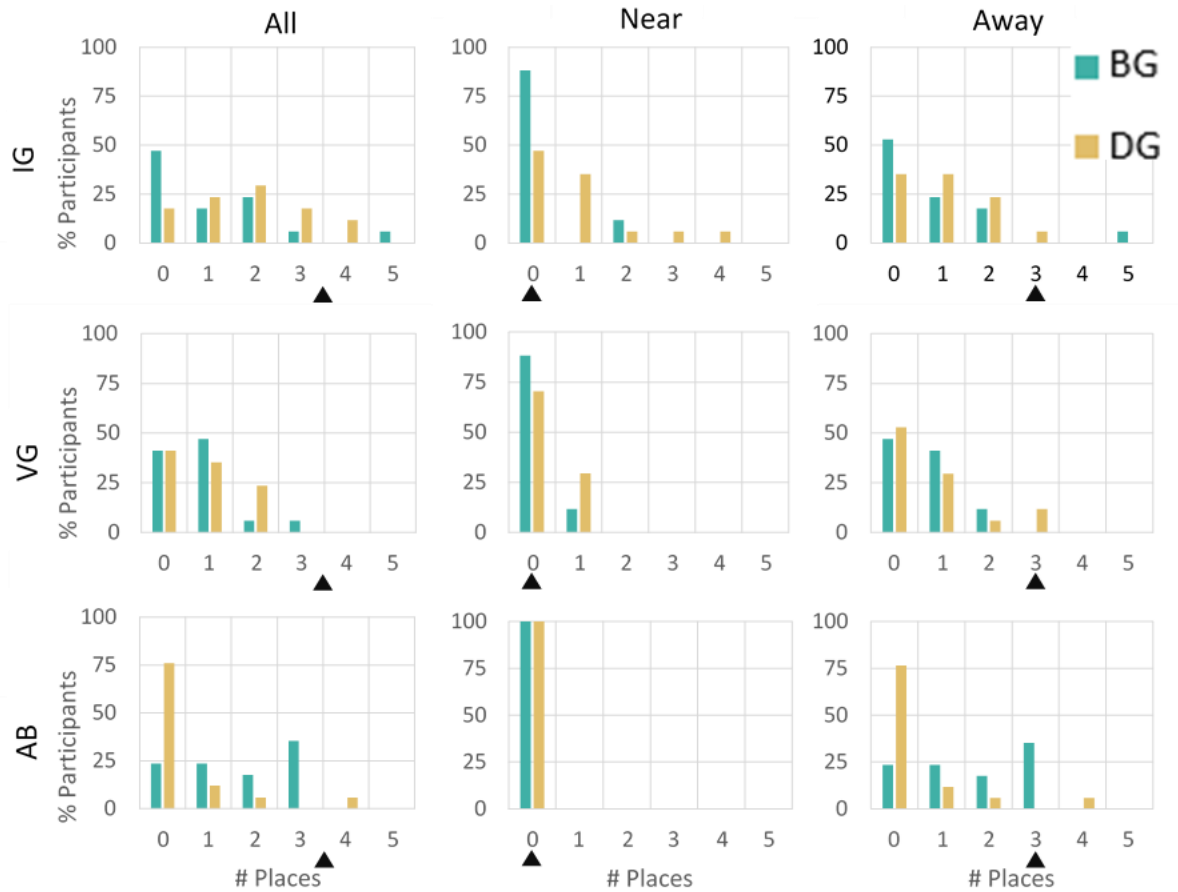
proximity of map symbols. Some locations altered to protect privacy (adapted from Martz et al., 2022).

Impact of Different Life Experiences on Youth Conceptualizations of Nature

The group of 17 participants who created story maps *during* the COVID-19 lockdown (hereafter *DG*) collectively included 59 unique nature places, globally; the similar group of 17 participants who created story maps *before* the COVID-19 lockdown (hereafter *BG*) included 60. We found differences between the groups in individual participants' generalized or varied conceptualizations of nature—identified in our codebook analysis of story map areas—that applied to different places in their story maps. Considering all participants in both groups, while some participants (DG: 35%; BG: 41%) had one conceptualization of nature that applied generally across all the places in their story map—interactively grounded (DG: 4 participants; BG: 2), visually grounded (DG: 2 participants; BG: 1), and abstract (DG: 0 participants; BG: 4)—more participants (DG: 65%; BG: 59%) had varied conceptualizations of nature between different places in their story map. Considering all places, more DG than BG participants included more places—often multiple—in their story maps where they conceptualized nature in an interactively grounded way (Figure 4). In contrast, more BG than DG participants included more places—often multiple—where they conceptualized nature abstractly. Notably, DG participants mostly did not include places where they conceptualized nature abstractly.

Figure 4

Between-Group Comparison by Prevalence in Individual Participants' Story Maps



Note. Percent of participants in Before group (BG) and During group (DG) who conceptualized nature in a way that was interactively grounded (IG), visually grounded (VG), or abstract (AB)—grouped by the number of places in a participant’s individual story map where they conceptualized nature in that way—for all places, places near Lafayette, and places away from Lafayette. The ▲ indicates the median number of places in individual participants’ story maps, regardless of nature conceptualization or group.

When we linked the conceptualization categories to the corresponding locations of story map areas (polygon centroids), we found that more DG than BG participants had interactively and/or visually grounded conceptualizations of nature in locations clustered

near Lafayette, most often in 1 place, and in multiple places in a few cases (Figure 4).

Conversely, more BG than DG participants conceptualized nature abstractly, often in 1 or multiple places, only dispersed *away from Lafayette*. Away from Lafayette, both BG and DG participants also had interactively and visually grounded conceptualizations of nature in 1 place, and sometimes in multiple places.

Discussion

Youth Conceptualizations of Nature

Our findings demonstrate the value of understanding youth conceptualizations of nature in relation to *specific places* as well as the *specific locations* of places. In relation to specific places, our findings suggest that individual youth may have a more generalized conceptualization of nature that applies across multiple places in their lives. Yet, our findings also suggest that individual youth more often have varied conceptualizations of nature between different places. This finding demonstrates that how individual youth conceptualize their meanings of nature may vary depending on the place, supporting the notion that it is important to understand youth conceptualizations of nature and, in turn, relationships with nature in relation to specific places (Beery & Wolf-Watz, 2014). Research on youth conceptualizations of nature most commonly explores how generalized conceptualizations may vary between individuals or groups of youth (Aaron & Witt, 2011; Adams & Savahl, 2017; Collado et al., 2016), but less commonly, how conceptualizations may vary for individual youth (Freeman et al., 2015). By exploring conceptualizations of nature that individual youth have in relation to specific places in their lives, we gained insight into how conceptualizations of nature for individual youth can apply generally across multiple places in their lives or, more often,

vary between different places. While we only asked youth to draw the areas of nature places that are special to them, perhaps asking youth to draw nature places that they know in general would lead to further varied results.

In relation to specific locations, our findings highlight that youth conceptualizations of nature also vary depending on the location. Near home, youth conceptualize nature in interactively grounded ways, in places where youth have likely had the time to develop familiarity. Away from home, youth also have grounded conceptualizations of nature, in places they have physically visited to develop familiarity or, in some cases, places they have not visited (e.g., a famous site), but they may be familiar with similar places that still allow them to conceptualize nature in a visually grounded way, even if vicariously. While grounded conceptualizations of nature may manifest near and faraway, youth abstractly conceptualize nature away from home. Perhaps it is not surprising that abstract conceptualizations of nature happen in places where youth likely have less familiarity. Nonetheless, these findings demonstrate that nature conceptualizations for individual youth further vary depending on the location of a place. The findings support the importance of understanding youth conceptualizations of nature and, in turn, relationships with nature—not only in relation to specific places, but—in relation to specific locations (Klaniecki et al., 2018; Restall & Conrad, 2015).

Impact of Different Life Experiences on Youth Conceptualizations of Nature

Our findings triangulate and add to findings from a qualitative GIS analysis in which we analyzed story map images and descriptions to identify qualitative themes in relationships with nature, linked the themes with corresponding locations of story map areas (polygon centroids), and mapped locations linked with specific themes to compare

spatial patterns between similar groups of participants with different life experiences, before and during COVID-19 lockdowns (Martz et al., 2022). In this analysis, we found that the COVID-19 lockdown focused youth relationships with nature on places located closer to home for reasons such as their lasting associations with nature places where they had spent frequent or extensive time. The findings revealed how youth relationships with nature are dynamic in response to changing circumstances, environments, and needs.

Here, when we linked the locations of story map areas (polygon centroids) to specific categories of conceptualizations of nature that emerged in our codebook analysis of areas (polygons), we found that youth during the COVID-19 lockdown had more grounded conceptualizations of nature closer to home. While youth conceptualizations of nature likely did not change in the relatively short time of the lockdown, the places that were important to youth, and why, did change. Amidst the lockdown, participants put a higher value on places—particularly nearby, but also faraway—where they had a more intimate, familiar, *grounded* conceptualization of nature. Unsurprisingly, the places where youth during the lockdown had more grounded conceptualizations of nature close to home were intertwined with lasting emotional ties to nature close to home that likely formed through their long-term, proximate, and/or repeated physical experiences of these nature places (Giusti et al., 2018; Martz et al., 2022; Morgan, 2010). Moreover, intimate, familiar, grounded conceptualizations of nature potentially added to the importance of these places preserving some level of continuity amidst the disruption of COVID-19 lockdowns to the normal places and routines in the lives of youth (Scannell et al., 2016; 2017). Conversely, abstract conceptualizations of nature in faraway places held diminished value to the lives of youth in a lockdown context. Even if temporarily, the

lockdown potentially shifted what is important to youth in their conceptualizations of nature, in turn, triangulating the dynamism of relationships between youth and nature in response to disruptions in their lives (Martz et al., 2022).

Findings from the codebook analysis added new insights related to the generalized and varied conceptualizations of nature amidst the lockdown for *individual youth*. Amidst the lockdown, some individual youth had generalized conceptualizations of nature that applied across all the places in their story map, while others had varied conceptualizations between different places. Yet, the way in which youth had generalized and varied conceptualizations of nature shifted. For individual youth amidst the lockdown who had one generalized conceptualization of nature in all their places, that conceptualization was grounded. Furthermore, individual youth amidst the lockdown demonstrated an increased value for multiple places where they had interactively or visually grounded conceptualizations of nature; some of these youth also put an increased value on one of these places near home (Figure 4). In contrast, most youth during the lockdown did not include any places where they had abstract conceptualizations of nature. While we were not able to compare the same individual youth before and during the lockdown, these findings offer preliminary evidence that COVID-19 lockdowns potentially focused individual youth more on their grounded conceptualizations of nature in general, and particularly closer to home. This evidence adds to our understanding of how conceptualizations of nature and, in turn, relationships with nature for youth are potentially dynamic in response to disruptions in their lives, *on an individual level*.

Considering the Value of a Qualitative GIS Codebook

By developing and applying a codebook to analyze individual areas drawn by youth on a map, we gained valuable information that helped us better understand youth conceptualizations of nature through (1) interpreting categories comparable at an individual level, (2) integrating spatial, geometric, and qualitative attributes of participant-drawn areas, and (3) engaging the specific context of each unique area. We consider each point and address some limitations of asking participants to draw on a map.

First, the codebook allowed us to *interpret categories comparable at an individual level*. We used the codebook to interpret a conceptualization category from each individual area, drawn by each individual youth. As a result, the uniform codebook application allowed us to compare the number of places—by category and by location—that individual youth included in their story maps. In doing so, we gained new insights into youth conceptualizations of nature, and added preliminary evidence for the impacts of different life experiences on how youth conceptualize nature, related to the generalized and varied conceptualizations of nature for youth at an individual level.

Second, the codebook *integrated spatial, geometric, and qualitative attributes of participant-drawn areas*. An area's attributes—extent, shape, locational accuracy, and feature(s) within an area—allowed us to interpret how a participant conceptualized their meanings of nature in relation to specific places, while ancillary attributes of areas—experience, interaction, vision—provided essential context. Youth communicated their conceptualization of nature *through* the act of drawing areas on a map that they associate with nature. The act involved youth determining where the area is located, finding feature(s) on the base map that are significant to them, and negotiating the size and shape

of the boundary where nature is meaningful to them. In turn, we used the codebook's integration of spatial, geometric, and qualitative attributes to tap into the meanings that participants embedded within the area itself through the act of drawing it. In doing so, we effectively formalized a link between the area (GIS object) and how youth conceptualize their meanings of nature (Pavlovskaya, 2009; Schuurman, 2006). Like themes that emerge from the analysis of ancillary qualitative data can be linked to the locations of associated GIS objects (Cieri, 2003; Jung & Elwood, 2010; Kwan & Ding, 2008; Lowery & Morse, 2013; Martz et al., 2022), categories emerged from the analysis of areas that linked to the locations of areas. Thus, we were able to symbolize the areas based on the associated conceptualization categories to explore spatial patterns in how youth conceptualizations of nature further vary depending on location.

Third, the codebook *engaged the specific context of each unique area*. Carver and others (2009) point out that participant-drawn areas on a map are *fuzzy* because it is hard for participants to define where their meanings associated with a place begin and end, particularly with the discrete outline of a polygon in a GIS. Accordingly, Lowery and Morse (2013) suggest the discrete outlines of areas (polygons) should be recognized as fuzzy, transitional boundaries between where is, and is not, meaningful to a participant. One participant in this study alluded to how the boundary of an area they drew was fuzzy: "Although I set boundaries for this location, I personally feel as if this environmental location has no real boundaries because the experience one has here is a place that cannot be contained." By incorporating multiple attributes of areas in the codebook, we aimed to reconcile the inherent challenge for participants to represent hard-to-define meanings with discretely outlined areas on a map (Cacciapaglia et al., 2012; Carver et al., 2009;

Huck et al., 2014). The most important component of multiple area attributes is how we integrated them, and *flexibly* drew upon different combinations, to understand the specific context of each unique area and, in turn, the conceptualization of nature it represented. Each attribute in the codebook offered important insights into how youth conceptualize their meanings of nature in a place, demonstrating how multiple attributes of areas, in addition to spatial extent (Cacciapaglia et al., 2012), can support understanding how participants conceptualize their meanings related to an idea such as nature. Effectively, the codebook enabled us to engage “fuzzy” participant-drawn areas (Carver et al., 2009; Lowery & Morse, 2013) with a “fuzzy” approach to analyzing them by integrating and flexibly drawing upon different combinations of attributes as they were relevant to understanding the specific context of each unique participant-drawn area on a map.

Additionally, all participants in this study possessed the ability to read and navigate Google Earth and the mapping tool to find places, similar to youth in other studies (e.g., Jarvis et al., 2017). Participants in this study accurately mapped the locations of 90.1% of their collective 185 places. At the same time, the codebook’s integration of multiple attributes addressed some limitations that can emerge when asking participants to draw on a map. For example, the locations of some nature places were challenging for participants to find when a place was located farther away from where a participant lived and/or they did not know the exact location of the place (Table 2, Example 2). As well, a few participants were challenged by the mapping tool and found it difficult to place vertices on the map, resulting in misshapen and/or twisted polygons (Table 2, Example 2). Also, participants demonstrated varying motivation to spend time drawing a detailed area on the map (Brown, 2004). Whether or not participants mapped

the exact location of a place, or outlined the area with specific detail, the integration of attributes provided additional context to interpret the conceptualization of nature from the area drawn on a map. For example, even though the participant did not find the exact location of St. Mark's Basilica, other attributes of the area they drew—their decisions to bound an immediate extent and include land and water, their selection of an image that included land and water, and their description of a short visit—indicated a conceptualization of nature that was not grounded in their physical interactions with the place so much as visually grounded in what they could see in the place.

Conclusion

Towards our first objective in this paper, individual youth drew on a map the specific area of places where nature is meaningful to them. The areas were valuable for understanding generalized and varied conceptualizations of nature for individual youth, in relation to specific places and locations, and based on different life experiences. Considering our second objective, we developed, implemented, and explored a qualitative GIS codebook that demonstrated value for interpreting categories comparable at an individual level, integrating spatial, geometric, and qualitative attributes of participant-drawn areas, and engaging the specific context of each unique area. Further, we note three key implications of this work for understanding youth conceptualizations of nature and for advancing qualitative GIS methods to support such understanding.

First, youth conceptualizations of nature are intertwined with places (Beery & Wolf-Watz, 2014; Castree, 2014). Our approach demonstrates the value of understanding youth conceptualizations of nature *through* their conceptualizations of the places that they associate with nature. By asking youth to draw on a map the specific area of a *place*

that they associate with nature, we were able to develop a more nuanced understanding of how they conceptualize that place. In turn, we were able to better understand how they conceptualize *nature* in that place—the size of the extent, the complexity of the shape, the detail of the locational accuracy, and the type of feature(s) on the map significant to their meanings of nature in that place. Because abstract concepts such as “nature” are challenging to communicate, we suggest such approaches are valuable in engaging youth to communicate their conceptualizations of nature in new ways.

Second, areas drawn on a map by participants are fuzzy because it is hard to define the boundary between where is and is not meaningful (Cacciapaglia et al., 2012; Carver et al., 2009; Lowery & Morse, 2013). Our codebook demonstrated a qualitative GIS approach to engaging participant-drawn areas on a map with an approach to analysis that was effectively fuzzy because it incorporated other attributes to contextualize the boundary of each unique area. Extracting the location-based meanings, experiences, and local knowledge embedded in areas participants draw on a map necessitates developing qualitative and mixed-methods approaches to analysis that are specific to the context of each study. While we developed a codebook to apply in the specific context of this study, we suggest that the attributes, codes, and implementation are an example for future qualitative GIS analyses of participant-drawn areas on a map that contribute to understanding how individuals or groups conceptualize an idea or an issue in relation to specific places.

Third, our qualitative GIS approach advances the formalization of links between polygon objects in a GIS and social meanings and experiences (Pavlovskaya, 2009; Schuurman, 2006) through the inductive analysis of the GIS object itself. When a

participant creates a multidimensional GIS object such as a polygon to share their location-based meanings, they embed their meanings within the spatial object itself to some degree, through the act of creating it (Jung, 2009; Jung & Elwood, 2019; Kwan, 2002). In turn, attributes of a multidimensional GIS object offer an opportunity to interpret the participant's meanings. We suggest the codebook in this study demonstrates the value and untapped potential of developing qualitative GIS approaches for analyzing participant-drawn spatial objects in a GIS to gain more nuanced understandings of participant meanings and experiences.

References

- Aaron, R. F., & Witt, P. A. (2011). Urban students' definitions and perceptions of nature. *Children, Youth and Environments*, 21(2), 145-167.
<http://www.jstor.org/stable/10.7721/chilyoutenvi.21.2.0145>
- Adams, S., & Savahl, S. (2017). Children's discourses of natural spaces: Considerations for children's subjective well-being. *Child Indicators Research*, 10, 423-446.
<https://doi.org/10.1007/s12187-016-9374-2>
- Arnold, K. D., & Casellas Connors, I. (2021). The 'anti-Instagram': Using visual methods to study the college experiences of underrepresented students. *Visual Studies*. Advance online publication.
<https://doi.org/10.1080/1472586X.2021.1893612>
- Beery, T. H., & Wolf-Watz, D. (2014). Nature to place: Rethinking the environmental connectedness perspective. *Journal of Environmental Psychology*, 40, 198-205.
<https://doi.org/10.1016/j.jenvp.2014.06.006>
- Boschmann, E., & Cubbon, E. (2014). Sketch maps and qualitative GIS: Using cartographies of individual spatial narratives in geographic research. *The Professional Geographer*, 66(2), 236-248.
<https://doi.org/10.1080/00330124.2013.781490>
- Brandt, K., Graham, L., Hawthorne, T., Jeanty, J., Burkholder, B., Munisteri, C., Visaggi, C. (2020). Integrating sketch mapping and hot spot analysis to enhance capacity for community-level flood and disaster risk management. *The Geographical Journal*, 186(2), 198-212. <https://doi.org/10.1111/geoj.12330>

- Brennan-Horley, C., & Gibson, C. (2009). Where is creativity in the city? Integrating qualitative and GIS methods. *Environment and Planning A*, 41(11), 2595-2614. <https://doi.org/10.1068/a41406>
- Brown, G. (2004). Mapping spatial attributes in survey research for natural resource management: Methods and applications. *Society & Natural Resources*, 18(1), 17-39. <https://doi.org/10.1080/08941920590881853>
- Cacciapaglia, M., Yung L., & Patterson, M. (2012). Place mapping and the role of spatial scale in understanding landowner views of fire and fuels management. *Society & Natural Resources*, 25(5), 453-467. <https://doi:10.1080/08941920.2011.580418>
- Caquard, S. (2013). Cartography I: Mapping narrative cartography. *Progress in Human Geography*, 37(1), 135-144. <https://doi.org/10.1177/0309132511423796>
- Carver, S., Watson, A., Waters, T., Matt, R., Gunderson, K., & Davis, B. (2009). Developing computer-based participatory approaches to mapping landscape values for landscape and resource management. In S. Geertman & J. Stillwell (Eds.), *Planning Support Systems Best Practice and New Methods*. (pp. 431-448). Springer. https://doi.org/10.1007/978-1-4020-8952-7_21
- Castree, N. (2014). *Making sense of nature*. Routledge.
- Chawla, L. (2015). Benefits of nature contact for children. *Journal of Planning Literature*, 30(4), 433-452. <https://doi.org/10.1177/0885412215595441>

- Chawla, L. (2020). Childhood nature connection and constructive hope: A review of research on connecting with nature and coping with environmental loss. *People and Nature*, 2(3), 619-642. <https://doi.org/10.1002/pan3.10128>
- Cieri, M. (2003). Between being and looking queer tourism promotion and lesbian social space in greater Philadelphia. *ACME: An International Journal for Critical Geographies*, 2(2), 147-166. <https://acme-journal.org/index.php/acme/article/view/691>
- Collado, S., Íñiguez-Rueda, L., & Corraliza, J. A. (2016). Experiencing nature and children's conceptualizations of the natural world. *Children's Geographies*, 14(6), 716-730. <https://doi.org/10.1080/14733285.2016.1190812>
- Cope, M., & Elwood, S. (2009). *Qualitative GIS: A mixed methods approach*. Sage.
- Curtis, A., Curtis, J. W., Ajayakumar, J., Jefferis, E., & Mitchell, S. (2019). Same space – different perspectives: Comparative analysis of geographic context through sketch maps and spatial video geonarratives. *International Journal of Geographical Information Science*, 33(6), 1224-1250. <https://doi.org/10.1080/13658816.2018.1514609>
- Curtis, J. W., Shiao, E., Lowery, B., Sloane, D., Hennigan, K., Curtis, A. (2014). The prospects and problems of integrating sketch maps with geographic information systems to understand environmental perception: a case study of mapping youth fear in Los Angeles gang neighborhoods. *Environment and Planning B: Planning and Design*, 41, 251-271. <https://doi.org/10.1068/b38151>

- Elwood, S. (2006). Negotiating knowledge production: The everyday inclusions, exclusions, and contradictions of participatory GIS research. *The Professional Geographer*, 58(2), 197-208. <https://doi.org/10.1111/j.1467-9272.2006.00526.x>
- Esri (Environmental Systems Research Institute) (2019a). *ArcGIS StoryMaps* [Computer software]. <https://storymaps.arcgis.com/>
- Esri (Environmental Systems Research Institute) (2019b). *ArcGIS Survey123* (Version 3.6.149) [Computer software]. <https://survey123.arcgis.com/>
- Forman, J., & Damschroder, L. (2007). Qualitative content analysis. In L. Jacoby & L. A. Siminoff (Eds.), *Empirical Methods for Bioethics: A Primer*. (pp. 39-62). Emerald Group Publishing Limited. [https://doi.org/10.1016/S1479-3709\(07\)11003-7](https://doi.org/10.1016/S1479-3709(07)11003-7)
- Freeman, C., van Heezik, Y., Hand, K., & Stein, A. (2015). Making cities more child- and nature-friendly: A child-focused study of nature connectedness in New Zealand cities. *Children, Youth and Environments*, 25(2), 176-207. <https://doi.org/10.7721/chilyoutenvi.25.2.0176>
- Giusti, M., Svane, U., Raymond, C. M., & Beery, T. H. (2018). A framework to assess where and how children connect to nature. *Frontiers in Psychology*, 8, 2283. <https://doi.org/10.3389/fpsyg.2017.02283>
- Gunderson, K., & Watson, A. (2007). Understanding place meanings on the Bitterroot National Forest, Montana. *Society & Natural Resources*, 20(8), 705-721. <https://doi.org/10.1080/08941920701420154>

- Huck, J. J., Whyatt J.D., & Coulton, P. (2014). Spraycan: A PPGIS for Capturing Imprecise Notions of Place. *Applied Geography*, 55, 229-237.
<https://doi.org/10.1016/j.apgeog.2014.09.007>
- Ives, C., Giusti, M., Fischer, J., Abson, D. J., Klaniecki, K., Dorninger, C., Laudan, J., Barthel, S., Abernethy, P., Martín-López, B., Raymond, C. M., Kendal, D., & von Wehrden, H. (2017). Human-nature connection: A multidisciplinary review. *Current Opinion in Environmental Sustainability*, 26-27, 106-113.
<https://doi.org/10.1016/j.cosust.2017.05.005>
- Jarvis, C. H., Kraftl, P., & Dickie, J. (2017). (Re)Connecting spatial literacy with children's geographies: GPS, Google Earth and children's everyday lives. *Geoforum*, 81, 22-31. <https://doi.org/10.1016/j.geoforum.2017.02.006>
- Jung, J. (2009). Computer-aided qualitative GIS: A software-level integration of qualitative research and GIS. In M. Cope & S. Elwood (Eds.), *Qualitative GIS: A mixed methods approach*. (pp. 115-135). Sage.
- Jung, J., & Elwood, S. (2010). Extending the qualitative capabilities of GIS: Computer-aided qualitative GIS. *Transactions in GIS*, 14(1), 63-87.
<https://doi.org/10.1111/j.1467-9671.2009.01182.x>
- Jung, J., & Elwood, S. (2019). Qualitative GIS and spatial research. In P. Atkinson, S. Delamont, A. Cernat, J. W. Sakshaug, & R. A. Williams (Eds.), *Sage research methods foundations*. Sage. <https://www.doi.org/10.4135/9781526421036818834>
- Kellert, S. R. (2002). Experiencing nature: Affective, cognitive, and evaluative development in children. In P. H. Kahn, Jr. & S. R. Kellert (Eds.), *Children and*

- nature: Psychological, sociocultural and evolutionary investigations.* (pp. 117-151). MIT Press. <https://doi.org/10.7551/mitpress/1807.003.0006>
- Kerski, J. J. (2015). Geo-awareness, geo-enablement, geotechnologies, citizen science, and storytelling: Geography on the world stage. *Geography Compass*, 9(1), 14-26. <https://doi.org/10.1111/gec3.12193>
- Klaniecki, K., Leventon, J., & Abson, D. J. (2018). Human-nature connectedness as a ‘treatment’ for pro-environmental behavior: Making the case for spatial considerations. *Sustainability Science*, 13, 1375-1388. <https://doi.org/10.1007/s11625-018-0578-x>
- Kwan, M. P. (2002). Feminist visualization: Re-envisioning GIS as a method in feminist geographic research. *Annals of the Association of American Geographers*, 92(4), 645-661. <https://doi.org/10.1111/1467-8306.00309>
- Kwan, M. P., & Ding, G. (2008). Geo-narrative: Extending geographic information systems for narrative analysis in qualitative and mixed-method research. *The Professional Geographer*, 60(4), 443-465. <https://doi.org/10.1080/00330120802211752>
- Lowery, D., & Morse, W. (2013). A qualitative method for collecting spatial data on important places for recreation, livelihoods, and ecological meanings: Integrating focus groups with public participation geographic information systems. *Society & Natural Resources*, 26(12), 1422-1437. <https://doi.org/10.1080/08941920.2013.819954>

- Martz, C. J., Powell, R. L., & Wee, B. (2020). Engaging children to voice their sense of place through location-based story making with photo-story maps. *Children's Geographies*, 18(2), 148-161. <https://doi.org/10.1080/14733285.2019.1685073>
- Martz, C. J., Powell, R. L., & Wee, B. (2022). The impact of COVID-19 lockdowns on youth relationships with nature: A socio-spatial perspective. *Children, Youth and Environments*, 32(1), 128-151. <https://muse.jhu.edu/article/855979>
- Martz, C. J., Powell, R. L., Wee, B., & Myers, A. (in press). Evaluating Environmental Education Programs Using a Qualitative Geographic Information Systems Approach. *Children, Youth and Environments*.
- Morgan, P. (2010). Towards a developmental theory of place attachment. *Journal of Environmental Psychology*, 30(1), 11-22.
<https://doi.org/10.1016/j.jenvp.2009.07.001>
- Mygind, L., Kjeldsted, E., Hartmeyer, R., Mygind, E., Bølling, M., & Bentsen, P. (2019). Mental, physical and social health benefits of immersive nature-experience for children and adolescents: A systematic review and quality assessment of the evidence. *Health & Place*, 58, 102136.
<https://doi.org/10.1016/j.healthplace.2019.05.014>
- Pavlovskaya, M. (2009). Non-quantitative GIS. In M. Cope & S. Elwood (Eds.), *Qualitative GIS: A mixed methods approach*. (pp. 13-37). Sage.
- Prener, C. (2021). Digitizing and visualizing sketch map data: A semi-structured approach to qualitative GIS. *Cartographica: The International Journal for*

Geographic Information and Geovisualization, 56, 267-283.

<https://doi.org/10.3138/cart-2020-0030>

Provalis Research. (2020). *QDA Miner* (Version 6.0.1) [Computer software].

<https://provalisresearch.com/products/qualitative-data-analysis-software/>

Restall, B., & Conrad, E. (2015). A literature review of connectedness to nature and its potential for environmental management. *Journal of Environmental Management*, 159, 264-278. <https://doi.org/10.1016/j.jenvman.2015.05.022>

Rice, W. L., Taff, B. D., Newman, P., Zipp, K. Y., & Pan, B. (2020). Identifying recreational ecosystem service areas of concern in Grand Canyon National Park: A participatory mapping approach. *Applied Geography*, 125, 102353.

<https://doi.org/10.1016/j.apgeog.2020.102353>

Saldaña, J. (2013). *The coding manual for qualitative researchers*. Sage.

Scannell, L., Cox, R. S., Fletcher, S., & Heykoop, C. (2016). “That was the last time I saw my house”: The importance of place attachment among children and youth in disaster contexts. *American Journal of Community Psychology*, 58(1-2), 158-173.

<https://doi.org/10.1002/ajcp.12069>

Scannell, L., Cox, R. S., & Fletcher, S. (2017). Place-based loss and resilience among disaster-affected youth. *Journal of Community Psychology*, 45(7), 859-876.

<https://doi.org/10.1002/jcop.21897>

Schoepfer, I., & Rogers, S. R. (2014). A new qualitative GIS method for investigating neighbourhood characteristics using a tablet. *Cartographica: The International*

Journal for Geographic Information and Geovisualization, 49(2), 127-143.

<https://doi.org/10.3138/carto.49.2.1810>

Schuurman, N. (2006). Formalization matters: Critical GIS and ontology research. *Annals of the Association of American Geographers*, 96(4), 726-739.

<https://doi.org/10.1111/j.1467-8306.2006.00513.x>

Wee, B. (2020). The nature of childhood in childhoodnature. In A. Cutter-Mackenzie, K. Malone, & E. Barratt Hacking (Eds.), *Research handbook on childhoodnature: Assemblages of childhood and nature research*. (pp. 1025-1042). Springer.

https://doi.org/10.1007/978-3-319-51949-4_56-1

Weiner, D., & Harris, T. (2003). Community-integrated GIS for land reform in South Africa. *URISA Journal*, 15, 61-73.

Chapter Five: Summary and Conclusions

Summary of Research

Overview

The primary motivation of this dissertation was to better understand the lived experiences of youth as socio-spatial processes. We aimed to do so by expanding location-based, qualitative GIS methods in research with youth to document and explore lived experiences relevant to their relationships with nature. Specifically, this research focused on the impacts of different life experiences—COVID-19 lockdowns, EE programming—on how and where youth relate with nature and conceptualize what nature is. We further focused on expanding the integration of qualitative data and analysis with GIS to understand how and where youth relationships with nature are impacted by different life experiences, developing a codebook to interpret meanings embedded in the areas of nature places drawn by participants on a map. In doing so, we explored our main objectives set out in the introduction of the dissertation:

Objective 1: Explore the value of location for understanding how and where different life experiences impact youth relationships with nature.

By integrating the locations of polygon centroids with qualitative themes of youth relationships with nature that changed amidst COVID-19 lockdowns and resulted from EE programming, we revealed findings that would not have emerged if we had treated

spatial and qualitative data separately (Jung & Elwood, 2010). In the case of COVID-19 lockdowns, by exploring spatial patterns in the locations where and reasons why youth related with nature, we found that youth relationships with nature were dynamic in response to the disruption of lockdown, shifting closer to home for reasons such as lasting associations with nature places. In the case of EE programming, by exploring spatial patterns in where and why youth related with nature for nature connection and health and wellness, we established preliminary evidence that more exposure to NKJN programming supported higher-exposure participants to realize more health and wellness benefits in their lives, particularly closer to home. Location-specific, qualitative findings demonstrate how integrating geographic locations with qualitative themes can offer greater location specificity to the relatively limited location-specific understandings of relationships between individuals and nature in general (Beery & Wolf-Watz, 2014; Klaniecki et al., 2018; Restall & Conrad, 2015), and youth in particular (Freeman et al., 2015). Moreover, qualitative GIS approaches are viable and worth further exploration for enhancing outcome measurements in EE program evaluation (Ardoin et al., 2018; Carleton-Hug & Hug, 2010; Stern et al., 2014).

Objective 2: Explore the value of analyzing participant-drawn areas on a map for understanding how and where youth conceptualize nature.

By developing a qualitative GIS codebook to tap into meanings embedded by participants in areas they draw on a map, we gained new insights into youth conceptualizations of nature as well as how youth conceptualize nature based on different life experiences. By exploring conceptualizations of nature in relation to specific places

and locations, we found that youth conceptualizations can apply generally across multiple places in their lives or, more often, vary between different places, on an individual level. We also found that youth conceptualizations of nature vary by location. Near home, youth primarily conceptualize nature in grounded ways, while abstract conceptualizations happen away from home, as do grounded conceptualizations. Furthermore, we established preliminary evidence that the life experience of COVID-19 lockdowns potentially focused individual youth more on their grounded conceptualizations of nature in general, and particularly closer to home. In turn, we added to our understanding of how conceptualizations of nature and, in turn, relationships with nature for youth are potentially dynamic in response to disruptions in their lives—on an individual level. These insights resulted from our development and implementation of a qualitative GIS codebook that demonstrated value for interpreting categories comparable at an individual level, integrating spatial, geometric, and qualitative attributes of participant-drawn areas, and engaging the specific context of each unique area. The codebook advanced the formalization of links between spatial objects in a GIS and social meanings and experiences through inductive analysis of the GIS object itself (Pavlovskaya, 2009; Schuurman, 2006).

Broader Community Impacts

In addition to the academic research objectives above, a core goal of this community-partnered research was to benefit NKJN's ongoing program evaluation efforts and, in turn, the Lafayette community in which NKJN provides programming (Jacquez et al., 2013). The goals of NKJN's program evaluation are to (1) understand

quality, effectiveness, and opportunities to improve programming, (2) assess impacts of programming on individual participants and the entire community, and (3) demonstrate the value of their work to funders. To collect data that would directly contribute to NKJN program evaluation, we worked with NKJN organization leadership to incorporate prompts at the conclusion of each story map activity, as well as during the follow-up interviews conducted for the current research, that aligned with questions that NKJN typically asks in interviews, focus groups, and other qualitative evaluation, as follows:

- “After your experiences in [this NKJN program], what does nature and time in nature mean to you in your day-to-day life?”
- “Can you describe any significant changes for you?”

Additionally, we worked with NKJN organization leadership to assist in qualitative data analysis of the program evaluation data from story maps. We used NKJN’s previously developed coding process, based on NKJN’s five program outcomes (Chapter 3, Table 1). We helped NKJN organization leadership share findings from the analysis of program evaluation data in the NKJN 2019-2020 year-end report, in which we also shared our preliminary location-based findings from Chapter 3 about NKJN programming impacts.

As with many aspects of society at large, NKJN program evaluation was disrupted by the COVID-19 pandemic. NKJN’s operational year runs from June to May and data collection for this dissertation ran from June 2019 to May 2020, corresponding with NKJN’s third year of ongoing programming and program evaluation. As it turned out, the collection and analysis of story maps and story map interviews provided the main source of program evaluation data and analysis for NKJN’s 2019-2020 programming.

This dissertation work became an important part of maintaining NKJN's ongoing program evaluation amidst a disruptive period for the organization and broader society.

Community-Partnered Research

Community-partnered research involves academic researchers and community organizations partnering on research that benefits the community organization (Jacquez et al., 2013). Through community-partnered research, we balanced our research objectives with goals of benefiting NKJN and the Lafayette community they serve. The partnership formed because NKJN was seeking academic partners to do research that contributed to their program evaluation goals. At the same time, the primary academic researcher for this dissertation was seeking a community organization to work with community members on research exploring relationships with nature. We initially connected through a combination of networks: (1) CCESL Scholar Shop at the University of Denver, a platform for community organizations to submit projects and connect with researchers who have aligning interests (NKJN submitted a program evaluation project), and (2) Metro Denver Nature Alliance (MetroDNA), a collective of non-profit, government, research, and private organizations partnering around nature-based efforts in Denver (NKJN was not a MetroDNA organization, but we connected through a shared MetroDNA contact). After connecting, we set out to develop a partnership around NKJN program evaluation goals and academic research objectives.

Community-partnered research is related to *community-based participatory research*, in which academic researchers partner with community members and/or organizations in all aspects of the research process—defining questions, collecting and

analyzing data, and applying results to address community concerns—to conduct studies that benefit the community (Israel et al., 1998; Jacquez et al., 2013). Community-partnered research shares aims to benefit the community, although it is less participatory and more focused on the partnership between academic researcher(s) and community organization(s). Initially, we set out to involve youth Lafayette community members in more aspects of the research process. As our partnership with NKJN developed, we weighed the need expressed by NKJN for data that could support their program evaluation, a desire on our part to explore specific research objectives, as well as the scheduling and timing constraints of NKJN programming and completing the dissertation (Elwood, 2006). We worked closely with NKJN organization leadership throughout the research process. As a result of our combined efforts to align priorities and navigate constraints, NKJN youth (Lafayette community members) had a lesser role throughout the research process. Their primary role was as participants in data collection activities for program evaluation and research. Instead, the partnership was focused on the community organization level and on providing benefits in terms of data collection, analysis, and reporting results from the evaluation of NKJN programming.

Geoprivacy in Qualitative GIS Research with Youth

A common desired outcome of community-partnered research is data sharing (Elwood, 2006; Jacquez et al., 2013). Story maps and other qualitative GIS approaches produce rich geographically referenced research data. However, we encountered limited guidance in the qualitative GIS literature for sharing these rich data with partners and

community members while protecting the (geo)privacy of research participants, particularly youth.

Advances in geospatial technologies, from location-aware devices to web-based mapping software, have contributed to an increase in the quantity and richness of georeferenced data, and in particular, data with socio-spatial linkages that combine geographic and qualitative information (Richardson et al., 2016; VanWey et al., 2005). These types of georeferenced data result from approaches that include social surveys and censuses (VanWey et al., 2005), mixed-methods (Boulos et al., 2009), story maps (Martz et al., 2020), and spatial video geonarratives (Curtis et al., 2015). These approaches often produce detailed personal data that link geographic locations with other potentially identifying information, such as addresses and demographic information or mapped narratives of lived experiences (Cope & Elwood, 2009; Curtis et al., 2015). Commonly, such socio-spatial data link individuals' homes, workplaces, daily activities, trips, and lived experiences with specific locations, expanding the potential for new spatial questions and research possibilities (Gutman et al., 2008; Richardson et al., 2016; VanWey et al., 2005). At the same time, these socio-spatial data are highly personally identifiable, especially when linked to other potentially personally identifying information that, along with locations, can be further linked to vast and growing amounts of data available online.

Furthermore, online spaces are increasingly common sites for research activities such as data collection, storage, and sharing, heightening the risk for potential leaks in online spaces that are potentially permeable, and where the consequences of internet

research are still uncertain (Ergler et al., 2016; Markham & Buchanan, 2012; Sparks et al., 2016). Research online introduces areas of increasing complexity related to personal disclosure, perceived and actual risks and harm to reputation, altered notions of public space and data ownership, as well as data that remain online for indefinite periods of time (Buchanan & Zimmer, 2021). Additional concerns include: changing conditions for recruitment and informed consent; protecting privacy when technologies are becoming increasingly ubiquitous; preserving anonymity and data confidentiality when researchers and participants may not fully grasp the terms and conditions of an online tool; and understanding data security implications of storing, hosting, and sharing data via cloud-based and/or third-party servers. Even though research online mostly follows the same ethical guidelines as research offline, such guidelines must be reexamined and, in some cases, rethought to address additional risks introduced in newer virtual contexts (Ergler et al., 2016; Madge, 2007; Sparks et al., 2016). Much like protecting geoprivacy in research contexts, the new online contexts of internet research present new ethical questions (Buchanan & Zimmer, 2021).

Moreover, engaging youth in research through online spaces and asking them to provide georeferenced data holds particular concerns for privacy (Livingstone et al., 2015; Livingstone et al., 2019). While youth are generally highly capable in digital environments, they have less critical understanding than adults of the present and future risks that exist with online environments, as well as less concern about privacy online. While a majority of youth have an awareness of online privacy risks (Livingstone et al., 2019), youth may have different views than adults, such as being more worried about

embarrassment or bullying by peers (UNICEF, 2017; Livingstone et al., 2019).

Additionally, insufficient regulatory guidelines lead to concerns that the government and private organizations responsible for designing online environments do not account for the specific needs of youth or recognize the varying capacities of youth of different ages (Livingstone et al., 2016; Livingstone et al., 2019).

The easiest way to address the risk and uncertainty of sharing qualitative GIS research data might be to avoid sharing altogether (Asher & Jainke, 2013). However, needs for research replication, data-sharing requirements of funding agencies, potential for research collaboration (Richardson et al., 2016; VanWey et al., 2005), and mutually beneficial community partnerships (Curtis et al., 2015; Elwood, 2006; Jacquez et al., 2013) place a high value on data sharing. Strategies vary for sharing data while taking care to address concerns over the risk and uncertainty associated with protecting the (geo)privacy and confidentiality of participants. In the context of sharing data with the broader research community, curated data repositories and archives are one way that research teams make sensitive research data available, so that data archive specialists can control the protection, preservation, and dissemination of data (Asher & Jainke, 2013; Guutman et al., 2008; VanWey et al., 2005). In other contexts, such as community-partnered research, academic researchers and community organizations often desire some level of shared ownership to access and use the data. In such cases, it might be more practical and appropriate for the researcher to act as the data archivist, sharing data more directly with community partners (rather than mediated through a repository or archive). Furthermore, in this research, the data provided by participants in the form of story maps

were also creative works. In such cases, it can be desirable to share story maps with the individual participant who created it as well as with community organizations who desire to share the creative works of their participants with the community.

Because of these factors, we posit that now more than ever there is a need for development of guidelines and examples to address geoprivacy concerns in qualitative GIS research, particularly in online environments and in research with youth (Curtis et al., 2015). While there is no “one-size-fits-all” privacy-preserving solution, more examples and guidance can support future researchers in making judgements and developing solutions that are context-aware, adaptable to rapidly changing technologies, and suitable for the specific research situation (Boulos et al., 2009; Madge, 2007; Markham & Buchanan, 2012).

Protecting Geoprivacy in a Publicly Available Story Map

In our qualitative GIS research with youth, efforts to share story maps with youth participants, our community partner, and the broader community involved numerous considerations because story maps (1) combine geographic locations with descriptions and images of lived experiences that together could potentially identify a participant and (2) are shared online with a publicly accessible URL. Among these considerations were *whether* we should share story maps, *how* we should share them, and with *whom*. Since the story maps were creative works and the result of community-partnered research, we desired to share story maps, in a de-identified format, with the youth who created them and with the NKJN organization. In consultation with the Institutional Review Board (IRB) at the University of Denver, we incorporated an option in the assent and

permission forms, in which youth and their parents/guardians were asked whether their story map could be made public online, in a de-identified format that would not give away their identity. To de-identify the participant story maps, we combined all the nature places from all the individual story maps—which we were permitted to share—to create one collective story map. In the collective story map, we took further steps to aggregate locations of nature places, blur potentially sensitive information in images of nature places, and remove potentially identifying information from descriptions of nature places. We then shared the URL of the de-identified, collective story map with NKJN program leaders, asking them to share the URL only with youth who had created a story map as part of this research project. Our goal was to provide youth with the opportunity to directly interact with the story map to find and view the nature places which they had contributed. After consulting with multiple librarians who use GIS, we decided to take down the publicly accessible URL of the collective story map after approximately one year because it had served its main purpose. In its place, we created a video presentation of the collective story map to share with NKJN (follow this [link](#) to watch the video). The purpose of the video was to share the collective story map in a way that limited the ability of viewers to directly interact with the story map, but still provided a sense of the story maps that youth created. While the collective story map was already de-identified to protect the privacy of youth, the video provided an additional layer of protection, should NKJN choose to share the video more broadly, such as with the Lafayette community.

Our considerations of *whether*, *how*, and with *whom* offer a sense of the higher-level decisions that went into sharing story maps in a way that gave participants, partners,

and the broader community access to the data created by the youth participants, while protecting their privacy. While our approach fell short of our goal to share the ownership of story maps with our community partner and study participants, we note that newer commercial software options are emerging that may facilitate these goals. (For example, see Esri's ArcGIS Hub application, a web-based data sharing platform that provides ways to implement differential accessibility to individuals or groups). We also note issues inherent to sharing and archiving dynamic web content that may be deprecated in the (not so distant) future.

Future Directions

This research points to potential for future work in several areas. First, COVID-19 lockdowns presented extreme spatially restrictive circumstances that disrupted the lives of youth, highlighting how youth relationships with nature are dynamic, socio-spatial processes. Yet, youth may face numerous potential spatial restrictions and other disruptions to their lives under more “normal” circumstances, suggesting a need for more research that explores the dynamism of relationships with nature for youth in everyday life. Second, we integrated location information into qualitative evaluation of EE programming, demonstrating how location-based, qualitative information helped establish preliminary evidence that exposure to NKJN programming affected *where* participants demonstrated program outcomes in their lives; specifically, participants who had spent more time in NKJN programming valued nature in locations closer to where they live. We suggest that incorporating location-based, qualitative information adds significant value in EE program evaluation, particularly for programs that emphasize

participants experiencing the place(s) where activities are located. Such place-based programs could benefit from assessing the impacts of specific program location(s) on the location(s) of program outcomes. Third, we note untapped potential in qualitative GIS that warrants further exploration of analyzing multidimensional, participant-created GIS objects to extract meaning, as demonstrated by the qualitative GIS codebook we developed to analyze participant-drawn areas on a map in conjunction with narrative descriptions of places. Developing new, and rethinking existing, data collection and analysis approaches will be necessary for advancing knowledge of youth conceptualizations of nature. As the ways that youth interact with nature shift physically and virtually due to the increasing amount of time spent connected to a digital world, the ways youth conceptualize and relate with nature will potentially change. For example, as virtual environments become more immersive, will vicarious interactions with nature result in more interactively grounded conceptualizations of nature? Capturing such changes will require developing and rethinking methods for engaging youth to share their relationships with nature in new ways.

References

- Aaron, R. F., & Witt, P. A. (2011). Urban students' definitions and perceptions of nature. *Children, Youth and Environments, 21*(2), 145-167.
<http://www.jstor.org/stable/10.7721/chilyoutenvi.21.2.0145>
- Aitken, S. C. (2018). Children's geographies: Tracing the evolution and involution of a concept. *Geographical Review, 108*(1), 3-23. <https://doi.org/10.1111/gere.12289>
- Aitken, S. C., Lund, R., & Trine Kjørholt, A. (2007). Why children? Why now? *Children's Geographies, 5*(1-2), 3-14.
<https://doi.org/10.1080/14733280601108114>
- Ardoin, N. M., Biedenweg, K., & O'Connor, K. (2015). Evaluation in residential environmental education: An applied literature review of intermediary outcomes. *Applied Environmental Education & Communication, 14*(1), 43-56.
<https://doi.org/10.1080/1533015X.2015.1013225>
- Ardoin, N. M., Bowers, A. W., Roth, N. W., & Holthuis, N. (2018). Environmental education and K-12 student outcomes: A review and analysis of research. *The Journal of Environmental Education, 49*(1), 1-17.
<https://doi.org/10.1080/00958964.2017.1366155>
- Asher, A. D. & Jahnke, L. M. (2013). Curating the ethnographic moment. *Archive Journal, 3*. <http://www.archivejournal.net/issue/3/archivesremixed/curating-the-ethnographic-moment/>

- Beery, T. H., & Wolf-Watz, D. (2014). Nature to place: Rethinking the environmental connectedness perspective. *Journal of Environmental Psychology*, 40, 198-205. <https://doi.org/10.1016/j.jenvp.2014.06.006>
- Boulos, M. N. K., Curtis, A. J., & AbdelMalik, P. (2009). Musings on privacy issues in health research involving disaggregate geographic data about individuals. *International Journal of Health Geographics*, 8, 46. <https://doi.org/10.1186/1476-072X-8-46>
- Buchanan, E. A. & Zimmer, M. Internet research ethics. (2021). In E. N. Zalta (Eds.), *The Stanford Encyclopedia of Philosophy (Summer 2021 Edition)*. <https://plato.stanford.edu/archives/sum2021/entries/ethics-internet-research/>
- Caquard, S. (2013). Cartography I: Mapping narrative cartography. *Progress in Human Geography*, 37(1), 135-144. <https://doi.org/10.1177/0309132511423796>
- Carleton-Hug, A., & Hug, J. W. (2010). Challenges and opportunities for evaluating environmental education programs. *Evaluation and Program Planning*, 33(2), 159-164. <https://doi.org/10.1016/j.evalprogplan.2009.07.005>
- Castree, N. (2014). *Making sense of nature*. Routledge.
- Chawla, L. (2015). Benefits of nature contact for children. *Journal of Planning Literature*, 30(4), 433-452. <https://doi.org/10.1177/0885412215595441>
- Chawla, L. (2020). Childhood nature connection and constructive hope: A review of research on connecting with nature and coping with environmental loss. *People and Nature*, 2(3), 619-642. <https://doi.org/10.1002/pan3.10128>

- Cieri, M. (2003). Between being and looking queer tourism promotion and lesbian social space in Greater Philadelphia. *ACME: An International Journal for Critical Geographies*, 2(2), 147-166. <https://acme-journal.org/index.php/acme/article/view/691>
- Cronon, W. (1996). The trouble with wilderness: Or, getting back to the wrong nature. *Environmental History*, 1(1), 7-28. <https://www.jstor.org/stable/i382276>
- Cope, M., & Elwood, S. (2009). *Qualitative GIS: A mixed methods approach*. Sage.
- Cosgrove, D. (1995). Habitable earth: Wilderness, empire, and race in America. In D. Rothenberg (Eds.), *Wild Ideas*. (pp. 27-41). University of Minnesota Press.
- Curtis, A., Curtis, J. W., Shook E., Smith, S., Jefferis, E., Porter, L., Schuch, L., Felix, C., & Kerndt, P. R. (2015). Spatial video geonarratives and health: Case studies in post-disaster recovery, crime, mosquito control and tuberculosis in the homeless. *International Journal of Health Geographics*, 14, 22. <https://doi.org/10.1186/s12942-015-0014-8>
- Demeritt, D. (2001). Being constructive about nature. In N. Castree (Eds.), *Social Nature: Theory, practice, and politics*. (pp. 22-40). Blackwell.
- Elwood, S. (2006). Negotiating knowledge production: The everyday inclusions, exclusions, and contradictions of participatory GIS research. *The Professional Geographer*, 58(2), 197-208. <https://doi.org/10.1111/j.1467-9272.2006.00526.x>
- Ergler, C. R., Kearns, R., Witten, K., & Porter, G. (2016). Digital methodologies and practices in children's geographies. *Children's Geographies*, 14(2), 129-140. <https://doi.org/10.1080/14733285.2015.1129394>

- Esri (Environmental Systems Research Institute) (2019a). *ArcGIS StoryMaps* [Computer software]. <https://storymaps.arcgis.com/>
- Esri (Environmental Systems Research Institute) (2019b). *ArcGIS Survey123* (Version 3.6.149) [Computer software]. <https://survey123.arcgis.com/>
- Freeman, C., van Heezik, Y., Hand, K., & Stein, A. (2015). Making cities more child- and nature-friendly: A child-focused study of nature connectedness in New Zealand cities. *Children, Youth and Environments*, 25(2), 176-207.
<https://doi.org/10.7721/chilyoutenvi.25.2.0176>
- Giusti, M., Svane, U., Raymond, C. M., & Beery, T. H. (2018). A framework to assess where and how children connect to nature. *Frontiers in Psychology*, 8, 2283.
<https://doi.org/10.3389/fpsyg.2017.02283>
- Gutmann, M. P., Witkowski, K., Colyer, C., O'Rourke, J. M., & McNally, J. (2008). Providing spatial data for secondary analysis: Issues and current practices relating to confidentiality. *Population Research and Policy Review*, 27, 639-665.
<https://doi.org/10.1007/s11113-008-9095-4>
- Holloway, S. L. (2014). Changing children's geographies. *Children's Geographies*, 12(4), 377-392. <https://doi.org/10.1080/14733285.2014.930414>
- Hutchinson, James. (1990). *Lafayette, Colorado, Treeless Plain to Thriving City: Centennial History, 1889-1989*. Curtis Media.
- Israel, B. A., Schulz, A. J., Parker, E. A. & Becker, A. B. (1998). Review of community-based research: Assessing partnership approaches to improve public health.

Annual Review of Public Health, 19, 173-202.

<https://doi.org/10.1146/annurev.publhealth.19.1.173>

Ives, C., Giusti, M., Fischer, J., Abson, D. J., Klaniecki, K., Dorninger, C., Laudan, J., Barthel, S., Abernethy, P., Martín-López, B., Raymond, C. M., Kendal, D., & von Wehrden, H. (2017). Human-nature connection: A multidisciplinary review.

Current Opinion in Environmental Sustainability, 26-27, 106-113.

<https://doi.org/10.1016/j.cosust.2017.05.005>

Jacquez, F., Vaughn, L., & Wagner, E. (2013). Youth as partners, participants or passive recipients: A review of children and adolescents in community-based participatory research (CBPR). *American Journal of Community Psychology, 51*(1-2), 176-189. <https://doi.org/10.1007/s10464-012-9533-7>

Jung, J. (2009). Computer-aided qualitative GIS: A software-level integration of qualitative research and GIS. In M. Cope & S. Elwood (Eds.), *Qualitative GIS: A mixed methods approach*. (pp. 115-135). Sage.

Jung, J., & Elwood, S. (2010). Extending the qualitative capabilities of GIS: Computer-aided qualitative GIS. *Transactions in GIS, 14*(1), 63-87.

<https://doi.org/10.1111/j.1467-9671.2009.01182.x>

Jung, J., & Elwood, S. (2019). Qualitative GIS and spatial research. In P. Atkinson, S. Delamont, A. Cernat, J. W. Sakshaug, & R. A. Williams (Eds.), *Sage research methods foundations*. Sage. <https://www.doi.org/10.4135/9781526421036818834>

Kellert, S. R. (2002). Experiencing nature: Affective, cognitive, and evaluative development in children. In P. H. Kahn, Jr. & S. R. Kellert (Eds.), *Children and*

- nature: Psychological, sociocultural and evolutionary investigations.* (pp. 117-151). MIT Press. <https://doi.org/10.7551/mitpress/1807.003.0006>
- Kerski, J. J. (2015). Geo-awareness, geo-enablement, geotechnologies, citizen science, and storytelling: Geography on the world stage. *Geography Compass*, 9(1), 14-26. <https://doi.org/10.1111/gec3.12193>
- Klaniecki, K., Leventon, J., & Abson, D. J. (2018). Human-nature connectedness as a ‘treatment’ for pro-environmental behavior: Making the case for spatial considerations. *Sustainability Science*, 13, 1375-1388. <https://doi.org/10.1007/s11625-018-0578-x>
- Kwan, M. P. (2002). Feminist visualization: Re-envisioning GIS as a method in feminist geographic research. *Annals of the Association of American Geographers*, 92(4), 645-661. <https://doi.org/10.1111/1467-8306.00309>
- Kwan, M. P., & Ding, G. (2008). Geo-narrative: Extending geographic information systems for narrative analysis in qualitative and mixed-method research. *The Professional Geographer*, 60(4), 443-465. <https://doi.org/10.1080/00330120802211752>
- Ladwig, J. G. (2010). Beyond academic outcomes. *Review of Research in Education*, 34(1), 113-141. <https://doi.org/10.3102/0091732X09353062>
- Livingstone, S., Carr, J., & Byrne, J. (2015). One in three: Internet governance and children’s rights. *Global Commission on Internet Governance Paper Series No. 22*. Centre for International Governance Innovation.

- Livingstone, S., Stoilova, M., & Nandagiri, R. (2019). *Children's data and privacy online: Growing up in a digital age: An evidence review*. London School of Economics and Political Science, Department of Media and Communications.
- Lowery, D., & Morse, W. (2013). A qualitative method for collecting spatial data on important places for recreation, livelihoods, and ecological meanings: Integrating focus groups with public participation geographic information systems. *Society & Natural Resources*, 26(12), 1422-1437.
<https://doi.org/10.1080/08941920.2013.819954>
- Madge, C. (2007). Developing a geographers' agenda for online research ethics. *Progress in Human Geography*, 31(5), 654-674.
<https://doi.org/10.1177/0309132507081496>
- Markham, A., & Buchanan, E. (2012). Ethical decision-making and internet research: Version 2.0. *Association of Internet Researchers*.
<http://aoir.org/reports/ethics2.pdf>
- Martz, C. J., Powell, R. L., & Wee, B. (2020). Engaging children to voice their sense of place through location-based story making with photo-story maps. *Children's Geographies*, 18(2), 148-161. <https://doi.org/10.1080/14733285.2019.1685073>
- Martz, C. J., Powell, R. L., & Wee, B. (2022). Exploring relationality among children's place attachments in their experiences of a new place. *Geographical Review*. Advance online publication. <https://doi.org/10.1080/00167428.2022.2050372>
- Mygind, L., Kjeldsted, E., Hartmeyer, R., Mygind, E., Bølling, M., & Bentsen, P. (2019). Mental, physical and social health benefits of immersive nature-experience for

- children and adolescents: A systematic review and quality assessment of the evidence. *Health & Place*, 58, 102136. <https://10.1016/j.healthplace.2019.05.014>
- Pavlovskaya, M. (2009). Non-quantitative GIS. In M. Cope & S. Elwood (Eds.), *Qualitative GIS: A mixed methods approach*. (pp. 13-37). Sage.
- Proctor, J. (1998). The social construction of nature: Relativist accusations, pragmatist and critical realist responses. *Annals of the Association of American Geographers*, 88(3), 352-376. <https://doi.org/10.1111/0004-5608.00105>
- Restall, B., & Conrad, E. (2015). A literature review of connectedness to nature and its potential for environmental management. *Journal of Environmental Management*, 159, 264-278. <https://doi.org/10.1016/j.jenvman.2015.05.022>
- Richardson, D. B., Kwan, M. P., Alter, G., & McKendry, J. E. (2015). Replication of scientific research: Addressing geoprivacy, confidentiality, and data sharing challenges in geospatial research. *Annals of GIS*, 21(2), 101-110. <https://doi.org/10.1080/19475683.2015.1027792>
- Schuurman, N. (2006). Formalization matters: Critical GIS and ontology research. *Annals of the Association of American Geographers*, 96(4), 726-739. <https://doi.org/10.1111/j.1467-8306.2006.00513.x>
- Sheppard, E. (2005). Knowledge production through critical GIS: Genealogy and prospects. *Cartographica: The International Journal for Geographic Information and Geovisualization*, 40(4), 5-21. <https://doi.org/10.3138/GH27-1847-QP71-7TP7>

Sparks, H., Collins, F., & Kearns, R. (2016). Reflecting on the risks and ethical dilemmas of digital research. *Geoforum*, 77, 40-46.

<https://doi.org/10.1016/j.geoforum.2016.09.019>

Stern, M. J., Powell, R. B., & Hill, D. (2014). Environmental education program evaluation in the new millennium: What do we measure and what have we learned? *Environmental Education Research*, 20(5), 581-611.

<https://doi.org/10.1080/13504622.2013.838749>

Taylor, A. (2011). Reconceptualizing the “nature” of childhood. *Childhood*, 18(4), 420-433. <https://doi.org/10.1177/0907568211404951>

Taylor, D. E. (2016). *The rise of the American conservation movement: Power, privilege, and environmental protection*. Duke University Press.

UNICEF (United Nations International Children's Emergency Fund). (2017). *The state of the world's children 2017: Children in a digital world*. United Nations Children's Fund.

U.S. Census Bureau (2020). “2020 Decennial Census.” Accessed December 4, 2021.

<https://data.census.gov/cedsci/>

VanWey, L. K., Rindfuss, R. R., Gutmann M. P., Entwisle, B., and Balk, D.L. (2005). Confidentiality and spatially explicit data: Concerns and challenges. *Proceedings of the National Academy of Sciences*, 102(43), 15337-15342.

<https://doi.org/10.1073/pnas.0507804102>

Wee, B. (2020). The nature of childhood in childhoodnature. In A. Cutter-Mackenzie, K. Malone, & E. Barratt Hacking (Eds.), *Research handbook on childhoodnature:*

Assemblages of childhood and nature research. (pp. 1025-1042). Springer.

https://doi.org/10.1007/978-3-319-51949-4_56-1

Zint, M. (2013). Advancing environmental education program evaluation: Insights from a review of behavioral outcome evaluations. In R. B. Stephenson, M. Brody, J. Dillon, & A. Wals (Eds.), *International handbook of research in environmental education.* (pp. 298-309). Routledge. <https://doi.org/10.4324/9780203813331>