

DISSERTATION

NATURE'S IMPACT ON TOMORROW'S YOUTH:
COGNITIVE AND NON-COGNITIVE FACTORS AFFECTING YOUTH
CONNECTION TO NATURE AND ENVIRONMENTAL STEWARDSHIP

Submitted by

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ABSTRACT

NATURE'S IMPACT ON TOMORROW'S YOUTH: COGNITIVE AND NON-COGNITIVE FACTORS AFFECTING YOUTH CONNECTION TO NATURE AND ENVIRONMENTAL STEWARDSHIP

This dissertation investigates the developmental trajectory of nature connection in childhood and its implications for environmental stewardship. While previous research has examined these relationships, few studies have analyzed both the cognitive and non-cognitive influences nature has on youth. This study explores children's capacity to develop this connection as early as age 9, identifying cognitive and non-cognitive components and their association with environmental behaviors. The findings support existing literature linking higher levels of nature connection to increased engagement in environmental stewardship activities. Path analysis examined direct and indirect effects of connection to nature. Demographic variables, such as sex, traditionally thought to moderate this relationship, did not emerge as significant moderators. Results indicate cognitive and non-cognitive factors significantly contribute to environmental stewardship. These findings contribute to a nuanced understanding of the mechanisms underlying connection to nature and offer practical insights for intervention design. Addressing disparities in access to nature experiences among diverse youth populations is crucial for promoting lifelong environmental stewardship and ensuring environmental justice. Overall, this dissertation advances knowledge on nature connection in childhood and its implications for environmental sustainability.

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Introduction

The ecological systems upon which humans rely for life support are in crisis. On a global scale, environmental problems are increasingly becoming more acute. These problems, including pollution of air, water, and soil; climate change; deforestation; and biodiversity loss, have led to drastic changes in the Earth's ability to sustain both human and non-human life (Osbaldiston & Schott, 2012; Millennium Ecosystem Assessment, 2005; Carpenter et al., 2009). The growing human population and corresponding rise in demand for food, energy, and raw materials continue to strain the finite resources of the planet (Ford & Scandura, 2023). Osbaldiston and Schott (2012) warn, "if the human population continues to grow and human aspirations continue to focus on increased material wealth, then humans are likely to cause our own ending" (p. 287). With the global population having exceeded the mark of 8 billion people and still growing at an exponential rate (United Nations, 2022), there are very few places on earth able to avoid the pervasive impacts of humans. Resource scarcity will be the driving force behind the actions of consumers, corporations, and governments for generations to come. Our youth, the torchbearers of tomorrow, stand at the crossroads of a world in need of healing. By understanding and fostering youth's bond with nature, we may unlock the potential to cultivate more future stewards of the environment – empathetic leaders who carry the responsibility of addressing the pressing issues threatening our planet. The need for research that can inform solutions to this global crisis, including ways to promote greater stewardship of our natural resources, has never been greater.

Humans are clearly at the root of this environmental crisis, threatening ecological systems both directly, via land use and exploitation of natural resources, and indirectly, through activities such as burning fossil fuels contributing to climate change (Akerlof & Kennedy, 2013;

Dunn et al., 2020). Directly attributed to human behavior, climate change has caused the sea level to rise by at least three inches, resulting in less available freshwater sources, and contributed to species extinction rates estimated to be 100 to 1,000 times greater than pre-human rates (Millennium Ecosystem Assessment, 2005; Pimm et al., 1995). Human behaviors are also contributing to biodiversity loss across the globe in the form of over-fishing, illegal timber harvesting, poaching, and bushmeat hunting (Ceballos & Ehrlich, 2002; Schultz, 2011). Biodiversity loss results from both intentional human actions eliminating certain species, such as eradication of bison and wolves in North America, and unintentional actions transforming ecosystems and selectively displacing wildlife, as seen with growing urbanization (Ripple et al., 2015; Diaz et al., 2015). Encouraging environmental stewardship to address the environmental crisis will thus require transformative changes in human behavior, both in terms of personal choices as well as large-scale collective action (Ford & Scandura, 2023).

To inform individual and collective behavior change solutions, there is a need to better understand the diverse array of factors affecting human behaviors. According to recently advanced ‘systems’ approaches incorporating psychological influences, behaviors can be understood as situated within multiple, nested levels of internal and external social and ecological influences (Lischka et al., 2018; Manfreda et al., 2017; Jones et al., 2021). These influences range from specific characteristics of the individual (e.g., cognitions, emotions, demographics) to broad, societal-level forces (e.g., modernization, socioeconomic trends) defining the context in which human thought and behavior are shaped. The magnitude of the ecological crisis requires these more holistic systems perspectives and intervention strategies that can attend to the myriad of multilevel influences on behavior.

Forces of modernization, as seen from a systems lens, have propelled a series of changes that have dramatically altered the social-ecological context of human-nature relationships and behaviors (Manfredo et al., 2020a). These forces include urbanization, increasing levels of income and education; increased life expectancy; and growth in technology. Urbanization, in particular, is one of the most notable modernization phenomena affecting both social and ecological conditions (Ripple et al., 2015). The emergence of “megacities” is radically changing ecosystems, for example, by impacting wildlife populations through habitat destruction, fragmentation, and decreased animal migration connectivity (Grimm et al., 2008; Seto et al., 2012; Marzluff, 2011). Increased urbanization has also led to social isolation and the physical distancing of people from nature and wildlife (Bruskotter et al., 2017; Soga & Gaston, 2016). Cities are centers of prosperity, employment opportunities, access to education and health and human services, and cultural advancement, all aspects of life that can promote mental and physical well-being (Glaeser, 2011). Nonetheless, cities can also be associated with decreased access to nature, especially for individuals living within economically deprived urban areas (Schwarz et al., 2017).

The trend of diminishing engagement with nature, particularly noticeable in urban settings, is increasingly replaced by indoor and virtual recreational pursuits. For instance, statistics reveal the average American youth devotes a mere four to seven minutes per day to unstructured outdoor play, while spending over seven hours daily engaged with screens (Larson et al., 2019; Cohen, 2020; Lloyd-Stovas, 2018). This shift is concerning not only for its proven impacts on mental and physical well-being (Dzhambov & Dimitrova, 2014), but also for its impact on the cultivation of positive sentiments, or attitudes, towards nature. Interactions with natural environments play a pivotal role in fostering these sentiments (Bratman et al., 2015;

White et al., 2013), which in turn are linked to the adoption of environmental stewardship behaviors (Soga & Gaston, 2016; Whitburn et al., 2020).

As society becomes more removed from direct day-to-day interactions with wildlife and the natural environment, children are being brought up in a new set of surroundings in urban settings (Manfredo, 2008; Manfredo et al., 2020b). As urban populations grow, residents generally have reduced opportunities to experience the natural environment and, without those opportunities, they may be less likely to develop a strong connection to nature, resulting in ambivalence or apathy toward conserving ecosystems and wildlife. The lack of nature contact and subsequent connection to the natural world may, thus, result in segments of the population being less concerned about the ecological crisis and less likely to take specific action to protect the environment (i.e., practice environmental stewardship; Kareiva, 2006; Miller, 2005; Soga & Gaston, 2016; Swaisgood & Sheppard, 2010).

Overall, urbanization is a key factor in the study of connection to nature because it signifies the ways in which human exposure to natural environments is changing, and in many cases dwindling, over time. This presents a significant challenge because urban environments continue to rapidly expand across the globe. The amount of developed land has increased, shrinking the availability for urban expansion projects. With urban density on the rise and more people living in closer proximity, opportunities for nearby access to and experiences in nature continue to dwindle for many urban inhabitants (Kabisch et al., 2016). As contact with the natural world declines for a growing percentage of the world's population living in cities, there is legitimate concern that a decline in nature connection among urban residents may translate into less concern about environmental issues. While understanding how urbanization impacts the physical environment is important as well, research on a connection to nature can provide useful

insights needed to thoroughly investigate the lesser-known social aspects of this issue and its wide-ranging implications (Grimm et al., 2008).

Continued and expanded study in this domain will be crucial for a deeper comprehension of the transforming relationship between humans and the natural environment, occurring in tandem with escalating worldwide urbanization. By understanding the impacts of urbanization on connection to nature, researchers and policymakers can be better prepared in their work to promote human well-being and environmental sustainability in urban areas. Research on connection to nature can help establish the need, as well as offer guidance, for urban design plans to include natural aspects. Intentional planning and design efforts could create opportunities for people to connect with nature in new and unique ways; for example, urban parks, community gardens, and green roofs can provide urban residents with local opportunities to experience nature within the city (Kabisch et al., 2016).

In sum, the contemporary socio-ecological crisis is an outcome of human-induced alterations to ecosystems, presenting a formidable challenge to global environmental sustainability and human well-being (Wilson, 2002). Despite varied intervention outcomes, scholarly consensus underscores the imperative for widespread societal behavior shifts to address the severity of the environmental crisis (Schultz, 2011; Mascia et al., 2003). Adopting a holistic, systems-based approach is paramount for comprehending the intricate dynamics and interdependencies inherent in the socio-ecological crisis (Hartig & Kahn Jr., 2016). By considering diverse behavioral influences, ranging from individual characteristics to broader societal factors, interventions can be tailored to foster sustainable behaviors and enhance stewardship of natural resources (Hartig et al., 2003). Encouraging a connection to nature, particularly among youth, by building on social science theory supported by empirical research,

offers a promising avenue for facilitating a shift towards more environmentally conscious behaviors.

Connection to nature as a response to the socio-ecological crisis

As urbanization continues unabated, experiences with the natural environment diminish across successive generations, posing a threat to the transmission of intergenerational connections to nature (Miller, 2005). This phenomenon gives rise to what has been termed "environmental generational amnesia" and "extinction of experience," wherein each succeeding generation experiences a diminishing exposure to the natural world and an exacerbation of environmental degradation, thereby altering the baseline for acceptable levels of natural quality, richness, and diversity of experiences (Soga & Gaston, 2016; Kahn, 2002; Pergams & Zaradic, 2008). This concept of environmental generational amnesia warns of a progressive narrowing of the spectrum of bio-related references shaping attitudes toward nature over time (Soga & Gaston, 2016). With fewer opportunities for cultivating connectedness to natural systems, particularly during formative years, there exists a risk of cultural evolution trending toward ambivalence or detachment from nature, which could have serious consequences for environmental stewardship (Kahn, 2011; Manzo, 2003). To address this situation, a better understanding of the factors that influence connection to nature can help facilitate the development of effective strategies for promoting such a connection among current and future generations.

Connection to nature can be conceptualized as individuals' subjective evaluations of their relationships with nature. More specifically, it refers to the cognitive and non-cognitive, or affective, bonds that individuals develop with the natural world surrounding them (Kals et al., 1999; Schultz, 2002). From a cognitive standpoint, connection to nature involves a conceptual understanding of the natural order, and from an emotional perspective, it entails positive feelings

towards nature, such as appreciation for natural beauty as well as a sense of belonging in the natural environment. The concept largely stems from theories and empirical research in psychology, which has been a prominent discipline in social science applications in conservation (Manfredo, 2008; Vaske & Manfredo, 2012; Bennett et al., 2017). This includes the subdisciplines of social psychology, which takes into account the influence of one's social surroundings, and environmental psychology. Research from social psychology, for example, indicates that the closeness of relationships between individuals is associated with empathy and willingness to help (Cialdini et al., 1976), and that this phenomenon may extend to human-nature relationships as well. That is, a close bond with nature may foster empathy for the natural world, which in turn may motivate caring and altruistic environmental stewardship behavior (Schultz, 2000). Expanding self-identity to include the natural environment and experiences of belonging with nature is key in defining connection to nature (Kals, 1999; Schultz, 2001). Environmental psychology, aimed at understanding how humans interact with their physical surroundings (i.e., human-environment interactions), has aided in deepening our understanding of the motivations behind a connection to nature (Clayton & Meyers, 2009; Gifford, 2014). Conservation psychology, another subdiscipline, has further examined how identities rooted in connections to nature can influence conservation priorities and willingness to support environmental initiatives (Nisbet et al., 2009; Mayer & Frantz, 2004; Clayton & Meyers, 2009).

A primary theoretical foundation for connection to nature is the biophilia hypothesis presented by E. O. Wilson (1984). Biophilia proposes that humans possess an instinctive affinity for other living organisms and natural systems because of our evolutionary adaptation. Through this lens, connection to nature stems from innate tendencies predisposing humans to seek an affiliation with nature. While evolution may have predisposed humans towards connectedness,

social and cultural factors also strongly shape one's relationship with nature, largely through processes of learning (e.g., semantic learning) (Clayton & Meyers, 2009; Manfredi, 2008). Family upbringing, community values, and inevitably the availability of nearby natural areas all mediate the expression of biophilic tendencies (Cheng & Monroe, 2012). Contemporary lifestyles intertwined with technology pose additional barriers to fostering connections in digitally oriented younger generations (Pergams & Zaradic, 2008; Louv, 2008).

Another formative perspective for understanding connection to nature is systems theory, which views humans as embedded within complex ecological webs, rather than separate from nature (Capra, 1997). Systems thinking frames connection to nature as cognizance of humanity's interdependence with other species and natural processes. Adaptive management and resilience in socio-ecological systems (Folke, 2016; Walker & Salt, 2012) provides a framework for understanding and addressing the socio-ecological crisis by recognizing the complexity, interconnectedness, and dynamic nature of the systems involved. By adopting a holistic perspective and developing integrated solutions, we can work towards ensuring the health and vitality of our planet for present and future generations. This perspective invites us to perceive the socio-ecological system, where each element interacts in intricate ways. For instance, deforestation not only disrupts animal habitats but also impacts biodiversity, local economies, and even global climate patterns. Systems thinking illuminates this feedback loop, where actions trigger consequences that reverberate throughout the system, often affecting behaviors. Recognizing these dynamics, we can anticipate unintended outcomes and devise interventions that target the underlying causes rather than mere symptoms of the crisis. This perspective is essential for recognizing that socio-ecological systems are constantly changing in response to internal and external factors, such as human activities, natural events, and policy interventions

(Ostrom, 2010). It underscores the need for adaptive and flexible approaches to addressing the crisis over time. Rather than treating environmental issues in isolation, it encourages cooperation across different sectors and stakeholders to address underlying systemic drivers and promote sustainable stewardship of the planet (Levin et al., 2017; Holling, 2001).

Public health research has also played a role more recently in understanding connection to nature, documenting the concept's influence on human well-being indicators including stress, attention capacity, and mood (Van der Berg et al., 2010; Bratman et al., 2015). This research has shown that spending time in natural environments promotes memory, focus, and recovery from mental fatigue, and alleviates symptoms of depression and anxiety (Hartig et al., 2014; Helbich et al., 2018; Tsunetsugu et al., 2013). Longitudinal research in this area has additionally explored how childhood recollection of nature experiences in green spaces is associated with lifelong psychological resilience (Wells & Evans, 2003).

Ultimately, promoting connection to nature necessitates an interdisciplinary understanding of a wide array of influences, including psychological, sociocultural, systemic, and health-related factors. Tied to this, there is a need to go beyond the traditional “rational actor” models that have frequently been employed in psychology and its applications in conservation (Manfredo, 2008). Such models include the value-attitude-behavior (VAB) framework (Homer & Kahle, 1988) and Theory of Planned Behavior (TPB) or Reasoned Action Approach (RAA; Fishbein & Ajzen, 2011). There is a demand for more holistic systems approaches to understanding human behavior in the conservation context (Clayton & Meyers, 2009; Manfredo et al., 2020a), and greater attention must be given to non-cognitive (e.g., emotions) and broader cultural and societal-level influences (Bennett et al., 2017). Improved understanding that can be obtained by addressing these gaps and limitations in the existing

literature is critical for informing effective conservation intervention strategies, including strategies aimed at promoting connection to nature and environmental stewardship.

Dissertation purpose and organization

The goal of this study is to contribute to innovative environmental stewardship solutions by addressing important gaps in how connection to nature is measured and understood.

Encouraging a connection to nature and promoting environmental stewardship behaviors will likely require interventions targeting behavioral (i.e., environmental stewardship), non-cognitive (i.e., emotions), and cognitive (i.e., attitudes, knowledge) pathways. Generally, this research was guided by the following questions: (1) How can the connection to nature concept be broadened to include both cognitive and non-cognitive dimensions; (2) How does this revised conceptualization of connection to nature influence environmental stewardship; and (3) How effective and transferrable is this predictive model across different demographic segments, including sex and age groups, of the youth population in the U.S.?

The overreliance on cognitive measures in previous research on connection to nature has left non-cognitive dimensions relatively unexamined. Filling this gap is important for several reasons. Firstly, utilizing path analyses allows for a deeper understanding of the relationships between variables and the underlying causal mechanisms driving pro-environmental behaviors. By employing this methodological framework, researchers can elucidate how both non-cognitive factors and cognitive factors influence environmental stewardship, providing valuable insights for designing effective interventions and policies aimed at promoting sustainability. Secondly, replicating scales previously used with adult participants in a cohort of youth aged nine to seventeen enables researchers to assess the generalizability of findings across different age groups. This not only expands our understanding of the factors influencing environmental

stewardship among youth but also enhances the comparability of results with existing literature, facilitating broader insights into the development of environmental attitudes and behaviors across the lifespan. Ultimately, filling this gap contributes to a more comprehensive understanding of the factors driving environmental engagement among youth, which is critical for fostering a generation of environmentally conscious citizens capable of addressing pressing environmental challenges.

This dissertation adopts a traditional five-chapter structure to analyze the interrelationships between connection to nature and environmental stewardship behaviors. Following this introduction, the literature review delves deeper into the relevant scholarly literature on these concepts across multiple disciplines. It commences with an in-depth exploration of connection to nature theory and then examines how connection to nature links to subsequent conservation behaviors. A key section then reviews research demonstrating connection to nature's influence on indicators of human well-being, substantiating it as a public health priority warranting early intervention. The chapter proceeds to review scholarly work on environmental stewardship, including underlying intrinsic and extrinsic motivations for stewardship behaviors. In summarizing this foundational body of interdisciplinary theory and research, the literature review provides the necessary foundation for the constructs being investigated in the ensuing empirical study.

The next chapter discusses the methods of the study, which entailed a survey of youth in schools across the country to measure non-cognitive and cognitive elements of connection to nature as well as specific environmental stewardship behaviors. Then the results chapter presents the study findings, showing how non-cognitive and cognitive dimensions of connection to nature

impact environmental stewardship. Finally, the last chapter concludes with a synthesized discussion including implications for future conservation-related research and practice.

Literature Review

Humans have an underlying connection to nature shaped by our evolution and our historical existence as a species. This connection is reflected in our behavior and can manifest in various ways, including our attitudes toward the environment, our recreational and leisure activities, and our health and well-being (Clayton et al., 2017). One of the most significant ways in which humans connect with nature is through our attitudes toward the environment. Our beliefs about the natural world, including our perceptions of its significance and our responsibility to care for it, are shaped by a complex mix of cultural, social, and psychological factors (Kellert & Wilson, 1993; Schultz, 2000; Clayton et al., 2017). Some people may view nature as a resource to be exploited for economic gain, while others may see it as a sacred and spiritual entity that must be protected and preserved (Bragg, 2013; Clayton et al., 2017; Raymond et al., 2013). A connection to nature can lead to an appreciation for the aesthetic and intrinsic value of nature, beyond its instrumental value for human use. This can lead to a desire to protect natural areas for their own sake, rather than just for the benefits they provide to humans (Nisbet et al., 2009; Van den Berg et al., 2016; Raymond et al., 2013). Understanding what shapes connection to nature and how that connection, in turn, motivates environmentally protective behavior can be used to encourage conservation behavior and inform conservation policies requiring broad-based public support (Clayton & Opatow, 2017; Steg & Vlek, 2009; Stern et al., 2019).

Even though there is generally a high level of concern about environmental problems and support for environmental protection globally, there has *not* been a widespread movement toward a more sustainable lifestyle (Fox et al., 2006). This gap is partially explained by barriers a

person may encounter to engage in environmental stewardship, such as personal cost (e.g., finance and time), lack of structural support (e.g., recycling schemes and efficient public transport), or knowledge (e.g., type of behavior that is useful). But, as recently discovered, it likely also stems from an undeveloped connection to nature in modernized societies. Over the past century, people have been increasingly concentrated in urban areas. In many instances, modern living habits involve reduced direct contact with nature and increased time spent indoors, using screens, and performing sedentary activities (Hofferth, 2009; Atkin et al., 2013).

An individual's connection to nature may motivate engagement in environmental stewardship (Mayer & Frantz, 2004). Conversely, a lack of connection to nature has been blamed for people's apathy toward environmental degradation and protection (Pyle, 2003). As Frantz et al. (2005) emphasize, "given the link between feeling connected to nature and pro-environmental actions, investigating factors that either promote or inhibit this sense of feeling connected to nature is critical" (p. 428). It is essential to research *why* people take actions that impact the environment, for better or for worse, for it is human behavior creating, both, the problems and contributing to solutions.

Connection to nature as a framework

The concept of connection to nature refers to the subjective experience of feeling connected to the natural world (Mayer & Frantz, 2004; Nisbet et al., 2009). This experience can take many forms, from a sense of awe and wonder at the beauty of natural landscapes, to a feeling of kinship with other living beings (Piff et al., 2015; Shiota et al., 2007). It encompasses emotional, cognitive, and experiential dimensions, reflecting an individual's sense of belonging and relationship with the environment (Brügger et al., 2011; Tam, 2013). Moreover, connection to nature is not limited to direct experiences in wilderness settings but can also manifest through

interactions with urban green spaces or even through symbolic representations of nature in art, literature, and culture (Beery & Jönsson, 2017; Kals et al., 1999; Tam, 2013). People who feel a sense of connection to nature are more likely to have positive attitudes toward the environment and to see themselves as part of a larger ecological system. This can lead to a sense of responsibility for protecting the natural world and a willingness to take action to do so. Figure 1 depicts factors that influence developing a connection to nature with possible positive outcomes. The researcher designed the figure following the in-depth literature review specifically for use in the current study. A growing body of research has explored the relationship between connection

INFLUENCES

Socio-demographics

- Age
- Gender
- Socioeconomic status
- Education
- Ability
- Geographic region
- Race/Ethnicity
- Culture
- Religion

Experiences in nature

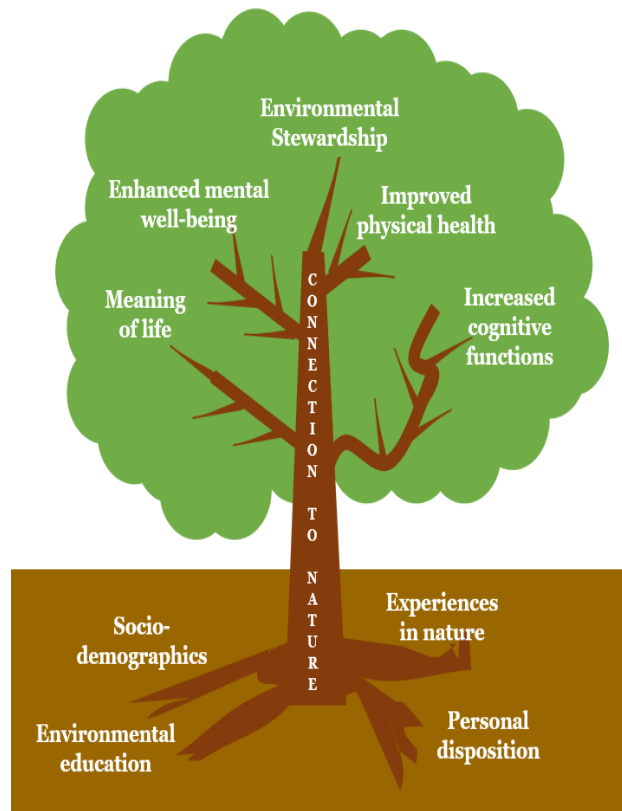
- Time spent outdoors
- Normative influences
- Youth exposure to nature
- Outdoor recreation interests
- Proximity to green space

Environmental education

- Awareness of environmental issues
- Understanding of the natural world

Personal disposition

- Biocentric value orientations
- Beliefs towards conservation
- Attitudes regarding nature
- Guardian interest in nature



OUTCOMES

Environmental stewardship

- Conservation advocacy
- Environmental protection
- Pro-environmental behaviors

Enhanced mental well-being

- Stress-reduction
- Reduced symptoms of depression
- Promotion relaxation and a sense of tranquility
- Increased happiness and satisfaction

Improved physical health

- Reduction in blood pressure
- Boosted immune system
- Catalyst for social interactions and belonging

Increased cognitive functions

- Improved concentration and memory
- Enhanced problem-solving and creativity

Meaning of life

- Sense of purpose
- Felt awe and wonder
- Personal growth and resilience
- Motivated self-discovery

Figure 1

Influences and outcomes of a connection to nature

Note. Created and designed by Salme M. Neubert (Author).

to nature and various aspects of human well-being, including improved mental and physical health, and environmental attitudes and stewardship behaviors.

Leopold's (1966) land ethic initiated an exploration, and continuing discussions, about how humans are connected to nature and the associated implications. The land ethic is a recharacterization of the role of humans in nature "from conqueror of the land community to plain member and citizens of it" (Leopold, 1966, p. 240) and has prompted a sizeable amount of literature being contributed to the investigation of connection to nature. Leopold (1966) emphasized the need for individuals to feel connected to nature as members of the natural environment to form a feeling of responsibility to engage in conservation behavior. Early research in this area also draws from E.O. Wilson's (1984) biophilia hypothesis, which posits that humans possess an innate drive to affiliate with other living organisms and view natural systems as an adaptive outcome of evolution.

Expanding on Leopold's (1966) work, Tanner (1980) and Peterson and Hungerford (1981) attempted to identify formative experiences contributing to individuals' 'environmental sensitivity'. Their landmark results showed a complex pathway centering connection to nature including affective, cognitive, and behavioral components. Following this logic, Mayer and Frantz (2004) found empirical support for the idea that "if people feel connected to nature, then they will be less likely to harm it, for harming it would in essence be harming their very self" (p. 512). Their conceptualization of connectedness to nature is one's "affective, experiential sense of oneness with the natural world" (p. 504). Focusing on intentions to engage with the natural world, Hinds and Sparks (2008) found that "the more one has an affective connection with the natural environment, the greater one's intentions to engage with it" (p. 115) and engagement is correlated with environmental stewardship.

The body of literature on connection to nature has developed in an interdisciplinary manner, drawing from fields such as environmental psychology, conservation psychology, and public health (Schultz, 2002; Scannell & Gifford, 2017). As a result, this concept has been conceptualized and operationalized in diverse, yet related, ways, collectively aiming to represent an individual's relationship with the natural world. For instance, some studies examine the construct of 'nature connectedness', whereas others investigate the concept of 'connection with nature' (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Richardson et al., 2019; Sobko et al., 2018). Related concepts have also been referred to as 'biophilia' (Wilson, 1984; Rice & Torquati, 2013), affinity with the biosphere (Giusti et al., 2014), environmental perceptions (Larson et al., 2011), implicit association with nature (Bruni & Schulz, 2010), and emotional affinity with nature (Mayer & Frantz, 2004). Furthermore, scholars have explored terms such as ecological consciousness (Dunlap & Van Liere, 1978), environmental consciousness (Dunlap & Van Liere, 1978), nature attachment (Scannell & Gifford, 2010), ecopsychology (Roszak, 1995), environmental empathy (Schultz, 2000), ecocentrism (Naess, 1989), nature affinity (Zelenski et al., 2015), environmental identity (Clayton, 2003), eco-spirituality (Swinton, 2002), and naturalistic worldview (Kahn, 2002). While scholars utilize slightly different terminology, the underlying principle of an individual identifying with the non-human environment remains consistent. For this research, connection to nature is understood comprehensively as one's perception of relationship with the natural world, regardless of specific semantic framings found within the literature.

While some research has defined connection to nature to include both cognitive and non-cognitive dimensions, this multi-dimensional conceptualization has not been consistently applied. The cognitive dimension relates to an individual's mental representations and attitudes

about nature (Schultz, 2022). Schultz (2002) defines it as “the extent to which an individual includes nature within his/her cognitive representation of self” (p. 67). The non-cognitive, or affective, dimension refers to one’s feelings of kinship and affiliation with the natural world (Mayer & Frantz, 2004).

These varied conceptualizations of connection to nature have also led to inconsistent measurement approaches. For example, the “Connectedness to Nature Scale” was designed to specifically evaluate people’s affective sense of bonding, or sense of kinship, with nature (Mayer & Frantz 2004). Meanwhile, the “Nature Relatedness Scale” comprises cognitive, affective, and experience-based subscales (Nisbet et al., 2009). Specifically, it includes a self-factor (i.e., an internalized identification with nature), a perspective factor (i.e., reflecting an external related view of nature), and an experience factor (i.e., reflecting a physical connection to the natural world). However, not all scales incorporate all three dimensions, which highlights the need for more research to justify including all three, particularly the non-cognitive dimension.

In all, there are at least 17 different scales measuring connection to nature (Whitburn et al., 2020; Tam, 2013), and survey items within these scales reflect at least one of the four interrelated dimensions of connection to nature (Table 1): cognitive functions (i.e., knowledge, attitudes, and beliefs about nature), non-cognitive functions (i.e., emotions and feelings toward nature), environmental stewardship (i.e., actions that help protect or conserve the environment), and well-being (i.e., mental and physical health; subjective happiness). Despite the diversity in

<i>Concept</i>	Definition	Example
<i>Connection to nature</i>	Subjective experience of feeling connected to the natural world	Sense of oneness with nature; Kinship with other species

<i>Cognitive functions</i>	Knowledge, attitudes, and beliefs about the environment	Environmental awareness; Knowledge of sustainability issues
<i>Non-cognitive functions</i>	Emotions and feelings towards nature	Awe of vistas; Love of nature; Empathy for other species
<i>Environmental stewardship</i>	Actions that help conserve or protect the environment	Recycling; Political activism; Conserving energy/water
<i>Well-being</i>	Mental and physical health; Subjective happiness	Lower stress, Higher life satisfaction; Better sleep

Table 1

Concepts, Definitions, and Examples

measurement approaches, there's a notable gap in studies that addresses how more than two dimensions interact.

This underscores the need for future research to bridge this divide and cultivate a more holistic understanding of connection to nature. Furthermore, insights gleaned from studies highlighting significant life experiences impacting this connection also serve as catalysts for further inquiry, propelling us toward a deeper comprehension of our relationship with the natural world (Chawla, 1999; Palmer, 1993; Sward, 1999). The quest for valid measurement tools remains an enduring challenge, given the intricate interdisciplinary foundations underlying connection to nature research (Mayer & Frantz, 2004; Nisbet et al., 2009).

Connection to nature and mental pathways

Connection to nature incorporates both cognitive and non-cognitive pathways (Mayer & Frantz, 2004; Nisbet et al., 2009). The cognitive pathway refers to intellectual representations and understandings of the natural environment, involving conceptual knowledge about ecological relationships and humanities role within the biosphere (Schultz, 2002). Cognitive dimensions are important to assess because accurate understanding of complex environmental issues can enable informed decision-making and participation in environmental stewardship.

When considered a values-based attitude (Brugger et al., 2011), connection to nature has qualities like a personality trait or value trait, from a psychological perspective, in that it differs between individuals and groups, is relatively stable over time, and transcends different situations (Mayer & Frantz 2004; Nisbet al. 2009). However, somewhat counter to this, some scholars have suggested that when connection to nature is treated as an attitudinal concept, it can be influenced and change. It can be considered a state of being or feeling that can be increased or decreased in the short-term, for example, through exposure to nature (Mayer et al., 2009) and may change with long-term or repeated exposure (Schultz & Tabanico, 2007).

The non-cognitive pathways encompass affective dimensions like feelings of kinship and identity-based affiliation towards nature (Mayer & Frantz, 2004). It involves an “individuals experiential state of connection with nature” (Mayer & Frantz, 2004, p. 4), rather than a purely intellectual assessment. It encompasses feelings of oneness, belonging, and caring toward the natural world (Mayer & Frantz, 2004). Strong non-cognitive bonds can satisfy basic psychological needs for competence, autonomy, and relatedness in biophilic ways (Ryan & Deci, 2000). Some research suggests that these emotion-based bonds may be stronger drivers of conservation-related behaviors over the long term compared to cognitive factors (Zylstra et al., 2014). Connection at this level is also associated with improved well-being through stress reduction and restoration from mental fatigue in natural settings (Mayer et al., 2009; Bratman et al., 2015).

Connection to nature and environmental stewardship behavior

Connection to nature is integral in fostering pro-environmental behaviors (Ernst & Theimer, 2011; Mayer & Frantz, 2004). Pro-environmental behaviors refer to actions taken by individuals or groups that positively contribute to environmental protection and conservation

efforts, including but not limited to energy and water conservation, waste reduction, sustainable consumption, anti-consumerism, donating to environmental organizations, political activism, and support for environmental policies (Soga & Gaston, 2016; Steg & Vlek, 2009; Stern et al., 2019). Collectively, pro-environmental behaviors contribute to environmental stewardship by promoting sustainable practices and encouraging collective responsibility for the protection and conservation of natural resources. Environmental stewardship refers to responsible and ethical management, protection, and conservation of natural resources and ecosystems for the benefit of present and future generations. It encompasses a range of practices and behaviors, including sustainable resource use, pollution prevention, habitat restoration, and advocacy for environmental policies and regulations. It reflects a commitment to preserving the health and integrity of the natural world, promoting environmental justice, and ensuring the sustainability of human societies in harmony with the Earth's ecosystems. Environmental stewardship involves making informed decisions and taking proactive actions to minimize environmental degradation. Research has consistently shown a positive and significant relationship between individuals' connection to nature and their engagement in environmental stewardship (Whitburn et al., 2020; Howell et al., 2011; Nisbet et al., 2009).

Two key meta-analyses have provided important insights into how connection to nature relates to environmental stewardship behaviors. Whitburn et al. (2020) conducted the most comprehensive meta-analysis to date focusing specifically on the link between connection to nature and environmental stewardship. Their search yielded 94 independent samples from 79 published papers, representing over 31,000 participants. Connection to nature was operationalized using 14 different measurement scales tapping mixed cognitive and non-cognitive dimensions. Environmental stewardship was assessed through both single items and

multidimensional scales across domains like conservation, activism, anti-consumerism, and charitable donations. Notably, Whitburn et al. (2020) observed significant heterogeneity in effect sizes across samples, warranting further exploration of potential moderators.

Whitburn et al. (2020) found that the relationship between connection to nature and pro-environmental behaviors was positive, significant, and moderately sized ($r = 0.42, p < .05$). The positive relationship was robust, holding when moderated by geographical region, sex, and age of participants. Scales encompassing affective, cognitive, and behavioral facets also showed stronger associations compared to solely cognitive or affective tools. For instance, Howell et al. (2011) found that individuals with a stronger connection to nature reported higher levels of pro-environmental behaviors, such as recycling and reducing energy consumption. Similarly, Nisbet et al. (2009) demonstrated that people who feel more connected to nature tend to exhibit greater concern for the environment and are more likely to engage in actions to protect it. Steg and Vlek (2009) highlighted the importance of psychological factors such as attitudes, values, beliefs, and norms in shaping pro-environmental behavior. Specifically, individuals' perceptions of environmental issues and their sense of personal responsibility significantly influence their willingness to adopt environmentally friendly behaviors. Martin et al.'s (2020) meta-analysis additionally supports that a stronger connection to nature is associated with greater adoption of pro-environmental behaviors and identified several strategies that are effective in fostering environmentally sustainable actions, such as environmental education programs, social norm interventions, and the provision of incentives or feedback.

Pro-environmental behaviors have been measured with at least eight different scales, including multidimensional latent constructs of self-reported pro-environmental behaviors, single-dimensional self-reported pro-environmental behaviors, and observed pro-environmental

behaviors (Whitburn et al., 2020). The meta-analysis revealed that multidimensional scales measuring several domains of pro-environmental behaviors had the strongest association with connection to nature. Multidimensional scales contained items that measure pro-environmental behaviors in the areas of energy and water conservation, waste avoidance, and recycling, transport, purchasing, self-education, and social or political actions in various combination (Whitburn et al., 2020). Since people do not consistently engage with a wide range of pro-environmental behaviors, and some behaviors (e.g., recycling) require less effort than others (e.g., political activism or using public transport), these multidimensional scales may capture a more realistic picture than measuring a single, specific behavior (Whitburn et al., 2020). In addition, multidimensional scales can reduce measurement error and thereby produce more generalizable results (Epstein, 1983; Kirkpatrick, 2003).

In the same meta-analysis, multidimensional scales for measuring connection to nature, including affective and behavioral or affective, behavioral, and cognitive dimensions, had the strongest association with pro-environmental behaviors (Whitburn et al., 2020). In contrast, single-item, cognitive scales had one of the lowest associations with pro-environmental behaviors, indicating that the distinction between cognitive and non-cognitive scales may be important. This suggests that addressing participant knowledge and beliefs alongside building an emotional and experiential connection to nature may, thus, be required in interventions to motivate greater environmental stewardship.

The meta-analysis suggests positive connectedness to nature relates meaningfully to environmental stewardship intentions and actions. Moreover, certain contextual and methodological nuances like operationalization choices significantly shaped linkage strengths across comparative research efforts. The results emphasize holistic conceptualization and

assessment of both predictor and outcome constructs. Overall, Whitburn et al.'s (2020) quantitative synthesis represented an indispensable step in clarifying and verifying theoretical connections proposed between meaningful relationships with nature and sustainable conservation behaviors.

Connection to nature and human well-being

Meta-analyses conducted by Whitburn et al. (2020) and Capaldi et al. (2014) suggest a close connection with nature is universally beneficial for both environmental and human well-being. Capaldi et al. (2014) focused on quantifying the impact of connection to nature concepts specifically on human well-being indicators. Their research identified 20 independent samples comprising 4,025 total participants. Connection to nature was significantly associated with small but meaningful increases in self-reported vitality, life satisfaction, and positive affect. These findings complement the stewardship behavior results by suggesting psychological benefits may motivate environmental concern through more positive emotional states.

Capaldi et al. (2014) found a relationship between connection to nature and happiness, and Whitburn et al. (2020) found that connection to nature had a positive association with vitality and life satisfaction. Capaldi et al. (2014) also observed substantial heterogeneity in effect sizes mirroring Whitburn et al.'s (2020) stewardship behavior analysis. Bratman et al. (2012) demonstrated in their meta-analysis that nature experiences substantially enhance cognitive function and mental health, thereby contributing to overall well-being. Furthermore, a meta-analysis by Pasanen et al. (2018) highlighted the beneficial effects of nature exposure on reducing stress and improving emotional well-being. Collectively, these meta-analyses provide compelling evidence for the positive impact of nature engagement on human well-being, highlighting its potential as a tool for enhancing humans' mental and physical well-being.

Together, the two meta-analyses also suggest contextual and demographic sensitivities shaping connection to nature's impacts which warrant nuanced methodological considerations.

Generally, individuals who engage in more outdoor activities report higher levels of connection to nature (Mayer & Frantz, 2004). Childhood and adolescent experiences in natural settings play a pivotal role in shaping an individual's connection towards the natural world, and early and frequent exposure to nature is positively associated with a stronger connection to nature later in life (Collado & Staats, 2016). The duration and quality of outdoor experiences during youth play a vital role in shaping individuals' attitudes, values, and behaviors towards nature (Chawla, 2006). Therefore, encouraging children and adolescents to spend time outdoors is essential for nurturing a lifelong connection to nature, which can have profound implications for their well-being and environmental conservation efforts. Exploring the benefits of spending time in nature, exposure to nature, and frequency of outdoor activities illuminates the power a connection to nature has on human well-being.

Mental well-being

Engagement with natural environments can yield a multitude of mental health benefits, ranging from stress reduction and improved sleep to enhanced mood and cognitive function (Ulrich, 1984; Kaplan, 2001; Berman et al., 2008). Individuals who feel connected to nature experience lower levels of stress and anxiety due to increased feelings of tranquility and relaxation (Bratman et al., 2015). This sense of connection fosters positive emotions such as happiness and contentment (Capaldi et al., 2014), while also enhancing cognitive abilities such as attention and creativity (Atchley et al., 2012). A connection to nature encourages mindfulness, allowing individuals to be present and appreciate the beauty of natural surroundings, which in turn reduces rumination and promotes emotional well-being (Bratman et al., 2015). Additionally,

a strong connection to nature has been associated with increased resilience to stress, helping individuals cope more effectively with life's challenges (McMahan & Estes, 2015). These aspects of well-being can be influenced by one's perception of nature and their sense of connection to it, rather than exclusively from the act of being outdoors. These findings underscore the profound impact connection to nature has on mental well-being, highlighting the importance of nurturing this relationship for overall psychological health.

Since spending time in nature also fosters a connection to nature, the benefits of both are intertwined. Exposure to nature and time spent outdoors can foster empathy, generosity, and other pro-social behaviors that contribute to overall mental well-being (Mayer et al., 2009; Zelenski et al., 2015). Moreover, spending time in natural settings has been associated with reduced mental fatigue, improved attention, and enhanced cognitive performance (Kaplan, 2001; Bratman et al., 2012; Berman et al., 2008; Berto, 2005; Hartig et al., 2014), all of which are crucial for mitigating the risk of depression, particularly when exacerbated by sleep problems and chronic stress (Grigsby-Toussaint et al., 2015; Hammen, 2005). The positive correlation between nature exposure and reduced incidence of various mental disorders has been supported with moderating factors such as socioeconomic status, sex, and age influencing these outcomes (Astell-Burt et al., 2014; Roe, 2016; Gascon et al., 2015; Van den Berg et al., 2016).

Empirical investigations have employed diverse study designs ranging from experimental to observational to elucidate the associations between time spent in nature and well-being. These include increased positive affect, happiness, subjective well-being, positive social interactions, and a sense of meaning and purpose in life (Bowler et al., 2010; White et al., 2013; Orban et al., 2017; Jennings & Bamkole 2019; O'Brien, 2011). White et al. (2013), for example, found that individuals who spent more time in natural environments exhibited higher levels of happiness

and subjective well-being compared to those with limited exposure to nature, highlighting its significance for psychological flourishing. Kaplan's (2001) attention restoration theory posits that spending time in natural environments replenishes cognitive resources, leading to improved attention and reduced stress levels. Additionally, Orban et al. (2017) discovered access to green spaces was associated with increased social cohesion and engagement within communities, underscoring social benefit. Longitudinal and experimental research has also underscored the mental well-being of nature experiences. For example, Dadvand et al. (2015) reported exposure to green spaces was associated with better cognitive development in children, including improved working memory and attention span. Similarly, Kahn and Kellert (2002) demonstrated nature-based experiences promoted imagination and creativity in children, providing further evidence of the cognitive advantages of nature engagement.

Physical well-being

Emerging scholarly inquiries suggest that the benefits of nature extend beyond these domains, manifesting significant enhancements in physical health and well-being as well. Individuals who immerse themselves in natural settings often engage in outdoor recreational pursuits such as hiking, camping, swimming, birdwatching, and gardening (Hartig et al., 2014). These activities not only provide direct exposure to nature but also promote regular physical activity, which is associated with a plethora of health benefits (Hartig et al., 2014). Kahn et al. (2002) found that adolescents who reported feeling emotionally connected to nature engaged in more physical activity and had lower rates of obesity. Regular engagement in outdoor activities contributes to enhanced cardiovascular health, weight management, augmented muscle strength, and a reduced risk of chronic conditions such as heart disease, diabetes, and obesity (Keniger et al., 2013).

Further investigations have contributed to a burgeoning body of literature highlighting a myriad of physiological advantages associated with exposure to natural environments. These include augmented immune function, as evidenced by heightened levels of natural killer cells and anti-cancer proteins (Li et al., 2008), as well as notable reductions in blood pressure (Hartig et al., 2003), improvements in sleep quality (Gaston et al., 2013; Grigsby-Toussaint et al., 2015), and heart rate variability (Orban et al., 2017). Moreover, Ulrich's seminal study in 1984 demonstrated that hospital patients with views of nature from their windows had faster recovery times and required less pain medication compared to those with views of urban scenes. Dadvand et al. (2015) found that children living in urban areas with more green spaces had a lower risk of developing asthma. By prioritizing interventions that encourage both time spent in nature and fostering a connection to the natural environment, society can promote physical well-being and cultivate a healthier populace.

Given the profound impact of nature on human well-being, the integration of nature into healthcare settings and daily routines emerges as a promising avenue for promoting comprehensive health and wellness (Grahn & Stigsdotter, 2003; Kaplan, 1995). The myriad of health benefits derived from engagement with natural environments underscores the importance of integrating nature into individuals' lives, particularly during formative years since exposure to natural settings offers a holistic approach to fostering well-being across various age groups (Ulrich, 1984; Kaplan, 1995; Berman et al., 2008; Mayer et al., 2009; Zelenski et al., 2015). Importantly, research consistently demonstrates that youth, in particular, stand to gain substantially from nature experiences, as these encounters not only contribute to their cognitive development but also shape their emotional and social competencies in fundamental ways (Dadvand et al., 2015; Kahn et al., 2002; Orban et al., 2017). By prioritizing nature-based

interventions and initiatives aimed at youth, society can cultivate a generation with enhanced resilience, creativity, and overall well-being, and at the same time foster a sustainable and harmonious relationship between individuals and their natural environment.

Connection to nature and youth

Even though nature connection, as a distinct topic, is a relatively new research interest, there are many indications that childhood is the ideal time to start building and developing a connection to nature (Ives et al., 2017; Kahn, 2002; Larson et al., 2011). Establishing a lifelong commitment to environmental stewardship in youth is particularly critical as forces of modernization, such as urbanization and other socioeconomic trends, evolve over time and alter the scope of the ecological crisis. Reversing the projected trajectory of continued ecological destruction must rely on (re)connecting the next generation with nature to inspire care and stewardship actions that will protect nature long-term (Kareiva, 2008; Kimbell et al., 2009; Wells & Lekies, 2006). This entails promoting opportunities for positive experiences in nature and intervening early in the lifespan to foster those experiences (Chawla, 2007; Nord et al., 1998; Theodori et al., 2010).

The body of existing research indicates that young people, under the approximate age of approximately 25, with more access and experiences in nature express higher levels of connection to nature (Barrable & Booth, 2020; Cheng & Monroe, 2012; Collado et al., 2013; Dornhoff et al. 2019; Giusti et al., 2014; Larson et al. 2018; Larson et al., 2019; Hansen et al., 2004; Richardson et al., 2021; Sheldrake et al., 2019; Soga et al., 2016). Later in life, those with higher levels of connection to nature are more likely to engage in more pro-environmental behaviors (Mackay & Schmitt, 2019; Whitburn et al., 2019; Tam, 2013; Martin et al., 2020; Richardson et al., 2019) and report having interacted frequently with nature during childhood

(Cleary et al., 2018; Fretwell & Greig, 2019; Guiney & Oberhauser, 2009; Pensini et al., 2016; Rosa et al., 2018; Tam, 2013; Windhorst & Williams, 2015; Wood & Smyth, 2020). Therefore, building a connection to nature in youth is likely associated with environmental stewardship throughout the lifespan. In fact, one of the most frequent research findings in the connection to nature literature is that people with a record of environmental stewardship also report regularly engaging with nature in childhood and adolescence (Chawla & Derr, 2012; Wells & Lekies, 2012). Children and adolescents with higher levels of connection to nature also show greater environmental knowledge (Cheng & Monroe, 2012; Otto & Pensini, 2017) and greater willingness to make commitments to conserving nature (Giusti, 2019; Zhang et al., 2014).

Ethnographic accounts show when children are outdoors in nature, they are simultaneously connecting with nature and learning about the natural world; and when people around them encourage empathy and care for plants, animals, and their habitats, children exhibit pro-environmental emotions and behaviors (Green, 2018; Humphreys & Blenkinsop, 2018; Pelo, 2018). Thus, time in nature during youth, and the examples set by role models who show an interest in nature, are key variables predisposing individuals to build a connection with nature and work to inspire the protection of nature (Chawla & Cushing, 2007; Louv, 2008; Wells & Lekies, 2006).

Studies suggest that outdoor programs with young children should emphasize learning to love nature, feel comfort immersed in it, and enjoyment in nature to build a connection (Sobel, 1996; Wilson, 2018). The cultivation of enjoyment in nature appears to be a consistent theme across different age groups in youth (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Giusti et al., 2014; Müller et al., 2009; Rice & Torquati, 2013; Richardson et al., 2019; Sobko et al., 2018). This pattern is evident in cross-cultural samples that, together, cover ages seven to

twenty-one, coming from the United Kingdom (Hughes et al., 2019; Richardson et al., 2019), Germany (Liefländer et al., 2013), Canada (Crawford et al., 2017; Krettenauer, 2017; Krettenauer et al., 2019; Michaelson et al., 2020), the United States (Larson et al., 2017) and China (Krettenauer et al., 2019).

A steadily growing body of research demonstrates that, beyond promoting connection to nature and environmental stewardship, having nearby access to nature benefits youth in several areas of their lives. When children have green-spaces around their homes, schools, and neighborhoods, it promotes their physical and mental well-being in addition to promoting cognitive performance (Chawla, 2015; Kuo et al., 2019; McCormick, 2017; Norwood et al., 2019; Tillman et al., 2018; Vanaken & Kanckaerts, 2018). Further, studies have found that youth who express a greater connection to nature report fewer psychological concerns, such as depression, irritability, nervousness, and sleep difficulties (Piccininni et al., 2018). Cross-cultural research suggests that these benefits from connection to nature in youth may be rather universal as well. For example, among 9-12-year-olds in Mexico (Berrera-Hernández et al., 2020), 10-11-year-olds in England (Richardson et al., 2019), and 11-12-year-olds in Australia (Whitten et al., 2018), children who expressed higher levels of connection to nature also reported a greater sense of well-being. The English children reported better overall health as well. These findings are also consistent with research on adult subjects that has found higher levels of nature connection associated with greater subjective well-being, positive emotions, and relief from stress (Capaldi et al., 2014; Cervinka et al., 2011; Dean et al., 2018; Mayer et al., 2009).

Among 11-14-year-olds, higher levels of connection to nature have additionally been shown to be positively correlated with five advantageous areas of youth development: self-reported measures of competence, confidence, social connections with other people, caring

behaviors, a sense of taking responsibility, believing in a hopeful future, and living by positive principles and values (Larson et al., 2017). These findings have been corroborated by other research showing that youth connection to nature may be associated with more progressive environmental and social values (Eames et al., 2018), as well as pro-social behaviors that are negatively correlated with peer conflicts and conduct problems (Sobko et al., 2018).

Unfortunately, children are losing opportunities for direct encounters with nature, which, as this research as a whole suggests, could have negative consequences for their health as well as their motivation to protect the environment. Low childhood levels of nature connection relate to more sedentary time spent inside and more hours watching television, playing digital games, and following social media, which are associated with physical health risks (Bruni & Schultz, 2010; Larson et al., 2019; Michaelson et al., 2020).

Measurement shortcomings in youth samples

Children's lived experience in nature and their connection, knowledge, empathy, and responsible action towards nature co-develop, but by separating, defining, and measuring these constructs separately, it becomes possible to explore the relationships between them. While a solid body of research on connection to nature in adult populations has emerged, such research among youth samples is comparatively limited. Findings from a Connection to Nature Workshop in 2018 revealed, for example, that only ten measures of connection to nature commonly reported in the literature were used in studies involving children, covering ages two to nineteen (Chawla, 2020).

Interdisciplinary literature contains insights relevant to this study and to understanding young people's connection with nature; through surveys, written narratives, and interviews, research has investigated the lifespan pathways of people who take action for the environment,

demonstrating the importance of early childhood experiences in nature. Relationships with nature in childhood and youth have been explored quantitatively and qualitatively through literature that crosses poetry, fiction, autobiography, geography, anthropology, psychology, education, environmental design, and the study of children's spirituality (Kahn & Kellert, 2002). However, a comprehensive view of connection to nature among youth, encompassing a full range of cognitive and non-cognitive elements and their influence on environmental stewardship, is currently lacking.

In sum, meta-analyses reliably substantiate connection to nature's positive associations with conservation behavior and human well-being (Figure 1), though relationships are intricate and demand appreciation of contextual and methodological complexities. Quantitative syntheses represent critical steps toward clarifying theoretical mechanisms and optimizing measurement practices, each crucial prerequisites for effectively cultivating meaningful nature relationships through applied interventions. Ongoing meta-analytic work can continue to refine our understanding of connection to nature's benefits at both individual and collective levels. This study aims to contribute to that body of literature.

Gaps in literature

A review of the relevant literature identified some important gaps in understanding the relationship between connection to nature and environmental stewardship behaviors. As noted by Manfredo (2008), the strong reliance on cognitive measures of constructs such as attitudes, knowledge, and beliefs in much of the past research on social science applications in conservation has left the affective and experiential dimensions of concepts like nature connection relatively unexamined. Scholars are calling for a broader systems approach considering factors

beyond just cognitive influences on conservation behaviors (Clayton & Meyers, 2009; Manfredi et al., 2014; Manfredi et al., 2017).

Prior investigations on connection to nature have predominantly focused on either cognitive or non-cognitive aspects, but a comprehensive understanding of the concept necessitates the consideration of both dimensions. It remains unclear whether cognitive processes, affective bonds, or a combination of both play a more dominant role in affecting behaviors. Furthermore, the potential influences of momentary, yet meaningful, peak-life-experiences in nature on lifelong connections and stewardship have been identified, but not systematically measured. As noted by Clayton and Meyers (2009), the pathway impacts of affective peaks, like sensations of awe, warrant further quantitative testing to address this gap. More research is also needed to explore the influence of contextual and individual factors, such as geographic location, age, sex, and socioeconomic status, on connection to nature and its outcomes.

Study purpose

The primary purpose of this study was to empirically investigate the intricate interplay between cognitive and non-cognitive facets of connection to nature and examine their implications for fostering environmental stewardship. A better understanding of these relationships has implications for fostering a lifelong commitment to sustainability, a mission crucial for the well-being of our present and future generations as well as our ecosystems. Early in the lifespan, among youth, stands out as a pivotal time for fostering a connection to nature. By inspiring care early in life, we can set in motion a paradigm shift that holds the promise of safeguarding the natural world for generations to come. Children's lived experiences in nature and their connection, knowledge, empathy, and responsible action may co-develop, but by

defining and measuring these constructs separately, it becomes possible to explore relationships between them.

Generally, this research was guided by the following questions: (1) How can the connection to nature concept be broadened to include both cognitive and non-cognitive dimensions?; (2) How does this revised conceptualization of connection to nature influence environmental stewardship?; and (3) How effective and transferrable is this predictive model across different demographic segments, including sex and age groups, of the youth population in the U.S.? The goal from a practical standpoint was to inform ways to lay the groundwork for fostering a greater sense of environmental responsibility among future generations. This study contributes to the existing body of literature and theory around connection to nature, while also providing valuable insights for intervention efforts aimed at promoting responsible environmental behavior for the wellbeing of both humans and the environment.

Methods

Survey design

Data collection occurred via administration of a quantitative survey instrument in the spring and summer of 2017. The survey design and approach built upon that of Dr. Daniel Silvas (2013), whose dissertation established a quantitative survey instrument to measure connection to nature in children. The tools used to measure connection to nature are in their relative infancy and, as highlighted by Chawla (2020) and Silvas (2013), the measures commonly used in previous studies are often adapted from those designed for adults without sufficient consideration of developmental appropriateness for youth. The cognitive abilities and reference points of children differ markedly from older populations. By validating an existing connection to nature instrument through rigorous psychometric testing, this research will help advance the field toward a more cohesive understanding of connection to nature as a construct.

Silvas' (2013) measurement approach was validated and found reliable in his study. However, as he articulated, this study was limited due to the purposeful sampling of only 266 fifth graders from Loveland, Colorado and the Bronx, New York City. He asked in his conclusions, "Would the 10 variables [referring to the Emotional Connection to Nature Scale here] still hold if we randomly sampled fifth graders from throughout the United States?" (Silvas, 2013, p. 39). He went on to argue for the need for future research to better understand the underlying influences on connection to nature, including both non-cognitive and cognitive elements. The current study addresses this call to action, expanding the application of Silvas' measurement approach to a broader population, including several regions across the U.S., and

conducting a path analysis to more fully understand the influence of cognitive and non-cognitive dimensions of connection to nature on environmental stewardship behaviors.

Considering the multidimensional nature of connection to nature, which encompasses both cognitive and non-cognitive components, mediation analysis is essential for disentangling the complex interplay between these factors. The theoretical framework guiding this study posits that cognitive variables serve as intermediaries in translating non-cognitive factors, like emotional attachment or affective responses to nature, into behavioral intentions like environmental stewardship. Empirical support from previous research in environmental psychology indicates that cognitive factors mediate the relationship between connection to nature and environmental behaviors (Mayer & Frantz, 2004; Nisbet et al., 2009). This work underscores the importance of cognitive processes in converting affective responses to nature into tangible behavioral outcomes.

Survey administration

This study utilized a systematic multi-stage nested sampling design to obtain a representative sample of the target population of youth residing across the United States. According to the U.S. Census Bureau (2020) population estimates, approximately 74 million children and adolescents comprised the target population of interest, which was youth aged 8-18 in the United States. To capture an appropriately broad range of demographic diversity present within potential participants, a stratified cluster sampling approach was employed (Rozikov, 2020). Specifically, the target population was stratified according to essential demographic factors to categorize sampling units before a selection process occurred at multiple stages aiming to maximize accessibility of varied population segments across the sampling design.

The first stage of this multilevel sampling process involved stratifying the country into the Pacific Northwest, South, Rocky Mountains, South Pacific, Midwest, South-Atlantic, and New England Census regions, which represent immense contiguous areas characterized by distinct environmental, climatic, cultural, social, economic, and policy landscapes. This stratification methodology allowed us to, at least in part, account for substantial inter-area variations in natural surroundings as well as differences in region- and community-level sociodemographic and socio-cultural factors. Furthermore, dividing the target population according to these important geographic bounds allowed for later investigation of possible influences stemming directly from regional variation on key variables of interest to the study.

With the regions serving as a broad sampling frame, a convenience sampling technique was applied to obtain a sample of youth participants within each region. In each of the seven U.S. regions, a single school district was identified for surveying students in grades four through twelve. Established contacts from Dr. Jerry Vaske, the study's Principal Investigator, at various universities were utilized to recruit participants in the seven school districts across the regions. Contacts from the following universities participated: University of Maine, Auburn University, University of Georgia, University of Illinois, University of Arizona, Oregon State University, and Colorado State University. With proper authorization from school administrators, these contacts distributed the survey to students in schools in their region. Individuals aged eight to eighteen were targeted for inclusion in the study. For comparison purposes, participants were stratified into distinct age cohorts based on school level, namely grade school, middle school, and high school.

Measurement

The survey consisted of 22-items (Table 2) intended to measure different dimensions (i.e.,

Table 2

Measurement items

Item	Standardized factor loading	Cronbach's alpha
Cognitive factors		.926
I feel attracted to nature	.811	
I feel close to nature	.803	
I feel a strong love for nature	.795	
Being in nature is fun	.788	
I feel an emotional bond with nature	.786	
I feel interested in nature	.757	
I like being in nature	.757	
I like spending time in nature	.659	
Non-cognitive factors		.965
Calm/Worried	.912	
Awestruck/Uninterested	.897	
Happy/Sad	.886	
Relaxed/Stressed	.882	
Fascinated/Unimpressed	.876	
Love/Hate	.863	
Confident/Scared	.839	
Thrilled/Bored	.798	
Peaceful/Afraid	.769	
Comfortable/Uneasy	.762	
Environmental stewardship		.758
I am willing to pick up litter that is not mine	.783	
I am willing to volunteer to help protect nature	.696	
I am willing to ride my bike instead of having someone drive me	.593	
I am willing to take action to protect nature	.559	

cognitive, non-cognitive) of connection to nature as well as behavioral intentions (i.e., environmental stewardship) and three demographic items (i.e., age, sex, region). The *cognitive* dimension of connection to nature was measured using the Attitudes Toward Nature (ATN) scale

from Silvas (2013), which was adapted from Perkins (2010) Love and Care scale. Attitudes are psychological tendencies characterized by individuals' evaluations of specific entities with varying degrees of favor or disfavor, influencing their behaviors towards the object in question, in this case nature (Manfredo, 2008; Fishbein & Ajzen, 2011). The ATN scale consists of a series of items measured on a 5-point Likert scale ranging from “strongly disagree” (-2) to “strongly agree” (+2) (Table 2). A score closer to 2 indicated a positive attitude toward nature, whereas a score closer to -2 reflected a negative attitude toward nature.

The *non-cognitive* dimension of connection to nature was measured using the Emotional Connection to Nature Scale (ECNS), a semantic differential scale developed by Silvas (2013). This measure was influenced by The Connection to Nature Scale (CNS) developed by Mayer and Frantz (2004), which not only captures individuals' affective responses but also delves into the nuanced intricacies of their emotional bonds with the natural world. According to the ECNS, those who hold positive feelings towards nature, such as happiness, will likely experience and exhibit a more positive ‘emotional disposition’ towards nature. In contrast, those who do not hold a connection to nature, or evaluate nature negatively, may express a negative emotional disposition, such as fear and boredom, while in nature (Silvas, 2013). Characterized by subjective feelings and physiological arousal, emotions influence individuals' attitudes and decision-making processes, ultimately driving their engagement in conservation activities (Stern & Guagnano, 1995; Manfredo, 2008).

Only words referring to an ‘Emotional State’ according to the Affective Lexicon (Ortony et al., 1987) were selected for inclusion in the ECNS scale. The Affective Lexicon consists of words that have a true emotional reference and fit the form of “I feel *x*.” For example, this could be structured as “I feel love” or “I feel hate;” however, the statement “I feel part of nature”

would not be considered an emotional response, but rather a cognitively based attitude. Notably, the ECNS scale also relates to the Inclusion with Nature Scale (Schultz, 2001), which is conceptually related but not the same, as it focuses more on the cognitive dimension of connection to nature. The Inclusion with Nature Scale, proposed by Schultz (2001), emphasizes perceptions of integration and unity with the environment. While both scales offer valuable insights into human-environment relationships, the ECNS provides a more nuanced exploration of individuals' emotional responses, enriching our understanding of the intricate interplay between emotions and nature engagement (Mayer & Frantz, 2004). The ECNS scale consists of a series of items measured on a 5-point response scale ranging from “very” (+2) to “somewhat” (0) to the opposing “very” (-2) (Table 2). An example would be, “When in nature, I feel... very happy” or, “When in nature, I feel... somewhat unimpressed.” A score closer to +2 is considered very emotionally connected to nature, whereas a score closer to -2 is considered very emotionally disconnected from nature.

To measure *environmental stewardship*, we used the Willingness to Protect Nature (WPTN) scale, adapted from Silvas (2013), who drew upon Kals et al.'s (1999) Willingness for Pro-environmental Commitment scale. Respondents indicated their intentions to engage in various behaviors on a 5-point scale ranging from “strongly unwilling” (-2) to “strongly willing” (+2) (Table 2). A score closer to 2 indicates a willingness to take action to protect nature, whereas a score closer to -2 reflects an unwillingness to protect nature.

Demographic variables of interest measured on the survey included participants' age and sex, which were measured using single self-report items. We also kept track of information on participants' grade and region within the United States for comparison purposes.

Data analysis

Descriptive statistics and demographic comparisons

Descriptive statistics were calculated to summarize the data using the Statistical Package for the Social Sciences (SPSS) version 24. This involved computing mean scores, standard errors of the mean (SEMs), and standard deviations for non-cognitive factors, cognitive factors, and environmental stewardship. Specifically, means and SEMs were derived for each variable to assess central tendency and variability within the sample.

To facilitate further understanding of potential variations within the sample, descriptive statistics that compared region, age, and sex with each variable were conducted. This involved conducting an analyses of variance (ANOVA) to examine differences in cognitive and non-cognitive factors of connection to nature and environmental stewardship across different demographic groups.

Confirmatory factor analysis

A confirmatory factor analysis (CFA) was conducted in SPSS to evaluate the underlying dimensional structure of the observed variables as measured in the study. These encompassed items pertaining to non-cognitive factors, cognitive factors, and environmental stewardship. The purpose of this analysis was to validate the measurement model and ensure that the items accurately represented the intended latent constructs before proceeding to test the structural model (Hair et al., 2010).

Standardized factor loadings exceeding .40 are commonly regarded as acceptable indicators of item reliability and construct validity (Babin et al., 2010). Assessment of the CFA model's adequacy was supplemented by the evaluation of three goodness-of-fit indices, namely the Comparative Fit Index (CFI), Goodness of Fit Index (GFI), and Root-Mean-Square-Residual

(RMR). Values for the Normed Noncentrally Fit Index (NNFI) and Goodness of Fit Index (GFI) surpassing .97 signified an acceptable fit for the model (Bollen, 1989). In addition to the CFA, the reliability of each of our scales was assessed by computing Cronbach's alpha coefficients in SPSS, with values of .65 or higher deemed indicative of acceptable internal consistency (Nunnally, 1978; Vaske, 2019).

Path analysis to test for mediation

To build on Silvas' (2013) findings and investigate the interplay of cognitive and non-cognitive factors in affecting environmental stewardship, we employed a path analysis to examine potential mediation effects. While understanding the direct association between connection to nature and pro-environmental behaviors is valuable, incorporating cognitive and non-cognitive dimensions through mediation analysis offers a deeper understanding of the mechanisms at play. Specifically, we utilized the mediation analysis framework proposed by Baron and Kenny (1986) to assess how cognitive factors mediate the relationship between non-cognitive factors and environmental stewardship. This approach allows us to delineate the pathways through which these constructs interact, providing insights into the psychological processes influencing individuals' engagement in pro-environmental behaviors. Furthermore, to test the strength of the index, we applied this same approach to test for mediation across different demographic segments defined by age and sex.

According to Baron and Kenny (1986), "A given variable may be said to function as a mediator to the extent that it accounts for the relation between the predictor and the criterion" (p. 1176). Following their approach, we expected mediation to occur if the following conditions in the path analysis, consisting of a series of linear regressions, were met:

- Regression 1: the predictor (i.e., non-cognitive factors) must significantly affect the criterion, or outcome variable (i.e., environmental stewardship behaviors)
- Regression 2: the predictor must significantly affect the mediator (i.e., cognitive factors)
- Regression 3: the mediator must significantly affect the criterion when both the predictor and mediator are included in the model. Full mediation occurs when the predictor has no effect on the criterion in the third regression. Partial mediation occurs when the effect of the predictor on the criterion is less in the third regression compared to the first regression.

Results

The final sample comprised 2,107 valid responses from students across grade school (30%), junior high (32%), and high school (37%), with participants ranging in age from 9 to 17 years. Sex distribution among respondents indicated a representation of 44% females and 56% males. Each of the 7 regions included 14% of the sample population. Analysis of demographic variables demonstrated normal distributions (e.g., Shapiro-Wilk, Kolmogorov-Smirnov).

Results of the CFA demonstrated the data provided an acceptable fit to the overall structural model consisting of non-cognitive, cognitive, and environmental stewardship constructs (Table 2). Values for the Normed Noncentrality Fit Index (NNFI) and Goodness of Fit Index (GFI), were in excess of .97, indicating an acceptable fit for the model (Bollen, 1989). Finally, the Root-Mean-Square-Residual (RMR), which measures the average discrepancies between the observed and the model-generated covariances, was .02 for the equation, suggesting a close fit of the data (Church & Burke, 1994). For non-cognitive items, the standardized factor loadings ranged from .76 to .912 ($SE = .12$ -.44). The standardized factor loadings ranged from .65 to .81 ($SE = .23$ -.48) for cognitive items and from .56 to .78 ($SE = .31$ -.69) for environmental stewardship items. Additional support for combining the specific variables into scales representing their associated constructs was evident from the reliability analysis. Cronbach's Alpha values were as follows: .97 for the non-cognitive scale, .92 for the cognitive scale, and .76 for environmental stewardship (Table 2).

Descriptive statistics

The descriptive statistics (Table 3) revealed mean scores of 1.35 (SEM = .019) for non-cognitive factors, 1.52 (SEM = .014) for cognitive factors, and 1.41 (SEM = .014) for environmental stewardship.

Table 3

Descriptive Statistics

	Mean	Mode	SEM	STD
Non-cognitive factors	1.35	2	.019	.892
Cognitive factors	1.53	2	.014	.657
Environmental Stewardship	1.41	1.75	.014	.647

The findings suggest a prevailing positive inclination towards nature for both non-cognitive and cognitive dimensions. Notably, the mode for non-cognitive variables was 2, signifying predominantly strong positive feelings among participants. The mode for cognitive factors also corresponded to a score of 2. For environmental stewardship, the mode was 1.75, reflecting a slightly lower yet still positive inclination towards engaging in environmental stewardship behaviors.

These descriptive statistics generally indicate a strong connection to nature and a high level of willingness to engage in environmental stewardship behaviors among the sampled participants. However, further examination of age and female-male comparisons provided deeper insights into potential variations within the sample. For these demographic comparisons, a means plot was generated. A means plot is useful in visually representing the central tendency of data and elucidating any discernible patterns or trends across different groups or conditions (Healy, 2018).

Demographics and cognitive factors

A decline in mean scores for cognitive factors is observable at the age of 12 for males, where older participants manifest the highest scores (Figure 2) among both sexes. This observed

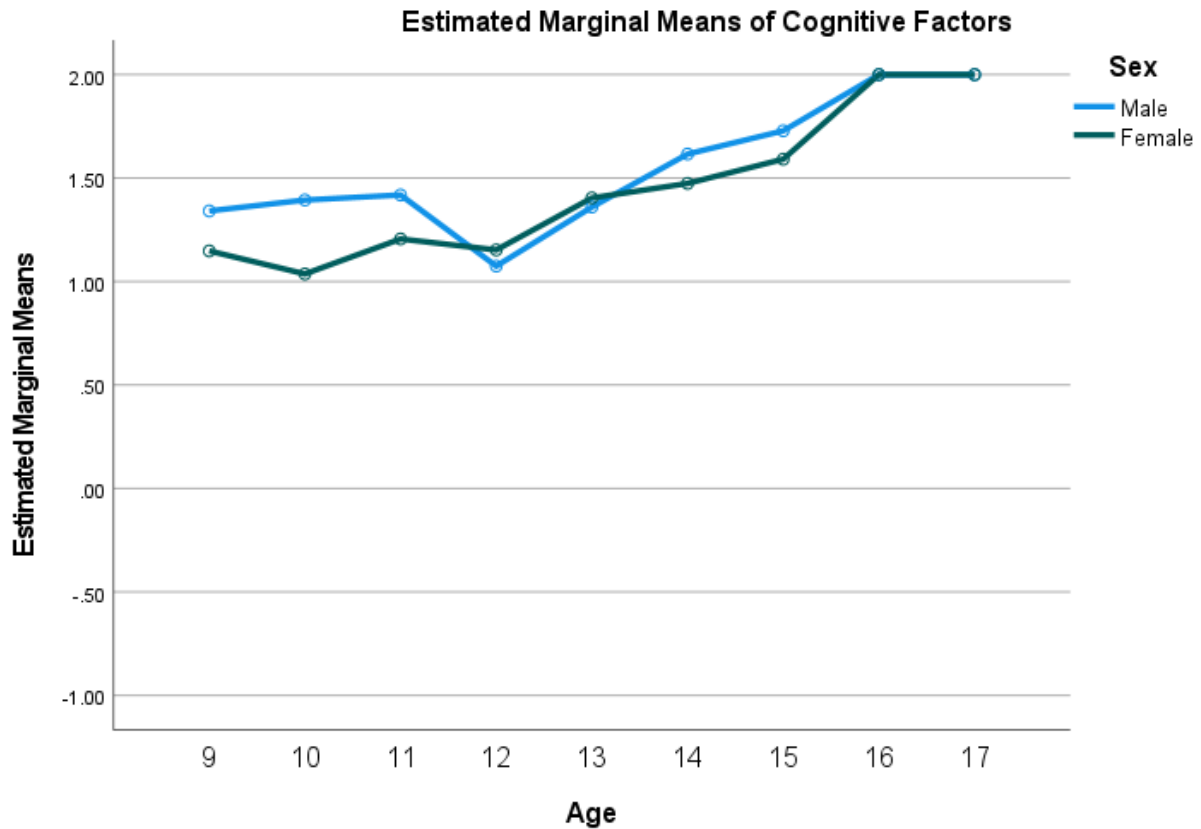


Figure 2

Cognitive factors by age and sex

pattern suggests a developmental trend, underscoring the maturation of adolescents' cognitive bond to nature with advancing age.

Demographics and non-cognitive factors

Non-cognitive factors demonstrate a distinct trajectory, as depicted in Figure 3. Here, an upward trend of mean scores is discernible, particularly from ages 10-15, indicating a

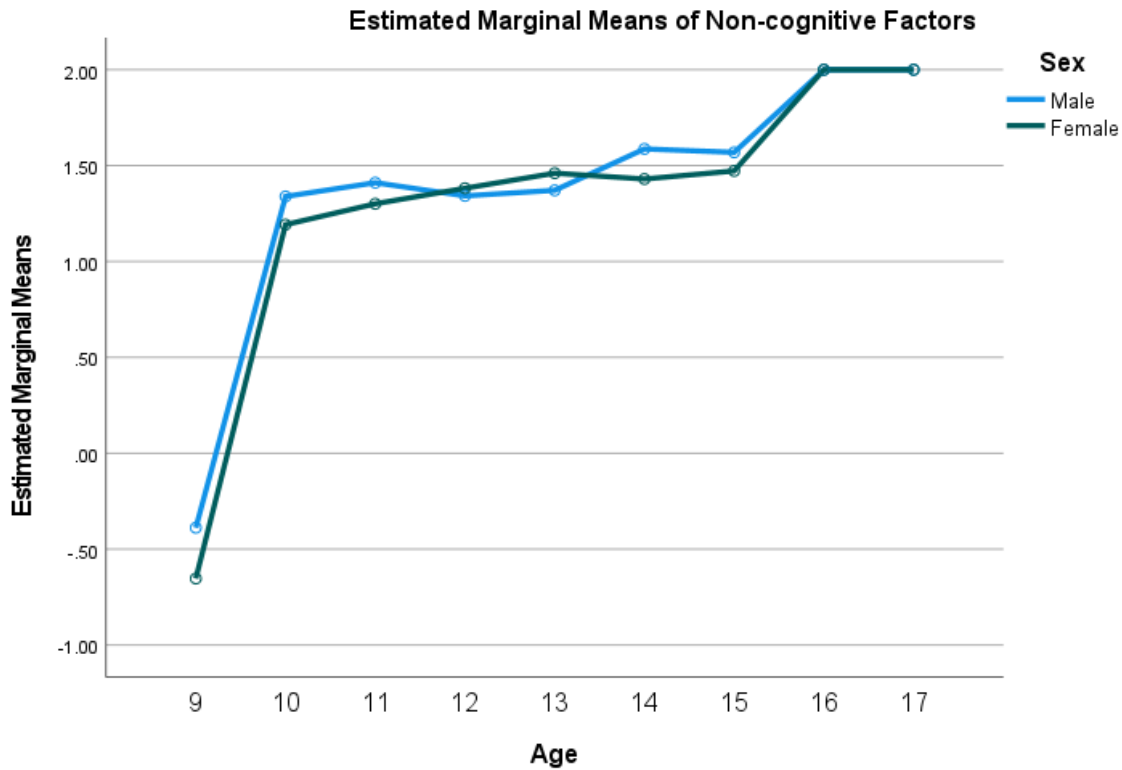


Figure 3
Non-cognitive factors by age and sex

gradual increase in the influence of non-cognitive factors on connection to nature (Brown et al., 2019). This trend suggests that at certain stages in life, non-cognitive factors may serve as a more potent predictor of environmental stewardship behaviors than cognitive factors.

Demographics and environmental stewardship behaviors

Across U.S. regions (Figure 4), no discernable differences in environmental stewardship patterns were identified among males or females, though it was slightly higher for males. All areas reported a moderately high level of willingness to engage in environmental stewardship.

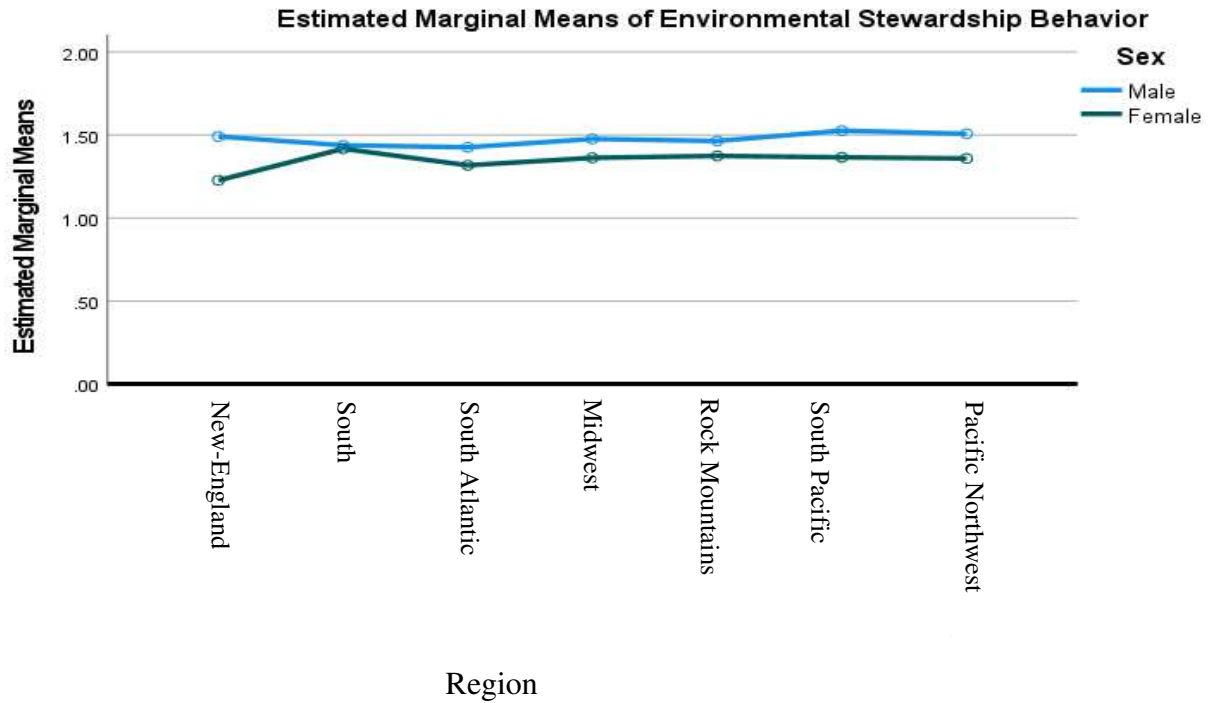


Figure 4

Environmental stewardship by region and sex

The chart depicted in Figure 5 shows the average scale scores for environmental stewardship among males and females and their behavioral intentions by age. The plot reveals a notable pattern across age groups, indicating a developmental trend in environmental stewardship engagement (Smith & Jones, 2020). Specifically, participants in the youngest age group (9-12 years) exhibited a lower mean score, suggesting a lower willingness to engage in environmental stewardship behaviors compared to their older counterparts. Conversely, older participants (above age 12) demonstrated the highest mean scores, indicating a heightened willingness to engage in environmental stewardship. These findings suggest a developmental trend, wherein individuals become increasingly engaged with stewardship as they progress through adolescence.

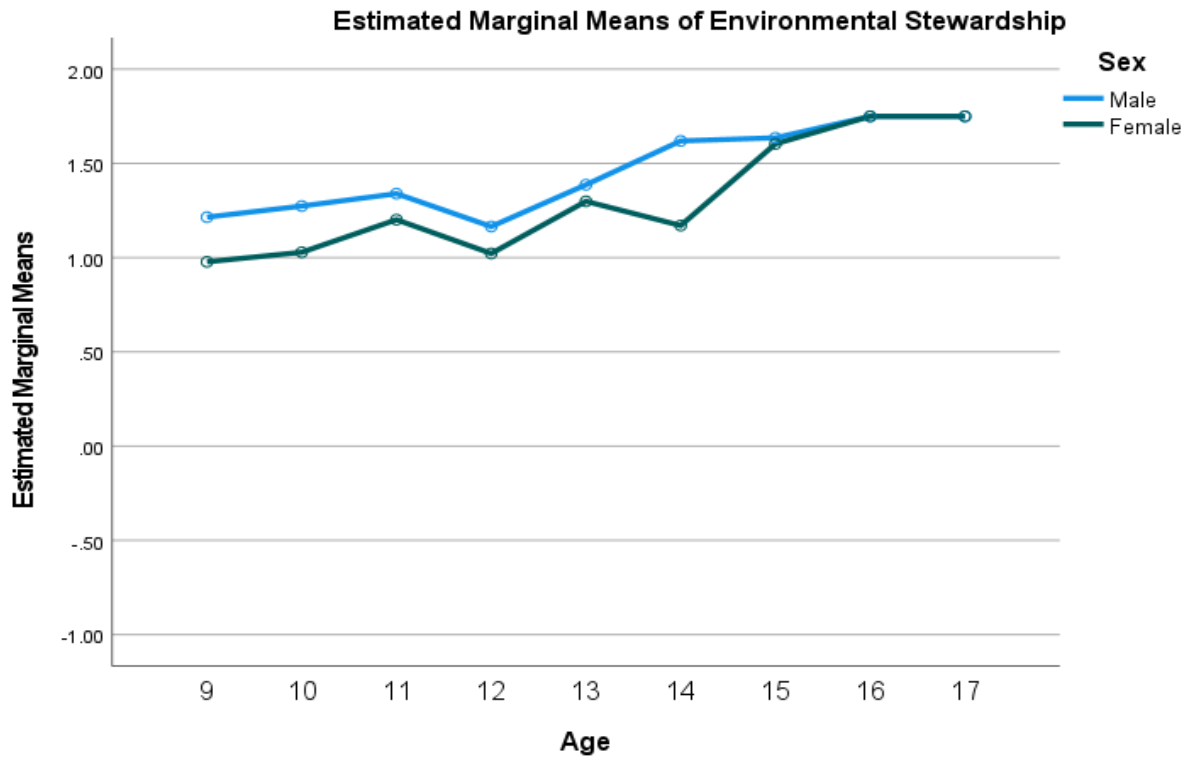


Figure 5
Environmental stewardship by age and sex

Path analysis results

Overall mediation model

Results of the path analysis to examine the effect of cognitive and non-cognitive dimensions of connection to nature on environmental stewardship behavioral intentions revealed several significant findings, consistent with theoretical predictions (Figure 6). First, a significant relationship was observed between non-cognitive factors (i.e., the predictor) and environmental stewardship (i.e., the criterion) (Regression 1: $\beta = .36$; $R^2 = .13$; $p < .001$). Second, a significant relationship was found between non-cognitive factors and cognitive factors (i.e., the mediator) (Regression 2: $\beta = .46$; $R^2 = .21$; $p < .001$). Third, a significant relationship was found between cognitive factors and environmental stewardship when both cognitive ($\beta = .62$) and non-

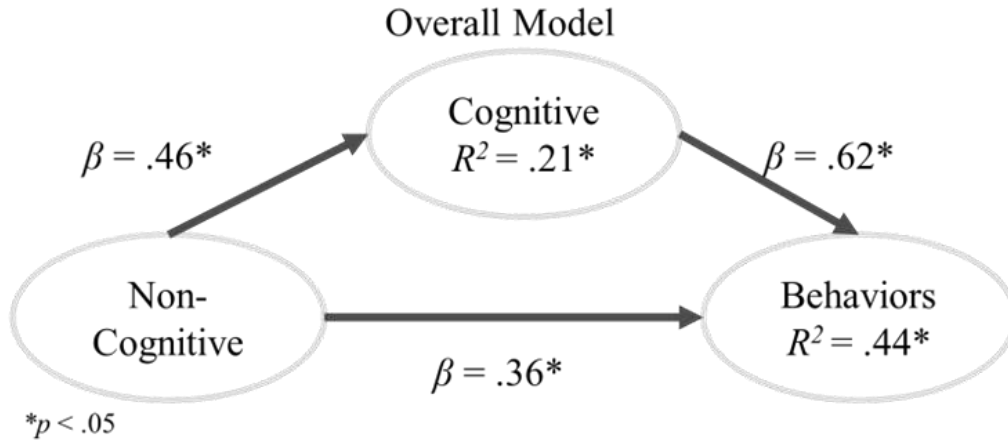


Figure 6

Overall Mediation Model

cognitive ($\beta = .08$) factors were included in the model (Regression 3: $R^2 = .44$; $p < .001$).

Together, the two dimensions of connection to nature explained 44% of the variance in behavioral intentions. Because non-cognitive factors were still a significant predictor in the third regression, and the beta for non-cognitive factors is less in the third regression than the first, we are able to support partial mediation. The overall results of the path analysis suggest partial mediation, where cognitive factors serve as a stronger direct influence on environmental stewardship, but non-cognitive factors indirectly contribute by shaping cognitive engagement (Baron & Kenny, 1986). These findings as a whole indicate that both cognitive and non-cognitive pathways are important, but cognitive factors demonstrate a slightly stronger direct effect on behavior. This underscores the importance of integrating both cognitive and non-cognitive pathways in comprehensive models of environmental engagement.

Female-male comparisons

To assess the robustness and transferability of our overall model, it was compared across demographic groups. The model pattern remained consistent across females and males (Figure 7), with significant relationships observed between cognitive factors and environmental

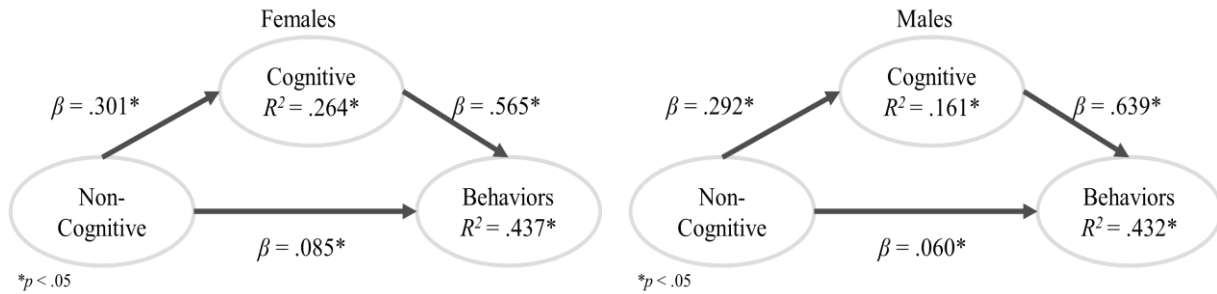


Figure 7

Female-male Comparison

stewardship for both females ($\beta = .565$; $R^2 = .44$; $p < .001$) and male participants ($\beta = .639$; $R^2 = 43\%$; $p = .001$). Among female participants, non-cognitive factors toward nature predicted both cognitive factors toward nature ($\beta = .301$; $R^2 = .26$; $p < .001$), and environmental stewardship ($\beta = .085$, $p < .001$).

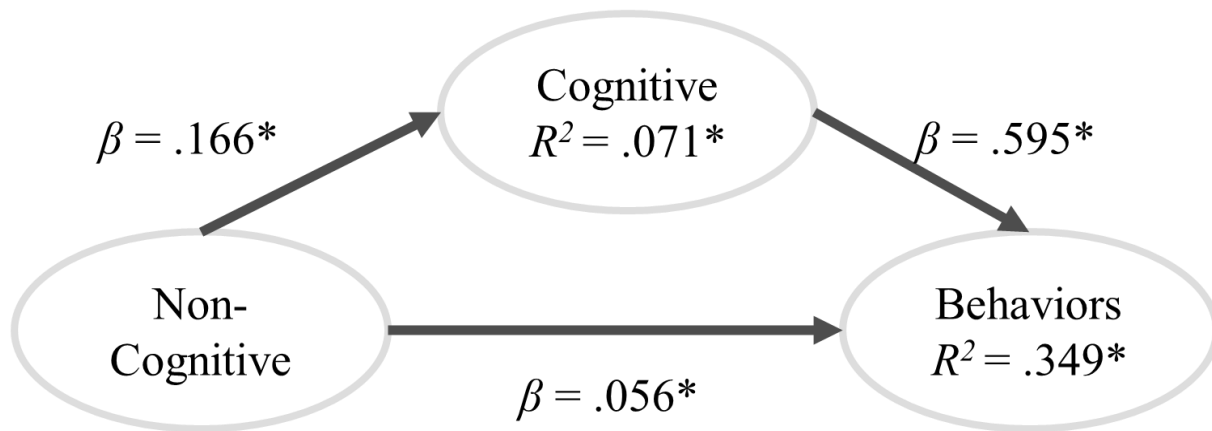
For females, non-cognitive factors have a significant, albeit weaker, direct effect on stewardship, implying that emotional and experiential connections are more likely to influence cognitive pathways first before translating into stewardship actions.

For male participants, non-cognitive factors toward nature predicted both cognitive factors toward nature ($\beta = .292$; $R^2 = .16$; $p < .001$), and environmental stewardship ($\beta = .06$, $p = .026$). Non-cognitive items and cognitive items explain 70% of the variance in environmental stewardship among females and 59% in males. This suggests that the influence of cognitive factors on environmental stewardship behaviors is consistent across females and males.

The lower effect size for non-cognitive factors among males suggests that their direct impact on stewardship is less than for females, with a stronger reliance on cognitive pathways to drive behavior. Together, cognitive and non-cognitive factors explain 70% of the variance in environmental stewardship for females and 59% for males, indicating partial mediation in both cases.

Age comparisons by grade

When examining the relationship between age groups and environmental stewardship, notable disparities emerge, shedding light on the nuanced developmental trajectories of environmental engagement. Among the youngest participants, the findings align consistently with the overarching model, as depicted in Figure 8. Specifically, a significant positive



* $p < .05$

Figure 8

Grade School Mediation Model

relationship is discerned between non-cognitive and cognitive factors and environmental stewardship ($\beta = .60$; $R^2 = .35$; $p < .001$). Non-cognitive factors directed towards nature are found to predict both cognitive factors towards nature ($\beta = .17$; $R^2 = .07$; $p < .001$) and environmental stewardship ($\beta = .06$; $p = .012$).

A small but significant direct effect indicates partial mediation, with non-cognitive factors contributing indirectly through cognitive pathways. These outcomes provide compelling evidence that non-cognitive factors exert a direct influence on environmental stewardship from as early as 9 years of age. Taken together, non-cognitive and cognitive factors jointly explain 42% of the variance in environmental stewardship among youth in grade school.

Among older age groups, the path model transitions as participants progress through adolescence. Between middle schoolers (Figure 9), a significant association between cognitive

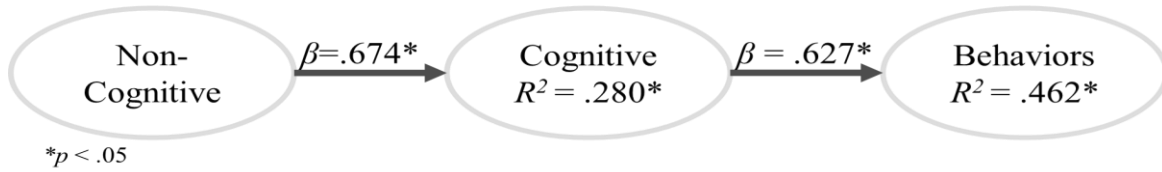


Figure 9

Middle School Mediation Model

factors and environmental stewardship emerges ($\beta = .63$; $R^2 = .46$; $p < .001$), accompanied by non-cognitive factors towards nature predicting cognitive factors towards nature ($\beta = .67$; $R^2 = .28$; $p < .001$). When accounting for cognitive factors, non-cognitive factors did not have a direct effect on environmental stewardship.

Similarly, in the high school cohort (Figure 10), participants exhibit a significant

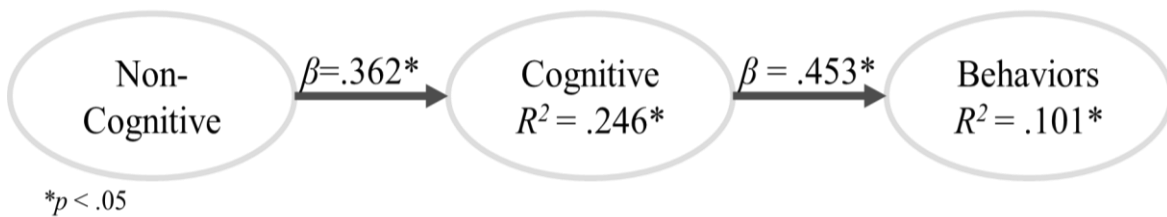


Figure 10

High School Mediation Model

relationship between cognitive factors and environmental stewardship ($\beta = .63$; $R^2 = .46$; $p < .001$) and non-cognitive items toward nature predicted cognitive items toward nature ($\beta = .67$; $R^2 = .28$; $p < .001$) but did not have a direct effect on environmental stewardship when accounting for the influence of cognitive factors.

As adolescents mature, non-cognitive factors increasingly mediate their environmental engagement by first influencing cognitive pathways, emphasizing the importance of targeting interventions at earlier stages. The transition suggests that non-cognitive factors increasingly

mediate the relationship between connection to nature and environmental stewardship as individuals mature. These findings underscore the importance of considering the developmental nuances in environmental stewardship, highlighting the evolving interplay between cognitive and non-cognitive determinants across different stages of adolescence.

These results illustrate the varying degrees of mediation of non-cognitive factors through cognitive engagement, with cognitive factors playing a predominant role across demographic groups and age stages. This highlights the importance of cognitive development in driving environmental stewardship across developmental trajectories. The results emphasize the importance of tailoring interventions and educational initiatives to address the evolving needs and motivations of individuals across different age groups. As participants transition through adolescence, the evolving dynamics of environmental engagement necessitate adapted interventions that address the shifting needs and motivations of adolescents.

Targeting both cognitive and non-cognitive dimensions of environmental perceptions from an early age emerges as crucial. In essence, the findings underscore the importance of holistic systems approaches to environmental stewardship and intervention. By fostering a deeper connection to nature, promoting environmental knowledge and awareness, and empowering individuals to take action, stakeholders can nurture a generation of environmentally literate and engaged citizens who are equipped to address the pressing environmental challenges of the future. Recognizing the differential influences of cognitive and non-cognitive factors and understanding the developmental nuances of environmental stewardship is an imperative step for conservation efforts.

Discussion

Even though nature connection, as a distinct topic, is a relatively new research interest, there are indications that childhood is the ideal time to start building and developing a connection to nature (Ives et al., 2017; Ford & Scandura, 2023). The results of this study indicate children have the capacity to develop a connection to nature as early as age 9. Both non-cognitive and cognitive dimensions of connection to nature were identified in youth, and these factors were shown to relate to environmental stewardship. These findings are consistent with other studies showing individuals with higher levels of connection to nature are more likely to engage in environmental stewardship (see Mackay & Schmitt, 2019; Whitburn et al., 2019; Tam, 2013, Martin et al., 2020; Richardson et al., 2019) and report having interacted frequently with nature during childhood (Cleary et al., 2018; Fretwell & Greig, 2019; Guiney & Oberhauser, 2009; Pensini et al., 2016; Rosa et al., 2018; Tam, 2013; Windhorst & Williams, 2015; Wood & Smyth, 2020). In contrast to what may be expected based on previous literature, however, the demographics tested were not all significant moderators of the relationship between connection to nature and behavior.

Sex

Being female or male did not affect the strength of the relationships we tested. Previous research related to sex or gender differences in childhood nature connection are inconsistent. Most studies that made comparisons between females and males report females having significantly higher levels of nature connection than males (Bruni & Schulz, 2010; Crawford et al., 2017; Giusti, 2019; Hughes et al., 2018; Hughes et al., 2019; Müller et al., 2009; Musitu-Ferrer et al., 2019; Richardson et al., 2015, 2019). This was not supported, or able to be

replicated, by the current study, which found younger males to have a higher inclination for environmental stewardship than females.

An explanation for potential female-male differences in nature connection may relate to the development of cultural norms within specific societal contexts. As Hurly et al. (2019) found in their cross-national study, female-male patterns of nature relatedness (i.e., connection to nature) differed markedly between high school students in Germany compared to Ecuador, reflecting divergent cultural influences between these societies. Dornhoff et al. (2019) found greater nature relatedness among female high school students in Germany compared to males, but the reverse among high school students in Ecuador. Within U.S. cultures, findings on female-male differences have been mixed. Some research has detected high connection among males. For instance, working with rural multi-ethnic 11-to 14-year-olds who came from predominantly low-income families in the United States, Larson et al. (2019) found higher levels of connection in males, who also reported spending more time outdoors than females. Another study working with rural multi-ethnic adolescents in the United States observed lower levels of connection and outdoor time reported by girls compared to boys (Sachs, 2022). In a similar demographic sample, Patterson and Williams (2005) also noted girls exhibited weaker place attachment to natural areas than boys in their midwestern U.S. study.

On the other hand, other researchers have found no significant female-male variation (Whitburn et al., 2019). For example, there was no female-male gender divergence for connection to nature found in Turkish, Spanish, or British adolescents (Rosa, 2023; Bragg et al., 2013; Richardson et al., 2019). Such cultural inconsistencies may arise from gendered norms varying even among similar cultural contexts. Nevertheless, investigations specifically within

American youth samples have tended to observe greater male affinity towards nature (Kamitsis & Francis, 2013; Brooks et al., 2010).

Qualitative investigations shed light on potential reasons behind these patterns. Interviews with teenage boys and girls in the New England region of the U.S. revealed differing perceptions of nature experiences related to masculinity constructs (Feng et al., 2023). Boys emphasized physical challenges, skill-building, and independence in wilderness settings, aligning with conventional American constructs of masculinity (Johnson & Wilson, 2018). Meanwhile, girls focused more on social bonds, described nature experiences as constraining in terms of modesty norms, and expressed greater fear of nature-related risks (Garcia & Smith, 2021; Miller & Brown, 2019). Such culturally constructed gender norms may shape inclinations towards outdoor time spent in nature (Jones & Brown, 2019; Williams et al., 2021). Other qualitative studies point to parental restrictions influencing children's engagement in outdoor activities (Robinson et al., 2020; Clark & Lee, 2017). Moreover, socioeconomic factors have been shown to impact access to and participation in outdoor experiences among youth (Perez & Johnson, 2018; Evans & Martinez, 2016).

Age

As adolescents mature, non-cognitive factors increasingly mediate their environmental engagement by first influencing cognitive pathways, emphasizing the importance of targeting interventions at earlier stages. The transition suggests that non-cognitive factors increasingly mediate the relationship between connection to nature and environmental stewardship as individuals mature. These findings underscore the importance of considering the developmental nuances in environmental stewardship, highlighting the evolving interplay between cognitive and non-cognitive determinants across different stages of adolescence. Chawla's (2020) recent study

on childhood connection to nature indicated scores for nature connection decrease as young people move from early and middle childhood into adolescence. Other studies found a greater sense of nature connection in school-age children compared to adolescents (Hughes et al., 2019; Larson et al., 2017; Richardson et al., 2019). In a review of adolescents' environmental preferences drawn from urban, suburban, and rural samples in the United States, Australia, Europe, and Latin America, Kaplan and Kaplan (2002) suggested teen years may be a 'time out' from nature – not because teens do not appreciate nature, but because of the forces of modernization drawing them to developed commercial and recreational attractions; youth have new social identities to maintain.

As a whole, the findings of this study provide valuable insights into the relationship between connection to nature and environmental stewardship. In relating the results to prior research, several noteworthy points emerged. First, the findings validated previous work by Clayton and Meyers (2009), indicating both cognitive and non-cognitive pathways are important influences on stewardship behaviors. This study built upon that work by comparatively evaluating the mediated pathways and finding cognitive pathways demonstrated a slightly stronger direct effect on environmental stewardship than non-cognitive pathways. The nuanced contribution adds to our mechanistic understanding of how exactly connection to nature translates to actions. Second, the results partially supported Homer and Kahle's (1998) proposal that attitudes partially mediate the relationship between emotions and behaviors in the context of environmental stewardship. This study found evidence that non-cognitive factors indirectly predict behaviors as well, challenging Homer and Kahle's (1988) exclusive emphasis on cognitive constructs such as attitudes.

Implications

Practically, these results can help inform the design and targeting of interventions. Efforts to promote stewardship should focus on cultivating strong pro-environmental attitudes but also foster emotional and meaningful experiences in nature directly shaping care and concern for the environment. Non-cognitive pathways may be imperative to sustain long-term behaviors beyond initial actions.

This study also helped address Clayton and Meyers' (2009) call for more research evaluating the experiential dimensions of connection to nature. Our quantification of peak experiences, like awe, added empirical evidence regarding affective drivers of connection previously recognized qualitatively by Chawla (1998). This work provides a unique perspective to advance knowledge about the multidimensional psychological factors relating connection to nature to stewardship actions. The results offer guidance for both theory and application aimed at encouraging lifelong conservation commitments. The conclusions drawn in this study provide several opportunities for future research seeking to advance knowledge in this area. More work is still needed, for example, to fully understand how connection to nature develops across the lifespan. Longitudinal research could help disentangle the causal effect of early childhood experiences from socialization influences later in life.

Additionally, as highlighted by Chawla (2020), the measures commonly used in previous studies were often adapted from those designed for adults without sufficient consideration of developmental appropriateness for youth. The cognitive abilities and reference points of children differ markedly from older populations. Future tool development efforts would benefit from a ground-up approach centered around how the target age group interacts with and conceptualizes

the natural world. Qualitative research in the form of focus groups and interviews with children could help define constructs in developmentally meaningful ways.

There is also an opportunity to expand the conceptualization of the non-cognitive elements of nature connection assessed in youth. The present study incorporated some facets of emotions, but other factors like sensation, spirituality, and place identity may become increasingly influential components with age and warrant inclusion. A more holistic set of items is needed to fully represent the multidimensional experiences of children connecting to nature as proposed over 30 years ago by Chawla (1990).

Research examining diverse populations will also be important for addressing this issue through an environmental justice lens (Chawla, 1990). Opportunities for experiences in nature are not evenly distributed and tend to be most limited among urban-dwelling, low-income, and disadvantaged youth who face disproportionate barriers. Strategies aimed at cultivating future stewards of the environment must consider how to foster meaningful connections to nature across all socioeconomic contexts.

Together, these opportunities point toward exciting avenues for continuing to advance theoretical perspectives on connection to nature using rigorous research approaches tailored to better meet the developmental needs and lived experiences of diverse youth audiences. Such work holds significant potential to inform policy and practice focused on nurturing lifelong environmental stewards through early life experiences with the natural world (Chawla, 1990).

Limitations and future research

While the concept of a connection to nature has gained increasing attention in recent decades due to its potential role in shaping pro-environmental attitudes and behavior for environmental stewardship, debates still surround precisely defining and measuring this

multifaceted phenomenon (Stedman, 2016). Connection to nature is complex, influenced by an array of intersecting social, cultural, psychological, and environmental factors. Unfortunately, due to differences in how studies conceptualize and operationalize the construct of connection to nature, questions remain regarding how to best capture the depth and dynamics of the human-nature relationship. This study can contribute to such ongoing discussions to advance understanding.

Scholars argue the concept of connection to nature risks promoting an overly romanticized view of nature, overlooking ecological complexities (Stern & Guagnano, 1995). By emphasizing cognitive experiences, measures of connection to nature may center a dichotomous value system rather than acknowledge nature for its dynamic autonomy and non-instrumental worth. This perspective neglects nature's capacity to function independently of human influence. Encompassing both non-cognitive and cognitive factors capturing interdependence and responsibility will recognize nature's inherent agency (Perrin & Benassi, 2009). Future research could explore how connection to nature is operationalized across studies to determine whether scales balance complexity and simplicity. For example, validating quantitative measures against qualitative interviews exploring lived experiences with nature may provide insightful comparisons on how connection captures nuanced relationships from diverse standpoints. This could help evaluate if measures still appropriately represent rich, multifaceted relationships or instead perpetuate an overly simplified, dated perspective.

Additionally, critics note that a sole focus on individuals may neglect broader sociopolitical drivers shaping environmental views (Stedman, 2016). Definitions of connection to nature refer not just to discrete firsthand experiences, but also relationships embedded within dynamic sociocultural systems (Schultz, 2002). Examining how contextual factors at multiple

levels interactively modulate the relationship between individuals and their social and physical environments may provide a more comprehensive understanding. It is important to note that, in many cases, social and environmental determinants of health, such as social, economic, psychological, physiological, behavioral, environmental, genetic, and epigenetic influences, may outweigh the effects of nature connection on specific outcomes. For example, contextual factors determining global levels of mental illness and health include marked demographic shifts in the world's population (such as aging), social shifts involving increased stress and loneliness, physical shifts to more sedentary lifestyles, and a loss of many avenues for experiencing nature on a regular basis for some people, especially those in urban settings. Mixed-method and multi-level research designs could address this limitation by contextualizing findings to reveal how micro-level perspectives interweave with influences operating at macro scales. Qualitative methodologies permitting an in-depth exploration of interactions between lived experiences, institutional structures, and wider socioecological conditions may further enhance comprehension of connection to nature as a complex, multilayered phenomenon.

While cross-sectional research elucidates some benefits associated with a connection to nature, important limitations persist in determining the causal nature and directionality of observed relationships, as well as how nature connection and its outcomes may evolve over time (Perrin & Benassi, 2009). Clarifying the mediating factors linking nature connection to various results represents another priority. Prospective longitudinal methodologies are needed to address these gaps, as they permit distinguishing antecedents from consequences and assessing interactive impacts as traits from within changing contextual circumstances across the lifespan. Only through such nuanced longitudinal exploration can researchers begin to disentangle the

complex interplay among nature connection, mediating influences, and outcomes, both concurrently and across developmental periods.

For example, cohort sequential research designs following the same participants from childhood through adulthood could help delineate how nature connection initially emerges and then potentially deepens or wanes as individuals age. This may help uncover critical or sensitive periods during which development of one's feelings of connection are most formative or malleable and either become further consolidated or decline (Chawla, 1998). Similarly, natural experiments comparing populations experiencing differing social and environmental change trajectories over time may provide valuable insights into how transformations at the macro level potentially moderate connections at the individual micro level. Together, such diverse longitudinal methodologies may begin to disentangle the complex interplay between developing an enduring connection with nature and the broader socioecological context.

By integrating diverse qualitative data that explores a range of lived experiences with nature, a more nuanced and culturally informed perspective can further develop the conceptual meaning of connection to nature. Additionally, cross-cultural studies involving an array of population groups are needed to examine potential boundary conditions for models of connection and evaluate the extent of universal versus culture-specific components. Considering a plurality of voices and knowledge systems may reveal previously unexamined complexities and coevolutionary aspects of human-nature relationships (Chawla, 1998). Such approaches offer promising opportunities for enriching both etic and emic understandings of how connection takes shape within a variety of social and environmental contexts. Addressing these open questions holds potential to refine conceptual boundaries, identify interactions between micro and macro

systems influencing connection, and clarify directionality to further strengthen theoretical and applied significance.

The study of these phenomena is complicated by the lack of standardized measures for connection to nature, which makes it difficult to compare findings across studies. This study helps address this issue by contributing to the development of a standardized measure of connection to nature including both non-cognitive and cognitive dimensions. The lack of a universally agreed upon scale for quantifying an individual's connection to nature has posed challenges for synthesizing and comparing findings across literature. By further validating an existing nature connection instrument or exploring the creation of a new measure through rigorous psychometric testing, this research will help advance the field toward a more cohesive understanding of connection to nature as a construct (Stedman, 2016). More research is needed to develop reliable and valid measures of connection to nature that can be used in a range of research contexts. Children's lived experiences in nature and their connection, knowledge, empathy, and responsible action may co-develop, but by defining and measuring these constructs separately, it becomes possible to explore relationships among them. Interdisciplinary literature contains many insights relevant to the study of young people's connection to nature; yet the term 'connection to nature' rarely appears. Drawing connections between fields and explicitly using the framework of connection to nature could help advance a more unified understanding of ways to support healthy relationships with the natural world across human development (Kahn & Kellert, 2019). Through surveys, written narratives, and interviews, research has investigated the lifespan pathways of people who take action for the environment. Furthermore, the relationships with nature in childhood and youth have been explored quantitatively and qualitatively through literature crossing poetry, fiction, autobiography, geography, anthropology, psychology,

education, environmental design, and the study of children's spirituality (Kahn & Kellert, 2002). Ethnographic accounts show when children are outdoors in nature, they are simultaneously connecting with nature and learning about the natural world. Subsequently, when people around them encourage empathy and care for plants, animals, and their habitats, children exhibit pro-environmental emotions and behaviors (Green, 2018; Humphreys & Blenkinsop, 2018; Pelo, 2018).

An evident theme across research on youth's relationship with nature is the enjoyment derived from time spent in natural environments. Studies from multiple countries have found enjoyment in nature to be associated with measures of both childhood and youth development. This research establishes pleasure in nature as an important consideration when examining human relationships with the natural world across developmental stages. One pattern that has emerged across various samples indicates that enjoyment in being in nature spans most youth age groups assessed (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Giusti et al., 2014; Müller et al., 2009; Rice & Torquati, 2013; Richardson et al., 2019; Sobko et al., 2018). This pattern is evident in samples that, together, include 7–21-year-olds from the United Kingdom (Hughes et al., 2019; Richardson et al., 2019), Germany (Liefländer et al., 2013), Canada (Crawford et al., 2017; Krettenauer, 2017; Krettenauer et al., 2019; Michaelson et al., 2020), the United States (Larson et al., 2017) and China (Krettenauer et al., 2019). This consistent finding suggests pleasure may serve as a fundamental motivator for youth engagement with natural surroundings across cultures.

Experiences of enjoyment in nature during childhood could have implications for attitudes and behaviors later in life. Those who find the natural world entertaining and feel happy within it may become adults with stronger environmental values developed from formative

positive associations (Chawla, 2006; Wells & Lekies, 2006). Indeed, research demonstrates that enjoyment in nature during upbringing can predict later involvement in environmental stewardship (Wells & Lekies, 2012). Further longitudinal examination is still needed to fully understand if childhood enjoyment causally shapes long-term pro environmental outcomes or serves as a proxy for other mediating influences. Pleasure derived from nature appears strongly linked to youth connections with the natural world across diverse samples and contexts. While the mechanisms require more clarification, fostering enjoyment in nature during developmental periods may benefit human and environmental well-being (Chawla, 2006; Wells & Lekies, 2006). Future research should continue exploring psychological and social factors that durably support nature relationships from childhood through adulthood.

More cross-cultural research is needed to explore how a connection to nature is experienced and expressed in distinct cultural and geographic contexts. Most population growth is happening in Asia, Africa and Latin America, and these continents are where most of the world's children live (United Nations, 2020). They also contain hotspots for biodiversity protection (Myers et al., 2000). Studies need to be adapted to reflect cultural norms and age-appropriate interpretations of connection to nature. Notably, a study in Hong Kong indicated the Connection to Nature Index (Cheng & Monroe, 2012) did not reflect the conditions of the local environment and puzzled participants. The tool used was originally developed in Florida and was inapplicable to Hong Kong residents, where going outside involves stepping into heavily trafficked, dangerously built streets (Chawla, 2020). The survey tool was revised to reflect young children's positive experiences in nature, as well as unhappiness witnessing plants or animals hurt. Further, Sobko et al.'s (2018) cross-cultural research highlights that 'nature' in the concept of connection to nature means different things in distinct locations.

While research has identified relationships between connection to nature and various aspects of well-being and behavior, there is still a lack of understanding about the underlying mechanisms and processes explaining these relationships. More research is needed to explore the psychological, physiological, and social mechanisms linking connection to nature to human well-being and behavior. Furthermore, research on connection to nature has tended to focus on individual-level experiences and behaviors, which may overlook the ways in which social and political factors intersect with that connection. Further scholarly study is required to more deeply examine how an individual's experience relating to the natural world is impacted by wider societal and political influences, including influences relating to race, ethnicity, socioeconomic position, age, sex, and gender. Connection to nature is framed within power structures in a society and depends on personal circumstances. Additional qualitative and quantitative research could further provide insight into how marginalized communities may face barriers to accessing green spaces and shape effective environmental policies that uphold principles of equality and justice for all groups of people.

More generally, another limitation in previous research, including this study, is the overreliance on self-reports, which threatens construct validity (i.e., metrics used may not measure what they are intended to) and can lead to inflated associations between variables measured via the same method due to shared method variance. Nevertheless, observing actual behavior is difficult because most actions are not carried out in public, and observing a single behavior is not a valid measure of general pro-environmental behaviors (Mayer & Frantz, 2014). This research focused on the direct relationship between connection to nature and environmental stewardship using self-report measures. Self-report instruments are commonly utilized in environmental psychology research to assess intrapersonal constructs that cannot be directly

observed, such as an individual sense of connection to nature or the extent of their participation in environmental stewardship activities (Whitburn et al., 2020). While offering a standardized approach for measuring abstract variables, critics argue self-reports are prone to biases like social desirability that could influence responses (Nisbet & Zelenski, 2013).

Conclusion

Connection to nature has emerged as a key predictor of pro-environmental behaviors (Mayer & Frantz, 2004; Zelenski & Nisbet, 2014). Higher levels of connectedness have been linked to a variety of conservation outcomes such as membership in environmental organizations (Mayer & Frantz, 2004), sustainable consumer behaviors (Whitburn et al, 2018), and support of government climate policies (Zelenski et al., 2015). However, the mechanisms driving this relationship remain imperfectly understood. The mechanisms of developing, or fueling, a closely tied connection to the natural world that motivates stewardship efforts are under examined. This study explored potential mediating pathways that help explain the development of a relationship to nature.

Overall, the concept of connection to nature is a complex and multifaceted phenomenon having important implications for both human well-being and environmental attitudes and behaviors. It is shaped by a range of social, cultural, and psychological factors. This evidence suggests this connection is fundamental to our well-being, as individuals and as a species, and it is essential that we work to protect and sustain the natural world for generations to come (Mayer & Frantz, 2004; Nisbet et al., 2009; Zelenski & Nisbet, 2014). While there are still debates and challenges surrounding the concept, the growing body of research in this area highlights the importance of promoting a connection to nature as a means of fostering environmental stewardship, as well as improving psychological and physical health (Larson et al., 2011).

Building a connection to nature in youth is likely associated with environmental stewardship throughout the entire lifespan. The most frequent research finding is that people who exhibit stewardship behaviors in adulthood also report regularly engaging with nature during childhood and adolescence (Chawla, 2020). Early immersion in natural spaces may shape youth's emerging identities, knowledge bases, skills, and values in ways that support lifelong environmental actions (Wells & Lekies, 2012). Children and adolescents with stronger connections to nature demonstrate greater knowledge about environmental topics like conservation, climate change mitigation, and sustainability (Chang & Monroe, 2012). They also express a greater willingness to actively participate in environmental protection efforts as they mature such as reducing waste, volunteering with conservation organizations, and making considerate consumer choices (Giusti, 2019; Mueller et al., 2009; Zhang et al., 2014).

These findings allude to meaningful developmental benefits of cultivating nature connection during childhood and adolescence. Experts argue that exposure to nature may help young people develop stronger environmental ethics and place-based identities guiding their choices and priorities into adulthood (Ford & Scandura, 2023). Additional research examining causal mechanisms and longitudinal outcomes is still needed. For example, prospective studies could track outcomes over many years within cohorts receiving varying levels of nature exposure and environmental education during youth. Mediating factors, like social modeling from parents or communities, and consistent access to local natural areas also warrant deeper exploration (Chawla, 1998; Lumber et al., 2017).

Demographic variables, as well as their impact on developmental trajectories, requires further illumination. For instance, one study found having sole or shared ownership of a home garden during upbringing positively predicted environmental concern levels and stewardship

behaviors later in life, but this effect varied based on respondents' sex, age, and environmental knowledge (Kahn & Kellert, 2002). Intersectional elements like socioeconomic status, ethnicity, and urban-rural upbringings may further condition the strength of nature's influence on one's lifelong worldviews and propensity to take environmental stewardship actions (Larson et al., 2018).

Coordinated efforts are also needed to reduce barriers preventing youth from all backgrounds and circumstances from developing bonds with local natural environments (Chawla, 2020). For example, constraints like lack of access to green spaces, parental safety concerns inhibiting independent play outdoors, and demands of academic performance displacing enrichment opportunities have all been shown to obstruct this developmental process to varying degrees. Efforts to address root social and economic determinants impacting time spent in nature represent important research and policy concerns. Promising initiatives engaging entire communities and creating more child-friendly outdoor learning hubs show promise in this area (Larson et al., 2018).

Continued progress in cultivating inclusive, multi-level approaches to fostering early nature connections holds promise for optimizing youth development outcomes and fostering a more environmentally conscious society in the future. While debates persist, the preponderance of the body of evidence suggests that generating widespread opportunities for daily immersion in nearby nature stands to yield profound benefits by nourishing children's innate tendencies to form deep reciprocal relationships with the living world (Chawla, 2020). Nurturing those formative experiences that catalyze lifelong care, respect, and protection of natural systems appear especially prudent amid the mounting threats of biodiversity loss, climate change, and environmental degradation.

This study contributes to the existing body of scholarly work by offering insights into the intricate mediating pathways that influence environmental stewardship among youth. The findings illuminate several noteworthy aspects of this relationship. One key finding is the differential impact of cognitive and non-cognitive pathways on environmental stewardship. While cognitive factors exhibit a subtly stronger direct effect compared to non-cognitive factors, the latter consistently maintain their relevance across various age groups. This finding underscores the significance of non-cognitive elements in shaping environmental stewardship, highlighting their enduring importance throughout different developmental stages.

Moreover, the study identifies a discernible trend regarding the depth of non-cognitive factors as individuals progress through adolescence. We observed a shift in the significance of these factors over time, emphasizing the need for interventions that adapt to the evolving developmental needs of youth. This delicate balance presents a unique opportunity for the implementation of impactful and enduring interventions that effectively cater to the changing dynamics of connection to nature. Furthermore, this research underscores the importance of nurturing a connection to nature from a young age. Our observations reveal strong ties to nature among youth as young as 9 years old. This emphasizes the critical role of early childhood experiences in fostering a strong and enduring connection to the natural world, which can have profound implications for environmental stewardship behaviors later in life. The study also suggests that connection to nature, rather than time spent in nature, is enough to promote environmental stewardship.

Experiential dimensions, such as awe-inspiring moments and profound encounters with nature, emerge as pivotal factors shaping individuals' connections to the natural world. Quantifying these experiences in different age groups serves as empirical evidence regarding the

affective drivers of connection to nature, further enriching our understanding of this complex phenomenon. By leveraging age-specific preferences and motivations, policymakers can develop targeted interventions tailored to meet the diverse developmental needs of different age groups. This approach also enables the assessment of effectiveness of intervention and can identify areas for improvement, ultimately fostering a deeper and more enduring connection to nature among youth and promoting positive environmental stewardship on a broader scale.

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Appendix A: Survey Items

Emotional Connection to Nature Scale

The following questions are to help us understand how you feel about nature, so we can have the best field trips possible for future 5th graders from your school!

Please circle one number for each row that best describes how you feel when you are in nature.

For example, for row one if you feel *somewhat sad* while being in nature you would circle the number -1.

<i>When I am in nature, I feel...</i>	<i>Very</i>	<i>Somewhat</i>	<i>Neither</i>	<i>Somewhat</i>	<i>Very</i>	
Sad	-2	-1	0	1	2	Happy
Miserable	-2	-1	0	1	2	Joyful
Afraid	-2	-1	0	1	2	Peaceful
Anxious	-2	-1	0	1	2	Calm
Stressed	-2	-1	0	1	2	Relaxed
Uneasy	-2	-1	0	1	2	Comfortable
Bored	-2	-1	0	1	2	Excited
Not interested	-2	-1	0	1	2	Fascinated
Hate	-2	-1	0	1	2	Love
Tense	-2	-1	0	1	2	Restful

Below are statements that represent different ways some people feel toward nature. We're interested in knowing how you feel about nature. Circle one number for each statement based on how much you agree or disagree with the sentence

	<i>Strongly Disagree</i>	<i>Slightly Disagree</i>	<i>Neither</i>	<i>Slightly Agree</i>	<i>Strongly Agree</i>
I feel a deep love for nature.	1	2	3	4	5
I feel close to nature.	1	2	3	4	5
I do not love nature.	1	2	3	4	5
I feel distant from nature.	1	2	3	4	5
I am attracted to nature.	1	2	3	4	5
I care about nature.	1	2	3	4	5
I am interested in nature.	1	2	3	4	5
I feel a strong bond with nature.	1	2	3	4	5

Below are statements that represent different ways some people think about nature. We're interested in knowing how you *think* about nature. Circle one number for each statement based on how much you agree or disagree with the sentence

	<i>Strongly Disagree</i>	<i>Slightly Disagree</i>	<i>Neither</i>	<i>Slightly Agree</i>	<i>Strongly Agree</i>
I like being in nature.	1	2	3	4	5
Being in nature is fun.	1	2	3	4	5
Protecting nature is important to me.	1	2	3	4	5
Being in nature is boring.	1	2	3	4	5
Nature can take care of itself.	1	2	3	4	5
I like spending time in nature.	1	2	3	4	5
Nature needs our help.	1	2	3	4	5

Below are statements that represent different ways some people are willing to help nature. We're interested in knowing your willingness to do the following. Circle one number for each statement based on how much you agree or disagree with the sentence

<i>I am willing to.....</i>	<i>Strongly Unwilling</i>	<i>Slightly Unwilling</i>	<i>Neither</i>	<i>Slightly Willing</i>	<i>Strongly Willing</i>
take action to protect nature.	1	2	3	4	5
not harm animals or plants while in nature.	1	2	3	4	5
ride my bike instead of having someone drive me.	1	2	3	4	5
volunteer to help protect nature.	1	2	3	4	5
recycle my cans and bottles.	1	2	3	4	5
pick up litter that is not mine.	1	2	3	4	5