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BRIEF REPORT

An exploration of intergenerational differences in wilderness values

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As populations and built-up environments increase around the globe, governments on every continent are setting aside pristine, natural landscapes from development to preserve their wild nature. In the USA, these areas are designated by Congress as wilderness areas and the connections people have with these wild places shape their wilderness values, i.e., the values they believe wilderness areas provide to society. Even though Congress has increased the number of acres under official wilderness protection since the passage of the Wilderness Act in 1964, congressionally designated wilderness lands account for less than 3% of the contiguous United States (Aldo Leopold Wilderness Research Instite (ALWRI), 2017).

Williams and Watson (2007) suggest that this increasing scarcity of wild landscapes may lead younger generations to develop an increased appreciation of wilderness— an otherworldly place, so different from their daily existence and experiences. Others warn that cohorts growing up surrounded by screens, rather than climbing trees, are not learning to engage with, and thus appreciate, nature (Blumer 1986; Dickinson 2013; Louv 2005). This distance from nature may lead the youngest cohorts to value wilderness differently from previous generations. Many Americans are not even aware that wilderness areas exist (Cordell et al. 2003). Consequently, they may fail to appreciate the full suite of values that wilderness areas can provide, such as recreation, spiritual inspiration, and ecosystem protection.

Public land management agencies are dependent on public support for wilderness stewardship in order to obtain funding from Congress to carry out their mission. If conservation values begins to wane, so will dollars allocated to wilderness stewardship, as values are bellwethers of economic support for environmental conservation. An analysis of data relating to environmental concern in the General Social Survey (GSS) finds that those who hold strong environmental values are more likely to support allocating tax dollars to environmental conservation (Smith et al. 2015). It is therefore

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pertinent for land managers and wilderness advocates to understand the state of wilderness values in society, and incumbent upon researchers to rapidly identify potential shifts in values. If value shifts are occurring, there may be a need to create new education campaigns and management direction to better align land management priorities with public preferences for land management.

Drawing on data from the National Survey on Recreation and Environment, this research adds a fresh methodological approach to the investigation of intergenerational differences in wilderness values. Uniting spatial demographic and cohort analysis, and controlling for urbanization, gender, educational attainment, quality of education, and exposure to wilderness areas (factors identified in the wilderness, demography, and sociology literatures as influencing wilderness values), this research examines how and why wilderness values may be shifting across cohorts.

Wilderness values as a concept and social construct

The Wilderness Act couches the value of wilderness lands in a framework that encompasses ecological, inspirational, and experiential values (Cole 2005). Over the years, there has been active conversation in the wilderness literature over how to appropriately measure the value of wilderness to society (Cole 2005; Cordell et al. 2005; Williams et al. 1992). In the *Multiple Values of Wilderness*, Cordell et al. (2005) summarize several wilderness value frameworks employed by scholars across disciplines. Bergstrom et al. (2005) suggest that wilderness values are a function of wilderness attributes, functions, and services. Their framework is grounded in natural resource management theory and implies that wilderness values are more likely to fluctuate with changes in the attributes and services wilderness lands provide, i.e., natural resource changes, but that wilderness values are not tied to shifts in social values. Cordell et al. (2005) refine this definition by aggregating wilderness values into a three-pronged, benefit-driven typology: (1) ecological services, (2) ecosystem protection, and (3) amenities for humans. *Ecological services* values are those benefits such as protecting clean air and clean water, which indirectly contribute to human health and well-being (Schuster et al. 2005). *Ecosystem protection* values include the benefits of protecting wildlife habitat, preserving unique plant and animal ecosystems and genetic strains, and protecting rare and endangered species. *Amenities for humans* include both use and nonuse values that contribute to social or economic well-being. Use benefits include providing recreation opportunities, providing income for the tourist industry, providing scenic beauty, providing spiritual inspiration, and preserving natural areas for scientific study. Nonuse benefits include just knowing that wilderness areas exist, knowing that in the future there will be the option to visit a wilderness area of one's choice, and knowing that future generations will have wilderness areas.

Social scientists, such as Williams and Watson (2007), apply a Durkheimian approach. They posit that wilderness values are social facts (Durkheim 1895), and thus may shift and be reproduced with societal trends. For the purposes of this analysis, the three-pronged, benefit-driven typology Cordell et al. (2005) put forth is applied to identify the variation in wilderness values across the population. Wilderness values are also conceptualized as social facts, and therefore, treated as capable of shifting across cohorts.

Competing views on shifts in wilderness values across cohorts

Younger birth cohorts, coming of age in a more technologically embedded society, where every-day routines have become embedded in technology, may be developing a different connection with nature, and thus, assigning different values to wilderness, compared to older cohorts. Younger cohorts spend more of their leisure time in technologically embedded settings, compared to older cohorts, when older cohorts were their age (Lenhart et al. 2015; Louv 2005). This rise in technological embeddedness in younger cohorts has been well documented in the literature (Peng et al. 2009; Sassen 2002; Volkoff et al. 2007). Theorists suggest that technological embeddedness can lead to social change as daily routines shift to a digital format (DiMaggio et al. 2001; Volkoff et al. 2007). In the context of wilderness values, technological embeddedness results in more time spent engaged with technology, and less time in nature. Louv (2005) argues that as fewer children have first-hand experience recreating in natural areas, they may grow up unfamiliar with, or even fearful of, wild, natural landscapes. Younger cohorts may also be less familiar with the more ethereal values that often stem from a previous phenomenological experience of communing with, and assigning meaning to, nature (Blumer 1986; Williams et al. 1992). For example, in 1985, 51% of children engaged in wildlife watching. By 2010, that number dropped down to 31% (U.S. Department of the Interior (USDI), U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2011). Louv (2005) warns that as younger generations spend less of their emerging adulthood years in nature, they will develop into adults who cannot perceive natural environments as valuable, in and of themselves. Social psychologists have studied generational differences in values and attitudes and found significant evidence of a decline in nature relatedness, one's subjective connection to nature (Metz 2014; Twenge et al. 2012; Zelenski and Nisbet 2014), in younger cohorts, compared to those in the prior generation (i.e., those born in the 1940s to 1960s). Nature relatedness is highly correlated with environmental values (Zelenski and Nisbet 2014). Thus, waning nature relatedness, posited as an artifact of higher technological embeddedness, may result in shifts in wilderness values in younger cohorts. Specifically, this decline in nature relatedness could result in a weakening of wilderness values in younger cohorts.

Conversely, Williams and Watson (2007) posit that as wild lands are transformed into suburban landscapes, wilderness will become increasingly valuable to society. This rise in value is linked to the economic concept of scarcity, where the value of a good increases as supply decreases. Wilderness, as both a symbol and an experience, becomes increasingly unique. As a natural, untrammeled place, wilderness provides a stark contrast to the built environment most inhabit on a daily basis. Thus, scholars have posited that wilderness values would be increasing across cohorts.

While the prevalence of wild landscapes across the country has been shrinking since the industrial revolution, the rise of technological embeddedness is a relatively new phenomenon.

In 1964, mobile computing was still science fiction. By 2008, mobile phones were ubiquitous and smart phones were gaining significant traction in consumer markets. This trend of increasing embeddedness in technology in everyday life has grown exponentially, particularly for the younger generations. A Pew Research Center survey found that 24% of teenage respondents were online "almost constantly" (Lenhart et al.

2015). Thus, while scarcity may have led to a rise in all wilderness values between the oldest cohorts and those coming of age before the new media revolution (i.e., those born pre-1970), it's possible that the relatively new influences of technology may be exerting a countervailing force, and may be weakening wilderness values in the youngest cohorts (i.e., those born post 1970).

These arguments, taken together, suggest that all wilderness values may have been strengthening across cohorts born at the turn of the twentieth century through the 1970s, as development led to increasing scarcity of wild landscapes. However, due to changing relationships with technology, the strengthening trend in wilderness values may have changed course, and thus, begun to weaken in the youngest cohorts. This is the central hypothesis to be tested in this work.

Additional factors influencing wilderness values: urbanization, education, gender, and exposure to wilderness

The literature suggests that urbanization, exposure to wilderness, educational attainment and educational quality, and gender may also be shaping wilderness values. This research examines whether the non-linear relationship between wilderness values and cohorts remains, after controlling for the key elements identified in the literature as influencing wilderness values. A brief review of the literature relating to the aforementioned control variables is described below.

Urbanization has been steadily increasing across the USA for decades and may be influencing wilderness values. In 1960, approximately one in three Americans lived in rural areas,[1] yet by 2010, that ratio dropped down to just one in five (US Census 2016; US Census 2016a). The urbanization literature charts how urban migration impacts societal values (Knox and Pinch 2014, Ratcliffe 2016). Urbanites are typically more relationally embedded, i.e., have more social ties providing them with larger social networks and opportunities for transfer of new ideas and information (Granovetter 1985). The more robust information networks in urban environments allow for more rapid flows of information. Stories and evidence of environmental degradation are more readily part of the urban nomenclature, thus furthering the perception of scarcity of wilderness lands, which in turn, should lead to an increasing valuation of wilderness lands. For example, the vast majority of the 1762 active Superfund sites, areas identified by the Environmental Protection Agency as posing a serious risk to human health, are located in urban areas (National Institutes of Health (NIH) 2016). These arguments suggest that urbanization could play an important role in shaping and strengthening the full suite of wilderness values.

Exposure to wilderness is often modeled as a positive predictor of all wilderness values, as those exposed to the concept of wilderness may form a positive connection with the notion of wild landscapes (Cole 2005). It is important to point out that exposure to wilderness is not a proxy for visitation, but rather, for awareness. As many wilderness scholars have posited, one does not need to visit a wilderness area to appreciate its value (Cole 2005; Johnson et al. 2004; Schroeder 2007). Others (Steed et al. 2011) suggest that exposure to wilderness may have the reverse effect on

[1] A rural area is defined by the US Census as a place with fewer than 2500 residents.

wilderness values as those most familiar with wilderness may have first-hand experience with trade-offs involved in ecosystem protection such as limitations on economic development, motorized and mechanized access, and logging. This analysis adds to the debate by providing a new empirical test to the question of how exposure to wilderness may impact wilderness values.

The literature suggests that upward trends in educational attainment may be influencing wilderness values. In 1960, the vast majority of Americans completed their formal education with a high school diploma. By 2010, around 30% had earned *at least* a college degree (US Census 2016b). As more Americans earn college degrees, the American public gains a firmer grasp on environmental systems and human-environment interactions (Cortese 2003). Many college degree programs require coursework in the natural sciences, where students learn the basic ecological processes and the link between protected land and ecological services such as clean air and clean water. As more of the public enters the higher education system, more people have the opportunity to become fluent in fundamental ecological processes and to understand the value of ecosystem protection (Yung et al. 1998). This potentially can lead to an increased appreciation for wilderness areas and a strengthening of ecological services and ecosystem protection values. Educational attainment may also lead to a weakening in use values as higher education often highlights the negative impacts human beings create when using wilderness directly (Yung et al. 1998) and the degradation caused by overuse.

The quality of K-12 education may also play a role in shaping wilderness values as STEM curriculum incorporates ecological processes and highlights the role wilderness landscapes play in providing clean air and clean water to the public. STEM and environmental education curricula also often include field components where students have the opportunity to engage in nature directly. Environmental education curriculum is designed and implemented at the state level (North American Association of Environmental Education (NAAEE) 2014). Therefore, while classroom resources vary within schools, the state is an appropriate level to capture effects of education quality on wilderness values. Higher quality K-12 education is expected to strengthen ecological service, ecosystem protection values, and amenity values.

Women often hold stronger environmental values and thus are likely to hold stronger wilderness values (McCright 2010; McCright and Xiao 2014). Researchers find that women hold stronger wilderness values, compared to men, controlling for race, ethnicity, income, and education (Johnson et al. 2004). The relationship between gender and environmental concern is formulated as an artifact of gender socialization—positing that women are socialized to develop a stronger ethic of care, rather than claiming any inherent differences in environmental concern across the sexes. The resulting effect is that women tend to have stronger levels of environmental concern, compared to men (Strapko et al. 2016). Women are, therefore, expected to hold stronger wilderness values, compared to men.

The central hypothesis tested in this analysis is that ecosystem protection, ecological services, use amenity, and nonuse amenity wilderness values had been increasing but are now decreasing in the youngest cohorts. Drawing from the literature, the analysis controls for factors previous found to influence wilderness values. Urbanization, educational attainment, K-12 education quality, exposure to wilderness, and gender are all likely affecting ecosystem protection, ecological services, use amenity, and

nonuse amenity wilderness values in different ways. Urban status is expected to predict stronger levels of all four wilderness values. Higher levels of educational attainment are expected to predict stronger ecosystem protection and ecological services values and weaker use amenity values. Quality of K-12 education is expected to predict stronger wilderness values. Being female is expected to predict higher levels of all four wilderness values. Exposure to wilderness is expected to influence wilderness values; however, the literature is unsettled on the expected direction.

Methods

This analysis draws on pooled data from the 2000 Version 2 and 2008 National Survey on Recreation and Environment (NSRE 2000–2008) datasets, which were gathered using a nationwide, random-digit dialing telephone survey administered by the US Forest Service Research and Development branch. Only landlines were included, which may have potentially skewed respondent demographics. To determine the limitations of the sample, key demographic variables are compared to 2006–2008 three-year American Community Survey (ACS) data (US Census 2018) and presented in Table 1. I selected the 2006–2008 dataset as a comparison since the three-year estimate is nationally representative of the US population and provides a more current reference for the combined NSRE 2000–2008 dataset. The comparison shows that the NSRE data are biased and overrepresent older, more highly educated, rural, non-Hispanic, White, and female members of the population.

The NSRE survey instrument was designed by researchers at the US Forest Service. The data include survey weights and are intended to provide a representative sample of the US population. Datasets are merged to maximize the sample size. Both the 2000 and 2008 datasets contained insufficient numbers of minority respondents in each cohort to allow for controls by race and ethnicity, which have been shown to predict differences in environmental values and behaviors (Bowker et al. 2006; Johnson et al. 2004; Kerr et al. 2016). Alaska and Hawaii have significant Native American and Pacific Islander populations, whose cultures tend to conceptualize and value wild landscapes and wilderness areas differently from the lower 48 states population, in general (Brown 2002). Respondents from Alaska and Hawaii were removed as their wilderness values are unique and not easily comparable to

Table 1 Comparing sample demographics and American community survey 2006–2008 (3 year data), US population, 25 and older

	Census (%)	Sample (%)
Percent age 60 and older	17	20
Percent with bachelor's or higher	27	41
Percent in urban area	81	76
Percent female	52	55
Percent non-Hispanic White	70	84

Data source: US Census 2018

values held by residents of the lower 48 states. Respondents under 25 are excluded to focus the analysis on an adult population.

Measures

The NSRE survey contains a wilderness values module and asks the following question: "Wilderness areas provide a variety of benefits for different people. For each benefit you read, please tell me whether it is extremely important, very important, moderately important, slightly important or not important at all to you." Table 2 displays the question wording, the list of benefits, the response codes, and the mean response values. The benefits listed in the survey instrument are derived by itemizing the suite of wilderness benefits, both direct and indirect, identified in the wilderness literature (Cordell et al. 2003; Mountford and Kepler 1999).

Constructing the dependent variables

A principal factor analysis in STATA 14, using the varimax rotation, is applied to distill the 13 wilderness benefits into unique wilderness value categories. Factors are retained by employing the Kaiser criterion, where each factor must explain at least as much variance as any single variable (eigenvalues above 1; Kaiser 1960). A cutoff point of 0.40 was used for the factor loading, a commonly used threshold recommended in the factor analysis literature (Brown 2006). Factor analysis is a valuable tool for distilling multiple, conceptually overlapping indicators into distinct, mutually exclusive categories (Brown 2006). It is particularly valuable when there is a

Table 2 Wilderness value survey question and response means (2000 and 2008 datasets)

Survey question: "Wilderness areas provide a variety of benefits for different people. For each benefit you read, please tell me whether it is extremely important, very important, moderately important, slightly important or not important at all to you." (1 = extremely important, 5 = not important at all)

Response options	Mean response	Standard deviation
Protecting air quality	1.52	0.70
Protecting water quality	1.53	0.67
Protecting wildlife habitat	1.63	0.76
Knowing that future generations will have wilderness areas	1.64	0.76
Protecting rare and endangered species	1.77	0.91
Preserving unique plant and animal ecosystems and genetic strains	1.81	0.90
Providing scenic beauty	1.92	0.88
Knowing that in the future I will have the option to visit a wilderness area or primitive area of my choice	1.95	0.97
Just knowing that wilderness and primitive areas exist	1.95	0.93
Providing recreation opportunities	2.15	0.94
Preserving natural areas for scientific study	2.27	1.03
Providing spiritual inspiration	2.40	1.19
Providing income for the tourist industry	3.06	1.18

need to group multiple indicators into generalized themes (Cutter et al. 2003; Vyas and Kumaranayake 2006). A weakness of factor analysis is that it does interject a measure of subjectivity into the analysis. Factor themes are ultimately determined by the researcher. By drawing on the wilderness literature and Cordell et al.'s (2005) predefined typology, the subjectivity inherent in identifying wilderness value themes using factor analysis is minimized. The factor analysis sorted the 13 wilderness benefits into four unique wilderness value categories. Four factors are retained, representing four distinct wilderness values. Table 3 lists the rotated factor loadings and uniqueness for each variable and the proportional variance explained by each factor. Variables with factor loadings above 0.4 for each factor are accented in italics. The four wilderness value factors retained are as follows: ecological services (e.g., clean water), ecosystem protection (e.g., protecting rare species habitat), use amenities (e.g., recreation), and nonuse amenities (e.g., just knowing wilderness exists). A higher score for a given wilderness value indicates a higher level of importance to the respondent.

Table 4 displays descriptive statistics for the four retained factors and the full list of variables accounted for in the models.

Table 3 Results of the principal factor analysis with varimax rotation of 13 wilderness benefits

Wilderness benefits	Ecological services	Ecosystem protection	Use amenities	Nonuse amenities	Uniqueness
	Rotated factor loadings*				
Protecting water quality	*0.66*	0.22	0.15	0.12	0.48
Knowing that future generations will have wilderness areas	*0.58*	0.25	0.18	0.33	0.46
Protecting air quality	*0.57*	0.37	0.19	0.15	0.48
Protecting wildlife habitat	*0.47*	*0.47*	0.18	0.28	0.45
Preserving unique plant and animal ecosystems and genetic strains	0.35	*0.67*	0.22	0.21	0.33
Protecting rare and endangered species	0.33	*0.64*	0.15	0.28	0.38
Providing spiritual inspiration	0.19	0.20	*0.52*	0.12	0.65
Providing income for the tourist industry	0.00	0.06	*0.51*	0.09	0.73
Providing recreation opportunities	0.23	0.05	*0.51*	0.26	0.61
Preserving natural areas for scientific study	0.22	0.35	*0.44*	0.05	0.64
Providing scenic beauty	0.22	0.29	*0.40*	*0.40*	0.55
Just knowing that wilderness and primitive areas exist	0.27	0.31	0.30	*0.47*	0.52
Knowing that in the future I will have the option to visit a wilderness area or primitive area of my choice	0.28	0.29	0.31	*0.45*	0.54
Proportional variance explained	0.35	0.33	0.29	0.19	

N=4859. Data source: National Survey on Recreation and the Environment (NSRE), 2000-2008, United States Department of Agriculture (USDA) Forest Service 2015

*The cutoff point for the factor loading is 0.4

Table 4 Descriptive statistics for variables in mixed effects, random intercepts model

Variable	*N*	Mean	Std. dev.	Min	Max
Individual-level predictors					
Cohort	4734	1954.41	13.97	1917	1983
Female	4734	0.55	0.50	0	1
Educational attainment	4734	4.57	1.36	1	6
Exposure to wilderness	4734	2.87	1.44	1	5
Urban	4734	0.76	0.42	0	1
State-level predictor					
Average per pupil K-12 spending	4734	$10,038.19	$2151.53	$5346	$15,374
Dependent variables (wilderness values)					
Ecological services	4734	0.00	0.75	− 4.50	1.60
Ecosystem protection	4734	0.00	0.75	− 3.46	2.07
Use amenities	4734	0.00	0.73	− 3.20	2.58
Nonuse amenities	4734	0.00	0.61	− 2.95	2.00

Data source: National Survey on Recreation and the Environment (NSRE), 2000-2008, United States Department of Agriculture (USDA) Forest Service 2015

Measuring cohorts

Cohort, a unit of analysis used for capturing intergenerational change (Ryder 1965), is modeled using year of birth and year of birth squared. The model treats cohort effects as a quadratic function, a common technique in the demographic literature to allow for curvilinear relationships between birth cohort and the variable of interest (Pampel and Hunter 2012). As the hypothesis to be tested is that wilderness values have strengthened and then weakened across cohorts, a concave relationship, a quadratic term is well suited to detect the hypothesized, non-linear relationship. The advantages of a quadratic term, compared to dummy variables, are that it allows for a more parsimonious specification of the model and does not require the researcher to make assumptions about the beginning and ending of a given cohort group effect (e.g., that the effects to younger generations start with those born in 1970 but not before). A significant effect of birth cohort in the model indicates a significant difference in wilderness variables across birth years. If the cohort term is significant and positive, and the cohort squared term is significant and negative, this suggests support for the hypothesis of a non-linear, concave relationship, i.e., that wilderness values have strengthened and then weakened across cohorts.

In a sensitivity analysis, I construct dummy variables for three cohort groups: those born pre-1945, those born between 1945 and 1965, and those born post-1965. The effects of the cohorts on the four wilderness values followed the same patterns of significance and direction as the observed birth year and birth year squared terms used in the final models.

The model does not definitively parse out cohort and age effects. An ideal model would be the A-P-C, or age, period, cohort model, which requires at least 30 years of

data, and controls for period and age effects. Unfortunately, the NSRE was not conducted that frequently. To provide evidence for a cohort, rather than an age effect, I run the models on the 2000 and 2008 datasets separately, and I parse out value responses by the following cohort groups: 1946–1964 and 1965–1980. The cohort groups expressed similar values in both datasets, suggesting wilderness values are more likely fixed earlier on in life, as Brooks and Williams (2012) suggest, and not likely to shift dramatically with age.

Measuring the control variables: gender, urban status, education, and exposure to wilderness

Control measures include gender, urban status, level and quality of education, gender, and exposure to wilderness. Gender is self-identified in the survey instrument and coded as a binary, where female = 1 and male = 0. Urban status is defined according to US Census Bureau criteria. The US Census Bureau criteria define urban as those living in areas with at least 2500 residents. This inclusive definition of urban differs from the common understanding of urban, which in the vernacular, denotes a large metropolitan area. Urbanization literature employs the US Census definition of urban to differentiate between populations that are geographically dispersed in contrast to areas where people are living in close proximity, have access to developed infrastructure, and have the ability to share information more readily (Ratcliffe 2016).

Educational attainment is measured by the level of formal education completed. The measure is constructed as a categorical variable with six groups. The variable is coded as follows: 1 = completed 8th grade or below, 2 = completed 9th to 11th grade, 3 = high school diploma or GED, 4 = some college, 5 = associate's degree, and 6 = bachelor's degree or higher. Those who earned a master's degree and higher are combined with those who earned a bachelor's degree in the final category.

Education quality is measured at the state-level using the average per pupil spending on K-12 education, a commonly used proxy (Eide and Showalter 1998; National Education Association (NEA) 2008). Per pupil spending, while a reasonable proxy for education quality overall, is not as defensible as a measure of quality of environmental education. However, environmental education is often embedded in the science curriculum and therefore this measure is a reasonable approximation of quality of science education at the state-level.

Exposure to wilderness is designed to capture the concept of wilderness awareness. Exposure to wilderness is estimated by calculating the total acres of all federally designated wilderness areas (United States Department of Agriculture (USDA) Forest Service 2015) within 100 miles of the centroid of the respondent's zip code (US Census 2015). Next, total acres are subdivided into quantiles, to determine the magnitude of wilderness exposure. A resident of a zip code located within 100 miles of 5000 acres of wilderness may have a different conception of wilderness, compared to someone living within 100 miles of 3,000,000 acres. The exposure to wilderness measure may underestimate the exposure levels of people who live close to wild places, such as roadless areas or wilderness study areas, but not within 100 miles of officially designated wilderness areas. The survey instrument defined designated wilderness areas and directed respondents to answer questions based on their knowledge of those congressionally designated wilderness areas. The 100-mile threshold was selected to capture

those who would have familiarity with a wilderness area, even if they do not visit it. As most Americans do not visit wilderness areas, even those people living in very close proximity, the exposure to wilderness variable is meant to capture awareness of wilderness areas and/or the wilderness designation concept, rather than likelihood of visitation. As most wilderness areas are located in western states, respondents in western states are more likely to have exposure to wilderness, compared to respondents in mid-western and eastern states.

Models

Multi-level, mixed effects cohort models are employed to assess the relationship between wilderness values and cohorts. Specifically, I use a mixed effects, random intercepts model and estimate the models with the "xtmixed" command in STATA 14, with state as the grouping variable. Multi-level models, which account for differences at both the individual and the state level, are appropriate as differences between states explain a significant amount of the variance across observations (Luke 2004). All variables are grand-mean centered. First, unconstrained models are tested, controlling only for differences in wilderness values among states. Next, individual-level variables and state-level variables are added to test the effects of all variables on each wilderness value (Luke 2004). Below is the base model used to predict each of four wilderness values. i refers to the individual in state j. γ_{00} is the grand mean across all respondents, u_{0j} is the random intercept that varies by state, and r_{ij} is the individual error term for each respondent within a state.

$$\begin{aligned} \textit{Wilderness Value}_{ij} = {} & \gamma_{00} + \gamma_{01(\textit{per pupil spending})j} + \gamma_{10(\textit{gender})ij} + \gamma_{20(\textit{educational attainment})ij} \\ & + \gamma_{30(\textit{cohort})ij} + \gamma_{40(\textit{cohort}^2)ij} + \gamma_{50(\textit{exposure to wilderness})ij} \\ & + \gamma_{60(\textit{urban status})ij} + u_{0j} + r_{ij} \end{aligned}$$

Results

Results of the four multi-level, mixed effects regression models are provided in Table 5.

The regression results shown in Table 5 provide formal tests of the hypothesis. Model results indicate a significant, concave, cohort effect for three of the four wilderness values, lending support to the central hypothesis that wilderness values had been strengthening but are now weakening in the youngest cohorts. The use values model was the one exception, where the cohort effect did not follow the hypothesized, non-linear relationship. Given the lack of significance of the non-linear specification of cohort in the use model, cohort was next modeled as a linear effect and results are presented in Table 6. The linear relationship between use values and cohort is statistically significant, suggesting that trends in use values across cohorts have followed a different course, compared to ecological services, ecosystem protection, and nonuse values.

The cohort effects on all four wilderness values are significant even after controlling for educational attainment, education quality, gender, urban status, exposure to wilderness, and differences across states. Variance explained by mixed

Table 5 Mixed effects, random intercepts regression models: determinants of wilderness values

Dependent variables	Ecological services		Ecosystem protection		Use amenities		Nonuse amenities	
Independent variables	*b*	*z*	*b*	*z*	*b*	*z*	*b*	*z*
Cohort	0.8937	4.70***	0.5271	2.8**	0.1875	− 1.02	0.8943	5.83***
Cohort^2	− 0.0002	− 4.68***	− 0.0001	− 2.77**	− 0.0000	− 1.04	− 0.0002	− 5.80***
Female	0.1391	6.38***	0.1923	8.92***	0.0733	3.47**	0.0348	1.98*
Educational attainment	0.0178	2.20*	0.0147	1.83	− 0.0661	− 8.43***	− 0.0325	− 4.98***
Exposure to wilderness	0.0019	0.25	− 0.0170	− 2.23*	0.0067	0.66	0.0225	3.63***
Urban	0.0423	1.63	0.0656	2.56*	− 0.0304	− 1.18	0.0278	1.33
Average per pupil K-12 spending	0.0000	2.89**	0.0000	2.11*	− 0.0000	− 1.30	0.0000	0.26
Constant	− 0.0003		− 0.0002		− 0.0085		− 0.0003	
Variance components	SD		SD		SD		SD	
State (intercept)	0.0000		0.0000		0.0846		0.0000	
Individual (residual)	0.7400		0.7350		0.7179		0.5998	
Number of groups(states)	48							
Number of observations	4734							
Model fit								
OLS R^2	0.02		0.04		0.03		0.03	
LR test chibar2(01)	0.00		0.00		15.12*		0.00	

Data source: National Survey on Recreation and the Environment (NSRE), 2000-2008, United States Department of Agriculture (USDA) Forest Service, 2015

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

effects, random intercepts models can be reported by specifying the level 2 predictors as level 1 variables and calculating the OLS R^2 (LaHuis et al. 2014). For each of the models, the OLS R^2 terms are reported in Tables 5 and 6. The OLS R^2 values ranged from 0.02 to 0.04, suggesting that although the relationship between cohort and wilderness values is statistically significant, the independent variables in the models only account for a small portion of the observed variance in wilderness values across respondents.

State-level factors did not account for differences in a respondent's ecological services, ecosystem protection, or nonuse values. This is evident in the LR test results in Tables 5 and 6, where only the random intercepts in the use values model have statistically significant variation. This suggests that differences in ecological

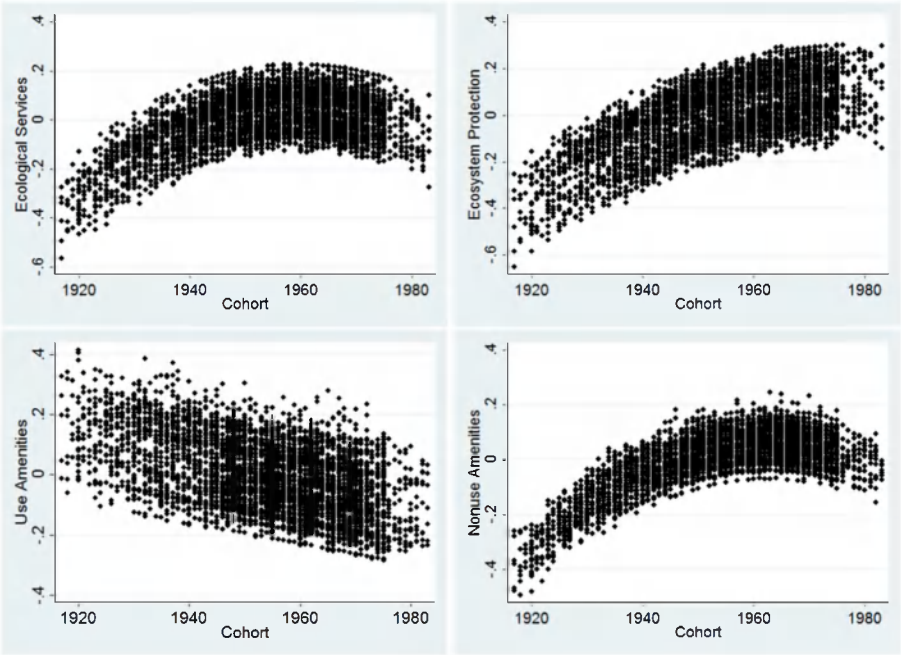
Table 6 Mixed effects, random intercepts regression model: determinants of use amenity wilderness values

Independent variables	Use amenities *b*	*z*
Cohort	−0.0034	−4.55***
Female	0.0726	3.44**
Educational attainment	−0.0657	−8.39***
Exposure to wilderness	0.0066	0.66
Urban	−0.0306	−1.18
Average per pupil K-12 spending	−0.000	−1.28
Constant	−0.0084	
Variance components	SD	
State (intercept)	0.08489	
Individual (residual)	0.7180	
Number of groups(states)	48	
Number of observations	4734	
Model fit		
OLS R^2	0.03	
LR test chibar2(01)	15.29*	

services, ecosystem protection, and nonuse amenity wilderness values are due to individual characteristics of respondents, rather than state-level characteristics. State-level characteristics do play a role in use amenity values; however, state-level K-12 spending was not significant. This finding suggests that other, unobserved state-level characteristics are affecting use values. Respondents in New York, New Jersey, and Connecticut have the lowest predicted use values while respondents in Arizona, Nevada, and Tennessee have the highest.

Figure 1 provides a visual representation of the association between predicted wilderness values and cohorts. Key findings and how they related to the stated hypothesis—that wilderness values had been on the rise but are now on the decline in the youngest cohorts—are summarized below.

- *Ecological Services*: Results indicate that ecological service values had been on the rise but have begun to decline in the youngest cohorts, supporting the hypothesized relationship. The negative, significant quadratic cohort term suggests that younger cohorts feel clean air and clean water benefits of wilderness are less important than those born in the 1940s, 1950s, or early 1960s believe them to be. This is evidenced in Fig. 1, where predicted values for ecological services begin to decline for those born in the late 1960s and early 1970s.
- *Ecosystem Protection*: Ecosystem protection values had been on the rise but have begun a very modest decline in the youngest cohorts. These findings support the central hypothesis, though to a lesser extent than the ecological services model as the size of the dampening effect of the youngest birth cohorts on ecosystem protection values is very small. Figure 1 shows a strengthening trend in

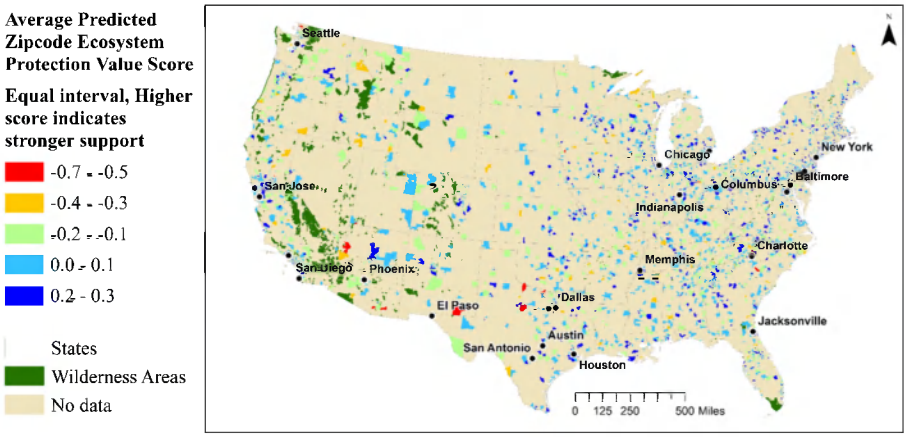


Data source: NSRE 2000 and 2008, USDA Forest Service 2015.

Fig. 1 Predicted wilderness values by cohort. Data source: NSRE 2000 and 2008; USDA Forest Service 2015

ecosystem protection values across cohorts with only a very moderate decline in ecosystem protection values between those born in the 1950s and 1960s and those born in later years. The exposure to wilderness effect was statistically significant and negative, lending support to the supposition that those most familiar with the economic trade-offs of large wilderness areas are least likely to value the ecosystem protection benefits of wilderness. Figure 2 maps the average factor score (i.e., level of importance) of the ecosystem protection value by zip code for respondents from the 2000 and 2008 datasets and highlights the negative effect of exposure to wilderness on ecosystem protection benefits. It is clear from Fig. 2 that those living closer to large wilderness areas (e.g., zip codes in northern Idaho and western Arizona) find ecosystem protection benefits less important than those living far away from large wilderness areas (e.g., zip codes in Northeastern states).

- *Use Amenities*: Unique among the four wilderness values, results of the use amenity value model do not support the hypothesized relationship between cohort and use amenity values. This is clear from the insignificant cohort quadratic term. Instead, the results of the refined use model in Table 6 show that use amenity values have been declining across cohorts since the 1920s.
- *Nonuse Amenities*: Nonuse amenity values, such as just knowing wilderness exists, had been on the rise but have begun to decline in the youngest cohorts. These findings support the central hypothesis. The relationship is clearly visible in Fig. 1, where the decline in predicted importance of nonuse values starts with those born in the late 1960s.



Data source: NSRE 2000 and 2008, USDA Forest Service 2015.

Fig. 2 Predicted ecosystem protection wilderness values by zip code (2000 and 2008 pooled data). Data source: NSRE 2000 and 2008; USDA Forest Service 2015

Discussion

This analysis set out to test whether wilderness values had been on the rise, but are now on the decline in the youngest cohorts. After controlling for gender, urban status, educational attainment, education quality, and exposure to wilderness, this research finds support for the hypothesized relationship between wilderness values and cohorts for ecological services, ecosystem protection, and nonuse amenity values. These finding suggest that while the concept of scarcity of wild lands may have led to an increase in the valuation of wilderness for many decades, technological embeddedness may be bucking those trends in the youngest cohorts. The youngest cohorts are coming of age in technologically embedded settings, and spending the bulk of their leisure time indoors using technology, rather than outdoors, exploring and learning to value nature, and thus, may be developing weaker wilderness values, compared to cohorts of the 1940s and 1950s. The downward trend is smallest for ecosystem protection values, suggesting that ecosystem protection values are least impacted by the influence of technological embeddedness in the youngest cohorts.

Use values appear to have taken a different trajectory and have been on the decline for cohorts born in the 1920s and later. One possible explanation for this trend is that scarcity has been leading to a decline in use values. With a growing awareness of the finite nature of the wilderness resource, society began acknowledging that direct use could be accelerating wilderness's decline, and therefore, direct use of wilderness becomes less valued, relative to the other benefits wilderness could provide.

The control variables in the models did not behave as expected in all cases, suggesting a need to refine the theoretical suppositions supporting how and why urbanization, educational attainment, and exposure to wilderness may be impacting wilderness values. Urban status was expected to predict stronger wilderness values. The results indicate urban status is only significantly affecting ecosystem protection values, which lends support to the argument that these values are being transferred

through urban networks. The lack of impact of urban status on amenity values suggests that technological embeddedness may be affecting both urban and rural cohorts similarly, i.e., younger cohorts from both urban and rural areas are spending less time in nature. An examination of data from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior (USDI), U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau, 2011) supports this notion. In 2010, Alabama and South Carolina had some of the lowest rates of children participating in wildlife-related activities (7 and 5%, respectively). Both states are considerably less urban than the country as a whole. Interestingly, educational attainment did not significantly influence ecosystem protection values, as expected, suggesting that these values are more likely acquired through social or familial networks or cultures, rather than through formal, higher education channels. Women assigned a higher importance to all wilderness values, compared to men, as expected. This finding highlights the importance of decoupling predictors of wilderness values from wilderness visitation, as the literature suggests (Cole 2005; Johnson et al. 2004; Schroeder 2007). Women visit wilderness less frequently than men (Green 2006; Johnson et al. 2004; National Visitor Use Monitoring Survey (NVUM) 2016), yet hold stronger wilderness values.

The unexplained differences in state-to-state variation in use values also merits further inquiry. The northeastern states of New York, New Jersey, and Connecticut had some of the lowest predicted use values. The western states of Arizona, Tennessee, and Nevada had some of the highest. This differential could be related to differences in political culture and how environmental ethics are communicated through partisan lenses. Democratic northeastern states may conceptualize wilderness as a place in need of protection, in line with the protectionist view of nature commonly part of the democratic rhetoric. Republican states may have a more utilitarian view of nature (Teel et al. 2005) and, therefore, wilderness may be seen as a resource with many beneficial uses. Exposure to wilderness did not have a significant effect on use values, suggesting that although the distribution of wilderness areas varies between states, where western states have more sizable wilderness areas, compared to other states, this uneven distribution of wilderness did not account for differences in use values across states. This could be due to the fact that the majority of Americans do not use wilderness areas directly, even those who live relatively close by (National Visitor Use Monitoring Survey (NVUM) 2016). For example, from 2010 to 2014, the annual rate of visits to wilderness areas by Los Angeles metro area residents (who live within close exposure to several Wilderness areas) was only eight visits per 1000 residents (Rasch and Hahn 2018). While beyond the scope of this analysis, further research is needed to explain the observed differences in use values between states.

Limitations of this analysis include the skewed nature of the sample data toward a more rural, non-Hispanic, White population, and the low explained variance in the models. As the US population becomes increasingly more racially and ethnically diverse, particularly in the youngest generations, wilderness values may be affected. Future analysis of the wilderness values of non-Hispanic Whites born in the 1980s and after, compared to those held by Americans with diverse racial and ethnic backgrounds, would provide key insights into how wilderness values may continue to evolve in the future. The models explained only a small portion of the variance in wilderness values

of respondents. It is clear that additional investigation is needed to identify the full suite of social and cultural forces that are significantly influencing wilderness values.

The moderate decline in support for ecological service values in younger cohorts, as shown in Fig. 1, is a worrying trend. Since educational attainment has significant positive influences on ecological service values, this highlights the need for promoting higher education to ensure that future generations are aware of the full suite of invaluable ecological services that wilderness areas provide.

Wilderness managers should note the disparity in wilderness protection values between those living close to large wilderness areas and those residing farther away, as evidenced in Fig. 2. During land management planning processes, such as forest planning, land managers are tasked with balancing the values and priorities of both local and national publics. It is important for managers to take note that even though the ecosystem protection value of wilderness may not be as strong for local publics living close to large wilderness areas, the vast majority of the American public does hold strong ecosystem protection values. These values should not be overlooked in the face of pressure from local stakeholders.

Wilderness advocates of the nonuse values of wilderness, such as the value of wild, untrammeled landscapes, should take heed that unless there is greater effort to ramp up education around the existence values of humility and wildness in wilderness, this sentiment may very well be lost on future generations. The short film *Untrammeled*[2] is one effort designed to fill this educational gap by chronicling the wilderness experience of Montana youth in the Bob Marshall and Scapegoat Wildernesses.

Wilderness managers hoping to engage future generations in wilderness stewardship may find messaging that extolls the ecosystem protection benefits of wilderness more effective at compelling younger cohorts to support the wilderness cause. Selling the wilderness recreation experience or focusing on the nonuse values of just knowing that wild places exist may fall flat with younger, more technologically embedded generations, who are less likely to visit wilderness areas than older cohorts (Bowker et al. 2006; Green 2006; Rasch and Hahn 2018) or appreciate wilderness for its more metaphysical existence values.

This research adds to the literature by providing a more nuanced understanding of how younger cohorts value wilderness, compared to older cohorts. While ecological services, use amenity, and nonuse amenity wilderness values may not resonate as much with the youngest cohorts, the ecosystem protection value of wilderness, as a concept, or social construct, seems to endure. Further research is needed to explore the underlying mechanisms that can explain how and why demographic phenomena are reshaping the social facts of wilderness values for current and future generations.

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[2] This film United States Department of Agriculture (USDA) Forest Service 2016 is a project of the United States Forest Service, the Back Country Horsemen of Montana, local outfitters, the Arthur Carhart National Wilderness Training Center, the Wilderness Institute University of Montana, Montana Wilderness Association, Missoula Public Schools, Confederated Salish and Kootenai Tribal Education Department, and others.

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