



# Social value shift in favour of biodiversity conservation in the United States

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**Global biodiversity loss is indicative of the massive influence of human activity that defines the Anthropocene. Some scholars argue that changes in behaviour at the scale necessary to address this crisis will require wholesale change in cultural values. However, evidence is lacking on whether values are shifting. To better understand this phenomenon, we analysed long-term, large-scale trend data regarding wildlife values in the United States, collected through a 19-state survey in 2004 ( $n = 12,673$ ) and 2017–2018 ( $n = 20,674$ ). Findings confirmed an increased endorsement of mutualism values (seeing wildlife as part of one's social community and deserving of rights like humans) accompanied by a decline in values emphasizing domination (treating wildlife as resources to be used for human benefit), a trend further visible in cross-generational cohort analysis. We also found strong associations between state-level values and trends in urbanization, connecting the shift to macro-level socioeconomic factors. Results suggest positive outcomes for conservation but the field's ability to adapt will be critical to realizing those outcomes.**

The last century and a half must be judged as the most transformative period in human history. In five generations, many of the world's societies have transitioned from agrarian to industrial to postindustrial modes of life. According to Daniel Bell, a leading scholar of the postwar era, life rapidly transformed from a “game against nature” to a “game against fabricated nature” to a “game between people”<sup>1</sup>. Processes of innovation and modernization have had many positive effects on societal conditions including improvements in economic well-being, health care, food security, personal safety, mobility, life expectancy and freedom<sup>2</sup>. Unfortunately, however, these improvements come at a serious price. There are indications of an impending crisis—a long-term loss of biodiversity and ecosystem function that threatens to erode our planet's life-sustaining services<sup>3,4</sup>. The enormity of this crisis is signalled by estimates suggesting humans have increased the rate of species extinction by roughly three orders of magnitude<sup>5</sup>, prompting a sixth mass extinction<sup>6</sup>.

Scholars who track these trends often come to a common conclusion: humans must change their behaviour if the planet's life-sustaining processes are to be preserved<sup>7</sup>. While some argue that changes in human behaviour at the scale necessary to achieve sustainability will require wholesale change in cultural values<sup>8,9</sup>, the ability to intentionally and systemically alter culture is, at present, beyond reach<sup>10</sup>. Still, research shows that values can shift in response to changes in social–ecological conditions<sup>11,12</sup>. This raises critical questions about the future: as societies and ecosystems change, is value shift occurring; if so, in what direction; and what does this shift imply for future efforts to conserve biodiversity? These questions are at the root of our investigation of how value shift is unfolding with implications for conservation in the United States. While the extant literature points to changing views of nature that, over time, have shaped the framing and purpose of conservation in modern societies<sup>13</sup>, scientific evidence is lacking on whether and how societal values related to conservation are actually shifting.

Using data from a survey replicated in 19 western states in 2004 and 2017–2018 (hereafter 2018), we provide the first evidence of an intergenerational shift in societal values toward wildlife and relate the shift to trends in state-level socioeconomic factors over time. Prior research has shown that wildlife values are strong predictors of myriad conservation-related attitudes and behaviours<sup>14–16</sup>, making them a meaningful object of study for exploring implications of value shift for conservation. Additionally, wildlife is highly salient to people, attracting interest and concern; often seen as a barometer of ecological health<sup>17</sup>; and core to global concerns about biodiversity loss and species extinctions that form the foundation for the so-called ‘crisis’ disciplines of conservation (for example, conservation biology)<sup>18</sup>.

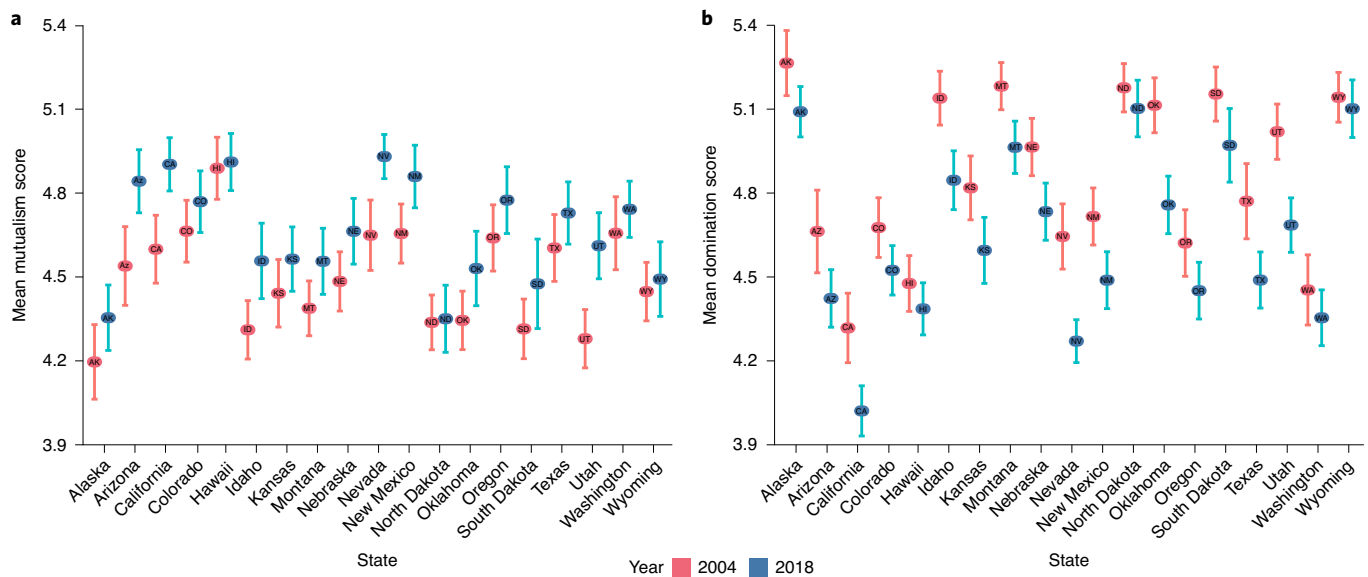
## Mechanisms of value shift

Given the many definitions of the term ‘values’<sup>19</sup>, it is important to provide conceptual clarity in our use of this term. We take a systems approach<sup>20</sup> and embrace the commonly used definition that values are ideals and principles that guide human behaviour<sup>21</sup>. They are core to an individual's cognitive system, giving direction to one's thoughts and actions. As they become shared across groups, values are embedded in our surroundings and apparent in how we shape the environment to meet our needs, identities we adopt<sup>22</sup> and ways of understanding. They drive collective action, including the rise of social movements, discourses and institutions. From this perspective, values are dynamic, adaptive and shaped through multilevel feedbacks in the broader social system<sup>20</sup>. While values are held by individuals, groups are characterized by their commonly held values, contributing to group unity and identity<sup>23</sup>. In an open, democratic society, policies ultimately reflect predominant social values.

Adoption of new values by society is not a conscious choice; societies do not ‘choose’ which values to have. Yet values do emerge from individual agency and the array of choices people make in meeting their needs. New goal structures arise from widespread shifts

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**Fig. 1 | Changes in value scores among 19 western US states between 2004 and 2018. a, b,** Mean mutualism (a) and domination (b) scores. Individual responses were weighted according to demographics within each state. Error bars represent 95% CI.

in thoughts and behaviours<sup>24</sup>, although the processes of change are poorly understood. To illustrate, immigrants to the US western frontier in the 1800s encountered threatening conditions and the need to be self-sufficient in day-to-day tasks<sup>25</sup>. The response to these conditions gave rise to an ideology of independence, adopted because it was advantageous in dealing with the new environment. The importance of independence was transmitted vertically through families and imitated across groups, giving rise to strong values of independence still apparent in the western United States.

We refer to social value shift as large-scale change in prioritization of values, as well as the possibility of introduction of entirely new cognitive goals. Loosely conceived, there is a chronology to these stages of change: changes in social–ecological conditions stimulate innovation, new discourses, and cognitive and behavioural changes that are advantageous. These changes are adopted by others and ultimately may spread throughout a population. Collectively, new ways of thinking about individual goals may result, which are in turn adopted and eventually embedded in culture. These processes are not linear; rather, they are iterative, unfolding at different timescales and involving feedbacks across levels of individuals, groups, organizations and societies. For our purposes, and as recognized in other studies of culture change<sup>21,26</sup>, shifts in values are expected to lag behind changes in social–ecological conditions.

There are three separate pathways by which societal value shift might occur. First is the possibility that individual values change over time, which, in aggregate, would result in a collective shift. While psychology researchers generally assume values are stable over an individual's lifetime, some research shows cohort value shift<sup>27</sup>. Other research proposes that life-changing events<sup>28</sup> and aging<sup>29</sup> affect the magnitude of value importance. In any case, it is recognized that psychological processes tend to reinforce value stability for individuals<sup>30</sup>, as do external forces such as environmental surroundings, normative pressures and cultural practices. There is inadequate evidence to suggest that intra-individual change is a major force in broad-scale social value shift. Second, the most widely endorsed explanation for population-level value shift is intergenerational replacement. This explanation advances the idea that values are formed in youth and change little within individuals over time<sup>31,32</sup>. As social–ecological conditions change, circumstances of youth change and new values emerge that differ from

those of previous generations. Intergenerational replacement is central to Inglehart's proposition that post-World War II economic growth produced a level of wealth and improved well-being that alleviated concerns about subsistence<sup>26</sup>. These improved conditions elevated the importance of higher-order needs, stimulating a transition from survival-oriented to self-expressive values. Third, migration can substantially impact the cultural composition of an area. While economic considerations are a primary driver of migration decisions<sup>33</sup>, research shows that individuals choose to live in communities with ideologies similar to their own to satisfy their need to belong<sup>34</sup>. This would have the effect of reinforcing the area's prevailing value structure.

### Case study of shifting wildlife values in the United States

Our theory is borne from social–ecological conceptualizations in psychology that explore how macro-environments affect human thought and behaviour<sup>12</sup>. We propose that wildlife value shift accelerated as part of the transformative global culture change of the twentieth century<sup>26</sup>. Notably, an increasingly urban lifestyle and rapid economic growth following World War II stimulated new conceptions of wildlife and human–wildlife relationships, resulting in a shift from domination to mutualism values. Domination, borne from the Reformation and considered the defining ethos of America's relationship with the natural environment<sup>35</sup>, represents a view wherein wildlife are construed primarily as resources available for whatever uses benefit humans. Mutualism views wildlife from a more egalitarian perspective as counterparts or companions in one's broader social community. We explain the transition as a multilevel process; improvements in societal conditions affected individual cognitive processing, resulting in altered thought patterns, social discourse and, ultimately, personal values. These processes emerged up through the social system, affecting organizations, power structures and policies<sup>20,36</sup>. Values concerning nature and wildlife are, like other values, formed largely through associative learning in youth, as children interact with adults, peers and their environment. Urbanization and economic growth changed the context of life by altering the environment and removing people from direct contact with and risk from wildlife<sup>37</sup>. Fear of wildlife and dependence on them for material well-being dissipated. At the same time, more Westernized lifestyles were marked by social isolation and

a tendency to anthropomorphize, resulting in animals being perceived as more human-like and thus afforded conspecific normative and moral considerations<sup>38</sup>. These conditions ultimately facilitated the rise of mutualism values that are gradually replacing domination values through intergenerational replacement and human migration.

Here, we sought to document the extent of actual change that is occurring using data collected across a 14-yr interval, from 2004 to 2018 (Methods). Although this is a relatively narrow window of time, it is similar to other efforts to characterize value shift<sup>39</sup>. Our first objective was to determine if we could detect a state-level shift from domination to mutualism values. Second, we explored whether such a shift was apparent across generational cohorts and if parallel changes were evident in each generation. Third, we examined whether changes in gross domestic product (GDP) and urbanization, as indicators of socioeconomic development, were related to state-level value changes. Fourth, we tested whether the rise in mutualism was associated with declines in hunting across states. We chose hunting as an important illustration of the potential implications of our findings for conservation, given the heavy reliance by state wildlife agencies on hunting as a wildlife management strategy, public recreation opportunity and important source of funding<sup>40</sup>.

## Results

We found changes in mean value scores across states in the expected direction. The mean mutualism score increased from 4.490 (95% confidence interval (CI) [4.464, 4.515]) in 2004 to 4.748 (95% CI [4.716, 4.779]) in 2018, a 5.75% proportional increase; and the mean domination score decreased from 4.885 (95% CI [4.861, 4.910]) in 2004 to 4.472 (95% CI [4.442, 4.503]) in 2018, an 8.45% proportional decrease. States with the greatest increase in mean mutualism scores (Fig. 1a) during that time period were **Utah** (raw score change +0.332; proportional change +7.77%), **Arizona** (+0.303; +6.68%), **California** (+0.303; +6.60%), **Nevada** (+0.281; +6.05%) and **Idaho** (+0.246; +5.72%). States with the greatest decline in mean domination scores (Fig. 1b) were **Nevada** (−0.374; −8.06%), **Oklahoma** (−0.356; −6.97%), **Utah** (−0.334; −6.65%), **California** (−0.297; −6.87%) and **Idaho** (−0.294; −5.71%). Analysis of variance (ANOVA) tests on value scores revealed a statistically significant interaction between main effects of state and year (2004, 2018) for mutualism ( $F[18, 33269] = 1.889, P = 0.013$ ) and domination ( $F[18, 33272] = 2.511, P < 0.001$ ). These interactions indicate that patterns of change differed by state: some states increased in mean mutualism scores, while others remained the same; and mean domination scores decreased or remained the same (Fig. 1). While several states showed significant increases in mutualism or decreases in domination, none showed significant decreases in mutualism or increases in domination.

When examining percentages of ‘value types’ (Methods), we found statistically significant differences by state ( $Q_{RS} [38.786, 1293346] = 24.503, P < 0.001$ ) and year ( $Q_{RS} [2.949, 98333.078] = 114.83, P < 0.001$ ). However, associations were relatively small (state Cramér’s  $V = 0.163$ ; year Cramér’s  $V = 0.151$ )<sup>41</sup>. The mean state percentage of mutualists (Fig. 2a) increased from 26.6% in 2004 to 31.5% in 2018 (18.1% proportional increase); the mean state percentage of traditionalists (Fig. 2b), who emphasize domination values, decreased from 40.1% in 2004 to 32.8% in 2018 (18.1% proportional decrease). Changes varied considerably across states (Supplementary Figs. 1 and 2 and Supplementary Table 2), with patterns similar to those found for mean value scores. States with the

greatest increase in mutualists were **Utah** (raw percentage change +11.8%; proportional change +57.8%), **Nevada** (+11.6%; +35.2%), **California** (+9.48%; +24.7%), **Oklahoma** (+7.06%; +34.9%) and **Texas** (+6.62%; +22.8%). States with the greatest decrease in traditionalists were **Arizona** (−14.4%; −37.0%), **Oklahoma** (−13.0%; −26.5%), **Utah** (−11.6%; −24.3%), **California** (−10.8%; −39.3%) and **Idaho** (−10.5%; −21.6%).

ANOVA tests on value scores by main effects of generational cohort (‘silent generation’, born 1928–1945; ‘baby boomers’, born 1946–1964; and ‘generation X’, born 1965–1980)<sup>42</sup>, state and year showed a statistically significant three-way interaction effect for mutualism ( $F[69, 32855] = 1.764, P < 0.001$ ) and domination ( $F[69, 32858] = 1.718, P < 0.001$ ). Value type percentages differed statistically by cohort ( $Q_{RS} [8.902, 296843.7] = 35.625, P < 0.001$ ), although the association was small (Cramér’s  $V = 0.099$ )<sup>41</sup>. Percentages of mutualists (Fig. 3a) steadily increased within and between generations over time, and percentages of traditionalists (Fig. 3b) steadily declined (Supplementary Table 3). Further, mutualists showed a steady increase across generations from the ‘greatest generation’ to ‘millennials’. Traditionalists had relatively constant representation across generations, up to generation X and millennials, among whom the percentages of traditionalists were significantly lower. These findings offer support for the proposal that value shift was largely a post-World War II phenomenon. We also found evidence of intragenerational shift in the form of a significant increase in mutualists and a significant decline in traditionalists within the silent generation, baby boomers and generation X. At either end, the greatest generation in 2004 and the Millennials in 2018 showed a continuation of this pattern.

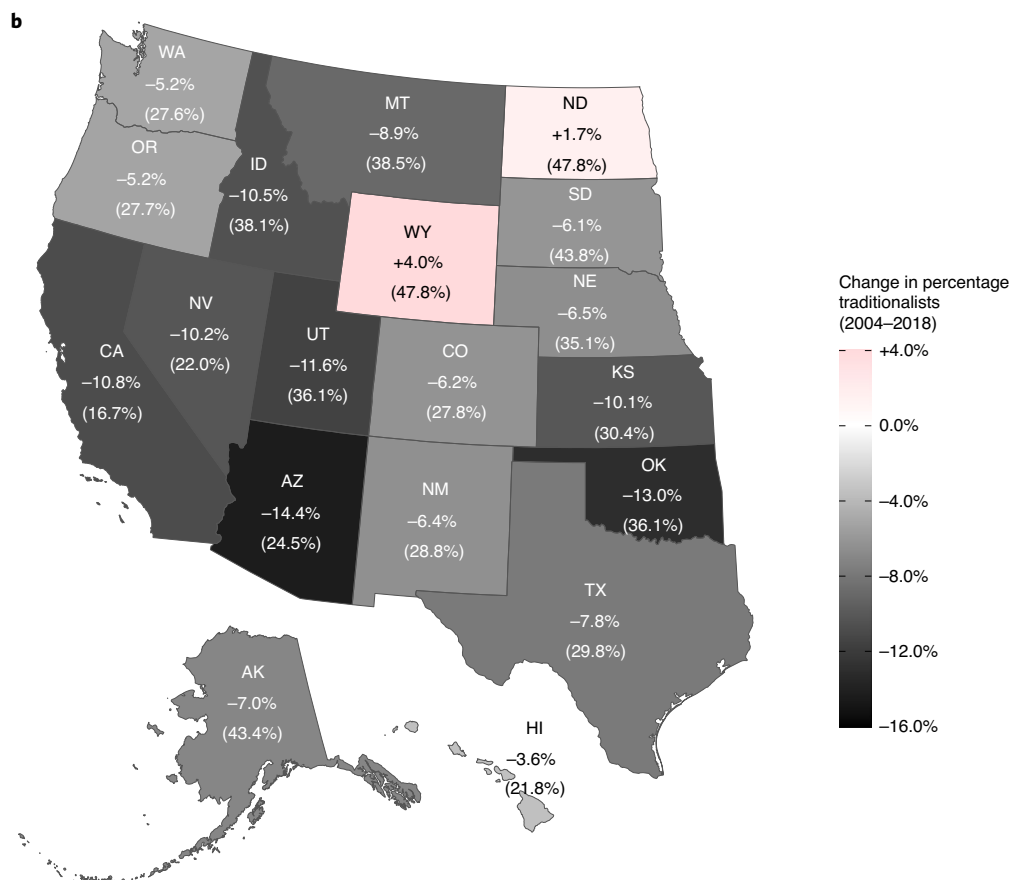
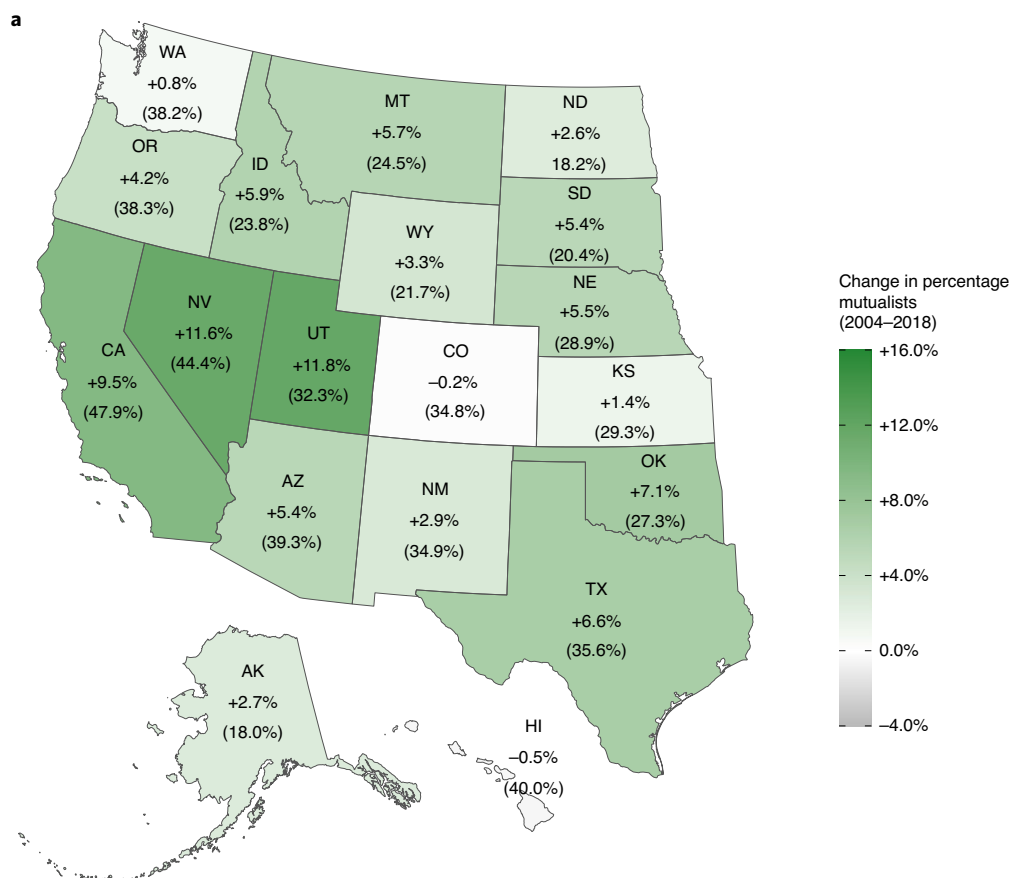
Changes in mean mutualism and domination scores across states had mostly moderate<sup>41</sup> correlations with changes in urbanization and GDP from 2004 to 2018 and since the post-World War II period (Table 1 and Supplementary Table 4). Correlations with changes in mutualists and traditionalists were also generally moderate or, in some cases, small. However, current (2018) mutualism and domination scores and mutualist and traditionalist percentages showed consistently large associations with urbanization and GDP both at their present levels and in changes over time. Correlations were generally stronger for urbanization than for GDP. While it is difficult to predict factors affecting value shift in such a short time period, these findings offer support for the socioeconomic influences we explored. Stronger associations found between present-day values and these variables may be due to a time lag between social change and value shift. It is also possible that greater variance would occur across a longer time horizon, resulting in stronger correlations than what we found in a 14-year period.

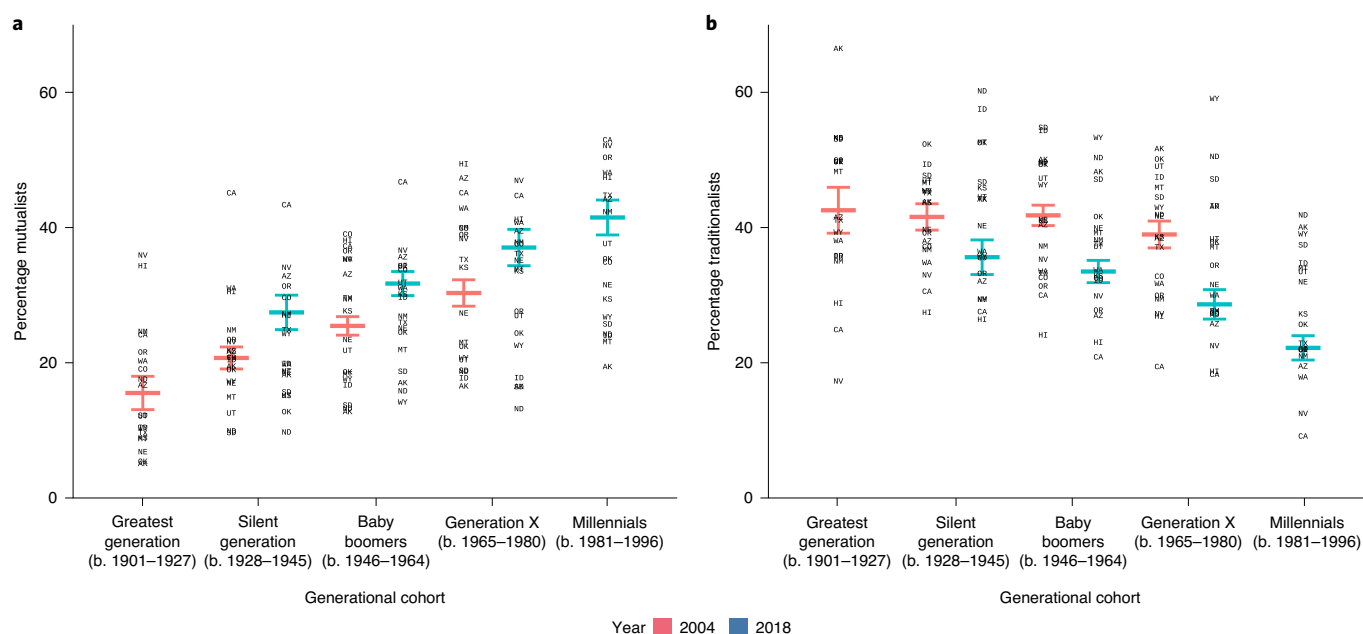
The percentage of hunters was strongly associated with the percentage of mutualists across states in 2004 ( $r = -0.917$ ) and 2018 ( $r = -0.961$ ) (Fig. 4). Consistent with expectations, we also found a steady decline across states in proportions of hunters over time, a trend indicative of the potential effects of value shift on conservation-related behaviours.

## Discussion

Our theory and research suggest that wildlife values in the United States are shifting from domination to mutualism, and the shift is associated with increased socioeconomic development, reduced contact with and threats from wildlife, and the rise of anthropomorphic thinking. Changes in urbanization and economic well-being are critical forces that alter life circumstances, thought processes,

**Fig. 2 | Changes in value types among 19 western US states between 2004 and 2018. a,b**, Change in percentages of mutualists (a) and traditionalists (b). Percentages of the total population in 2018 are shown in parentheses. Individual responses were weighted according to demographics within each state. AK, Alaska; AZ, Arizona; CA, California; CO, Colorado; HI, Hawaii; ID, Idaho; KS, Kansas; MT, Montana; NE, Nebraska; NV, Nevada; NM, New Mexico; ND, North Dakota; OK, Oklahoma; OR, Oregon; SD, South Dakota; TX, Texas; UT, Utah; WA, Washington; WY, Wyoming.





**Fig. 3 | Changes in value types within and between generational cohorts among 19 western US states between 2004 and 2018. a,b**, Change in percentages of mutualists (**a**) and traditionalists (**b**). Percentages are of overall responses weighted by state-level demographics. State-level percentages are depicted as state name abbreviations. b, born. Error bars represent 95% CI.

**Table 1 | Correlations between wildlife value scores and value type percentages, and urbanization and gross domestic product**

	Urbanization (2010)	GDP (2017)	Change in urbanization since 1950 <sup>a</sup>	Change in urbanization since 2000 <sup>a</sup>	Change in GDP since 1963	Change in GDP since 2004
<b>Mutualism score (2018)</b>	0.846	0.392	0.725	0.483	0.398	0.384
<b>Domination score (2018)</b>	−0.882	−0.583	−0.747	−0.490	−0.591	−0.580
<b>Mutualists (2018)</b>	0.908	0.540	0.774	0.514	0.547	0.536
<b>Traditionalists (2018)</b>	−0.865	−0.508	−0.742	−0.441	−0.516	−0.501
<b>Change in mutualism score since 2004</b>	0.381	0.255	0.418	0.540	0.264	0.243
<b>Change in domination score since 2004</b>	−0.300	−0.269	−0.280	−0.544	−0.266	−0.255
<b>Change in mutualists since 2004<sup>a</sup></b>	0.331	0.413	0.351	0.594	0.417	0.405
<b>Change in traditionalists since 2004<sup>a</sup></b>	−0.187	−0.097	−0.169	−0.299	−0.098	−0.088

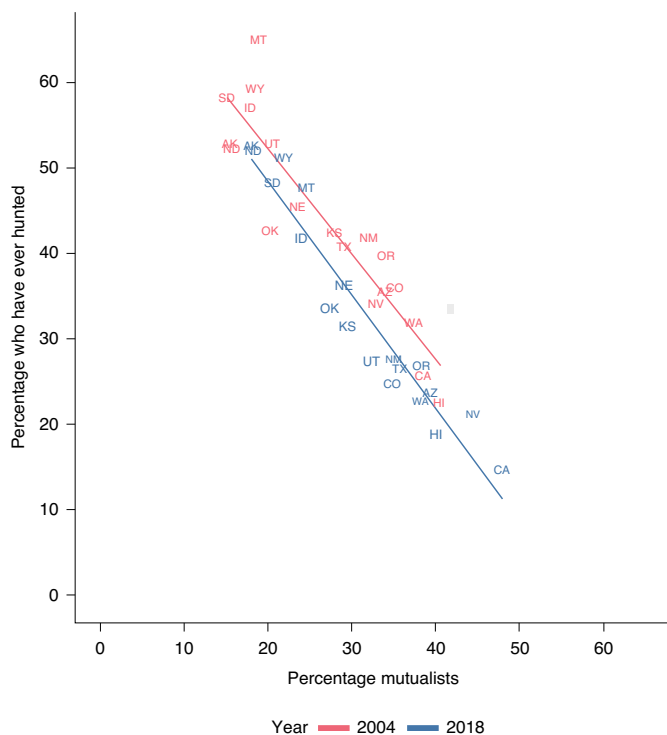
Rows represent value scores and value types, while columns represent socioeconomic variables, both at the state level. <sup>a</sup>Measures were adjusted to account for the amount of change observed relative to the amount possible given their starting values (that is, change in proportion, divided by 1 – starting proportion).

and social and environmental interactions. As such, these factors are indicators of a much wider array of changes than assessed in this study.

Prior research revealed associations between mutualism and state-level socioeconomic factors (for example, urbanization)<sup>36</sup>, anthropomorphic attributions to wildlife<sup>38</sup> and attitudes toward a diverse array of wildlife-related issues<sup>14–16</sup>. Here, we provide the first evidence of trends regarding the shift toward mutualism, relying on 2004–2018 trend data from 19 western states. On average, states showed a 4.9% increase in mutualists and a 7.3% decline in traditionalists, who emphasize domination values. Analyses further indicated that the current composition of values in a state is strongly associated with current levels of urbanization and urbanization trends since 1940. This relationship also occurred with GDP, albeit associations were weaker. Changes in urbanization and GDP, however, were only modest predictors of value change over the 14-yr period. These latter results are somewhat similar to those of Tormos

et al., who examined change using Schwartz's value classifications and European Social Survey data for a similar time period (2003–2013)<sup>43</sup>. They found that socioeconomic variables had a notable effect on value composition across nations but changes in those variables over time were poor predictors of value shift.

What might explain this pattern of findings? First, it is unlikely that change within a state is linear and monotonic; rather, it is likely to pulse and pause along its path in response to a variety of factors. There may be limitations, therefore, in using empirical data from a limited timespan to establish causes of change processes that take many decades to unfold. Short-term trends may misrepresent broader trends. Change at any one point in time is probably a function of its position along a historically dependent trajectory. Second, it is important to recognize differing scales and orderings of change, as they may create time lags and randomness in the change process. While socioeconomic conditions might change rather quickly and create the stimulus for shift, the process of cultural change will



**Fig. 4 | Percentages of hunters by percentages of mutualists across 19 western US states, 2004 and 2018.** Individual responses were weighted according to demographics within each state. Trend lines depict linear models fit using least squares regression.

be slower, as it involves intergenerational value acquisition and spread, adoption of new ideas across multiple segments of society, and emergence to group levels and broader saturation as new value structures become culturally embedded.

Our analysis of trends across generational cohorts provides support for our stance that value shift stemmed from a change in life conditions associated with urbanization and improved economic well-being. The decline in traditionalists accelerated in generations following the silent generation and baby boomers, while mutualists increased consistently from the greatest generation through millennials. While findings support an explanation of intergenerational value shift, we also found change within generations, which may in part be explained by the effect of immigration—that is, people moving primarily into urban areas with values similar to those of residents (mainly mutualism). Another possibility, although less supported in the literature, is the occurrence of within-individual value change<sup>44</sup>.

What, then, do these findings suggest for the future of conservation? For conservation professionals in the United States, it is important to realize that a substantial portion of the public does not view wildlife through the same anthropocentric and utilitarian lenses prevalent during the early formative period of organizations that govern wildlife conservation<sup>45</sup>. While discourse about human–nature relationships has shifted<sup>13</sup>, the ideology of the wildlife profession<sup>46</sup> has been remarkably resilient to change. Illustrating the impacts of this situation, we found that increases in mutualists were associated with significant decreases in hunter proportions. Hunting is not only an important source of funding for state wildlife agencies but is also deeply embedded in the cultural traditions of wildlife management that society is moving away from.

While our focus was on wildlife values, our broader programme of research shows that the prevalence of mutualists across all 50 states is positively associated with support for environmental

protection over economic growth ( $r=0.76$ ); protecting declining or endangered species over private property rights ( $r=0.74$ ); and the idea that the earth is getting warmer due to human activities such as burning fossil fuels ( $r=0.85$ )<sup>47</sup>. Mutualists, more so than traditionalists, are concerned about wildlife population decline, habitat protection, restricting humans to benefit wildlife and maintaining natural conditions<sup>15,16</sup>. The shift toward mutualism would probably elevate concern for wildlife sustainability over utilitarian interests, facilitating greater support for conservation and pro-conservation behaviours. At the same time, it is likely to foster an idealized perception of wildlife behaviour. For example, urban residents with less direct contact with wildlife may be unaware of the risks that wildlife pose; simultaneously, mutualism values that are more predominant in these areas promote a desire to get close to wildlife as companions. This can lead to risky or harmful behaviours, such as feeding or approaching wildlife from an unsafe distance, that are increasingly of concern in relation to the growing problem of human–wildlife conflict.

It is difficult to predict whether the shift we detected will persist in the same direction. Given the strong association with urbanization and projections that urbanization will continue to increase through the mid-twenty-first century<sup>48</sup>, it is reasonable to assume that this value transition will remain on its current path. However, change can be random and unpredictable, and future trends will be influenced by multiple social and ecological factors. With climate change and associated population growth, the future holds a vast array of life-altering environmental events such as earthquakes, fires, drought, hurricanes, floods and zoonotic disease that have been shown to impact values<sup>49</sup>. Evidence suggests that human cognition will adapt to environmental threats<sup>11,12</sup> but it is unclear exactly how these events will affect change and sustainable outcomes are not a certainty<sup>50</sup>. This is a critical area for future research.

Some scholars argue that widespread changes in human values and associated behaviours are necessary to avert environmental catastrophe<sup>7</sup>, sparking debate about the effectiveness of efforts targeting value shift<sup>51</sup>. Human agency through innovation and discourse will certainly affect adaptive behaviours and may influence how values evolve. However, complex macro-level social processes like value formation are not well understood and the ability to intentionally affect the direction of change is unproven. As Wilson notes, “cultures work largely without anyone designing them or knowing how they work” (p. 192)<sup>10</sup>. The focus of change efforts will probably be more effective when directed toward cognitions (for example, attitudes) more proximate to individual behaviour and innovation. The future of conservation, we argue, depends on how well the field as a whole is able to adapt to these social changes and work within existing value structures in sufficient time to avoid the worst aspects of ecosystem collapse<sup>4</sup>.

## Methods

**Data collection.** For the 2004 study, we administered a mail survey with appropriately tailored procedures<sup>52</sup> to a sample of residents in each of the following states: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington and Wyoming<sup>14,36</sup>. We obtained resident contact information from Survey Sampling International (Shelton, Connecticut), with samples stratified by state and age to ensure adequate representation of population subgroups, and sought, through requests in our cover letters, equal representation of males and females. We received 12,673 completed surveys (over 400 per state, allowing for population estimates within 5% at the 95% confidence level<sup>53</sup>). To test for non-response bias, we phoned a sample of non-respondents in each state following data collection ( $n=7,388$ ). We found significant differences between respondents and non-respondents on age and participation in wildlife-related recreation but only marginal variation (partial  $\eta^2 < 0.01$ , the level at which the effect size is defined as small<sup>41</sup>) in value scoring. We weighted data to adjust for under-representation of younger age groups and over-representation of certain forms of wildlife-related recreation within each state<sup>14</sup>.

For the 2018 study, we collected data via administration of a mail survey with an online option to a random sample of residents in all 50 states<sup>47</sup>. We conducted

two pilot studies in 2016, testing mail, telephone and email panel methods to inform decisions about final data collection mode. Given low response rates that are increasingly a challenge for US public surveys<sup>54,55</sup>, we supplemented samples in each state with an email panel survey. To boost response in under-represented racial and ethnic categories, we also conducted a separate follow-up email panel survey targeting these groups. We obtained samples from commercial firms: Survey Sampling International for the mail survey and Qualtrics (Provo, Utah) for the email panel survey. We recruited mail survey participants via three mailings (two survey mailings and a reminder postcard) and requested participation by the adult in the household with the most recent birthday to attempt equal representation of males and females<sup>52</sup>. We over-sampled residents under age 35 and under-sampled residents age 55 and older to help correct for the disproportionately higher response typical among older age categories in mail surveys. We recruited email panel participants via an email invitation and used screening criteria to ensure samples were representative of gender and age proportions in the state. We received 46,894 completed surveys, including over 400 per state, in our combined samples. We merged mail and email panel data by state and weighted by age, gender and race/ethnicity<sup>56</sup>, and by participation in hunting and fishing<sup>57</sup>, for greater accuracy in state population estimates. Because some states opted for a larger, stratified geographic sample (for example, by county), we also weighted data in these states to reflect the relative proportion of the state's population in each stratum. For reporting at national and regional levels (all states combined), we applied additional weights to account for state population sizes.

We took a subset of data from 2018 that matched the 19 states represented in the 2004 study, yielding 20,674 survey respondents. Data were also selected to match prior demographic sampling criteria applied in 2004 to allow for direct comparison. The two datasets combined resulted in a total sample size of 33,347 participants. Final survey and administration procedures for both studies were approved by Colorado State University's Institutional Review Board (protocols 02-135H and 049-17H).

**Measurement.** We measured wildlife values using multiple survey items validated in previous research to represent basic beliefs about wildlife and wildlife management (Supplementary Table 1)<sup>14,15,36</sup>. A domination value orientation was indicated by beliefs representing dimensions of hunting and wildlife use, whereas a mutualism value orientation was indicated by belief dimensions of caring and social affiliation. Respondents rated their level of agreement with belief items on a scale from 1 (strongly disagree) to 7 (strongly agree). Reliability analysis conducted in SPSS (Chicago, Illinois) revealed that our groupings of items into belief dimensions and value orientations provided a good fit for the data (Cronbach's alpha was >0.75 for all scales). To compute value orientation scores, we assigned respondents a score for each belief dimension (for example, wildlife use), computed as the mean of all items within that dimension. We then assigned a value orientation (for example, domination) score by computing the mean of corresponding belief dimension scores. We segmented respondents into value types by comparing their scores on domination and mutualism simultaneously. High scores were defined as >4.50 (above the scale midpoint), whereas low scores were defined as ≤4.50. Individuals with predominately domination values ('traditionalists') scored high on domination and low on mutualism, and those with primarily mutualism values ('mutualists') scored high on mutualism and low on domination. Additional types included individuals who scored high on both ('pluralists') or neither ('distanced') of these scales<sup>14</sup>.

We retrieved socioeconomic data on urbanization and GDP from the US Census Bureau and US Bureau of Economic Analysis, respectively. We combined historical urbanization data from 1900 to 1990<sup>38</sup> with census data from 2000 and 2010 (Census Table P002). As the decennial census dates do not match perfectly with the dates for our two studies, we used urbanization levels in 2000 to represent conditions at the time of the first survey, in 2004, and levels in 2010 for the second, in 2018. We retrieved data on annual GDP by state (in millions of current US\$) from 1963 to 2017<sup>39</sup> and used data from the respective years of the two surveys. Finally, we measured participation in hunting by asking respondents to indicate (yes/no) whether they had ever engaged in this activity in the past.

**Analysis.** Analyses were performed using the R statistical environment (v.3.6.1) and guided by a priori explanations on the basis of our theory of wildlife value shift<sup>40</sup>. We created separate variables for the survey data and socioeconomic data at the 2004 and 2018 time points, and calculated the amount of change across the two time points. We then adjusted variables that represented the proportion or percentage of a whole (that is, proportion of value types and proportion of urbanization) to account for the amount of change observed relative to the amount possible given their starting values and their distance from 100%. We did this by dividing the change in proportion by 1 minus the starting proportion, to obtain the relative amount of change. We then used these adjusted values for any analyses related to the amount of change in these variables.

We assessed differences in mean mutualism and domination scores by groups using factorial Type I ANOVA tests. For all ANOVA tests, we used the combined individual-level datasets from the 2004 and 2018 surveys and included state sampling weights in the regressions. To examine changes in percentages of value types, we used second-order (Satterthwaite) Rao–Scott chi-square tests to account

for weighted proportions and Cramér's *V* to measure the relative strength of these associations. To assess the degree of association between numeric variables, we used Pearson's (*r*) correlations. We used an alpha level of  $P < 0.05$  for significance in all statistical tests, and *P* values for multiple comparisons against the same outcome variable (value score or value type percentage) were adjusted to control for false discovery rate<sup>61</sup>. We also relied heavily on effect size measures to determine practical significance and account for a higher likelihood of finding statistical significance with large sample sizes<sup>41</sup>.

**Reporting Summary.** Further information on research design is available in the Nature Research Reporting Summary linked to this article.

## Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## Author contributions

M.J.M. wrote the manuscript with input from all of the authors. M.J.M. and T.L.T. conceptualized and designed the project, secured funding and collected the data. J.T.B. and S.K. contributed to conceptual development. R.E.W.B. conducted data analysis.

## Competing interests

The authors declare no competing interests.

## Additional information

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Data collection We obtained samples from commercial firms: Survey Sampling International (Shelton, Connecticut) for our mail surveys and Qualtrics (Provo, Utah) for our email panel survey.

Data analysis We conducted analysis in SPSS (version 25) and R (version 3.6.1).

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Sampling strategy	For mail surveys in both time periods (2004 and 2017-2018), we obtained resident contact information from Survey Sampling International (Shelton, Connecticut), with samples stratified by state and age to ensure adequate representation of population subgroups, and sought, through requests in our cover letters, equal representation of males and females. We conducted multiple mailings to maximize response. We supplemented samples in each state in 2017-2018 with an email panel survey administered through Qualtrics (Provo, Utah). We employed screening criteria in the email panel survey to ensure samples were representative of gender and age proportions in the state. To boost response in underrepresented racial and ethnic categories, we also conducted a separate follow-up email panel survey targeting these groups. We received over 400 completed surveys per state in both time periods, allowing for population estimates within 5% at the 95% confidence level (Scheaffer et al. 1996).
Data collection	See above. Data were collected via self-report mail and email panel surveys.
Timing	Data were collected in 2004 and 2017-2018 using the survey items, allowing for longitudinal comparisons.
Data exclusions	All data for the 19 western U.S. states in both time periods that were relevant to our objectives in this manuscript were used in analysis.
Non-participation	Survey participation rates varied by state. To address potential nonresponse bias, we weighted data at the state level using outside sources (e.g., U.S. Census) for greater accuracy in state population estimates.
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