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BOOK REVIEWS

Research and Theory in Human Ecology

Spanish Environmental Generations in the Twentieth Century

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Abstract

This article is an attempt to relate the concept of generation, as a variable that helps to explain certain environmental behaviors, with theories on intergenerational changes in values (Inglehart, 1977, 1991, 1998; Inglehart & Flanagan, 1987). This theory predicts an increase in post-materialistic values in more developed societies, with ecology being one of these values. According to these forecasts, a greater ecological commitment should be expected from younger generations in developed societies, where material needs are covered. However, my data did not fit into predictions of this theory. On the contrary, there is evidence of an increase in values which could, in a certain way, be called low-cost post-materialistic, applying the term proposed by Diekmann & Preisendörfer (2003).

Keywords: environmental attitudes, generations, intergenerational change, post-materialistic values

Introduction

The research question that directs this work is: How are predictions regarding intergenerational changes of values related to the environmental behavior of Spanish generations? As a work hypothesis, which arises from the question, I consider: (1) if it is possible to identify contemporary Spanish generations and (2) if their collective environmental identity can be defined.

The answer to this question requires the existence of a previous generational model to apply the variables that determine a higher or lower environmental profile. That is why one of the fundamental theoretical components of this work is the generation theory, which is still rarely applied in sociology. The starting point for the construction of the generation model was the results of previous studies (Caballero, 2015; Caballero & Baigorri, 2013), in which six contemporary generations were characterized and defined from historical, socioeconomic (according to the

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level of scarcity/abundance), and environmental (according to the expression of environmental values and behaviors) aspects; and from which only a small synthesis is shown.

This article consists of a wide theoretical framework that, in addition to the generations theory, includes an approximation to environmental attitudes and values systems as well as a synthesis of the post-materialistic values theory, especially regarding intergenerational value change predictions. The article continues with the method designed to answer the research question. To finish, the results are presented and the main conclusions that are drawn from them.

An approximation to the generation theory

Two schools of thought can be found at the origins of the sociological generation concept: the French positivist school and the German historicist school. The founder of the first, Auguste Comte, developed a lineal and mechanical generation concept based on the amount of time needed for one generation to substitute another: 30 years is the expected time for this to happen (Comte, 1839, p. 639). While the historicist school does not focus on the mechanical continuity and succession of generations, but on the lack of continuity in the way that each one affects the course of history (Dilthey, 1875), what is important for this school is the quality of what unites the members of one generation that has shared political, social, intellectual, or artistic events. This rupture with Comte's positivism introduces an almost unsolvable methodological difficulty, because the key is not objectively set in the "amount of time" needed to determine the change from one generation to another, but in identifying the influence that the life of individuals has on the shared social–historical "quality of experiences."

The proposals of the Spanish philosopher Jose Ortega y Gasset and the German sociologist Karl Mannheim posed a more systematic approach to the generational concept, which fueled philosophy, literary criticism, history, and sociology during the twentieth century. For Ortega y Gasset (1970), the definition of generation implies the coexistence of several generations during the same historical period, creating the need to differentiate between peers (of the same age) and contemporaries (living at the same time). He established the duration of generations as 15 years, and divided the life of generations into five 15-year periods, which correspond to five vital moments (childhood, adolescence, early adulthood, adulthood, and old age). Each generation lives on two levels: "one consists in accepting and learning from older generations' previous experience, the other would be to let their own spontaneity flow" (Ortega y Gasset, 1970, p. 41). The vital spirit that encourages each generation depends on both of these factors. In historical terms, when there is homogeneity between what was received (inherited) and what the new generation creates, the generation lives in a "cumulative epoch." But when there are big differences between

what is received and created, the generations live in "eliminatory" or "polemic" epochs, which Ortega y Gasset called "combat generations." The alternation between cumulative and polemic epochs, between older and younger generations, is the rhythm of history.

Mannheim (1993) created the generation concept, not so much from the date of birth, as from sharing a same generational situation, which is where a point in history and conditions for our existence are joined. The creation of a generational link means that the individual is affected by a lack of continuity in the historical process; these lacks of continuity are experienced during a phase in their lives when the socialization process is not completed and, therefore, individuals still have flexible ways of interpreting reality. But the process does not give rise to just one collective identity; it also depends on each person's position within the social arena, that is, the economic, social, and cultural conditions that they live in, "because it is they who decide their possible ways of acquiring experience and awareness" (Ghiardo, 2004, pp. 24–25).

The use that sociology has made of this concept has been scarce and irregular in time and its epistemology. Some authors (e.g., Bell, 1962; Lapassade, 1963; Riesman, 1965; Toffler, 1973; Wright Mills, 1961) have come close to the concept, managing it well with regard to what would be the richest and most creative sociological approach, but with a weak empirical foundation. The second type of approximation, with the intention of resolving the problems that the methodological issue raises, is connected to the life cycle (Abrams, 1970; Attias-Donfut, 1991, 2000; Devriese, 1989; Donati, 1999; Eisenstadt, 1956; Elder, 1998; Erikson, 1980; Lalive d'Épinay & Cavalli, 2009; Ryder, 1965).

But taking the next step—going from theory to putting the concept into practice (operationalization)—is more complicated. Perhaps that is why it is one of the lower praxis sociological concepts in the history of sociology; in fact, we have to resort to other disciplines, such as history, to know of one attempt for a more systematic application, that by William Strauss & Neil Howe (1991, 1997). These historians, in cross-disciplinary terms, reconnect all things that have been separated from the generation theory, reformulating it again and combining it with cyclical models, like those of the historian Arnold Toynbee or the sociologist Pitirim Sorokin.

In the United States, Strauss & Howe (1991) identified generational cycles between approximately 80 and 100 years, consisting of four stages, each of approximately 20 years, which are repeated on a recurring basis. These four stages (called high, awakening, unraveling, and crisis) correspond to four collective identities (prophet, nomad, hero, and artist). The stages are identified on the basis of times of crisis and economic bonanza, and collective identities are adjusted to a greater or lesser presence of strong institutions and social order, which in turn allows a higher or lower dose of individualism, personal freedom, and new lifestyles.

Strauss & Howe's work is a primary source for the current study of generations, and its influence can be found in typologies that either develop or add to those divisions. In a few cases they are a result of the work of advertisers and marketing centers (Boschma & Groen, 2006). Other sources, such as the Canadian Census Office, include modifications (national changes) to the number of cohorts (Canadá Statistique, 2011). In Europe the organizational analysis has been applied: Becker (1990) deals with leadership styles and Bontekoning (2008) analyzes generational conflict; other more recent works along the same line are by Haeger and Lingham (2013) and Hillman (2014).

Generations in the Spain of today

In the case of sociology, among the very few applications that have been created, Díez-Nicolás (2008) analyzed the shift toward post-materialistic values in Spanish society and the effects on behavior during elections; and in the case of anthropology, Feixa (1998) analyzed the evolution of Spanish youth.

The generation model used in this work has been developed by taking all the indicated limitations into consideration and accepting that its effectiveness should be confirmed by more in-depth studies. Caballero & Baigorri (2013) discussed the potential of the concept and adapted the Strauss & Howe model for the Spanish case. The qualitative (social, historical, and cultural) aspects have been focused on, which define certain features of the members' collective personality and the detail of the milestones that have identifiably "marked" the generations shown in Caballero (2015). Regarding the size of the generations, the 15-year cohort model has been taken from Ortega y Gasset (1970). The generational structure of the contemporary Spanish population is summarized in Table 1 and brief explanations of the sociohistorical milestones that define these generations follow.

Table 1. Contemporary Spanish generations in 2016

Classification	Born between	Age group 2011	Age group 2016
Silent generation	1914–1928	96–82	101–87
Francoist generation	1929–1943	81–67	86–72
Baby boomer generation (protest generation)	1944–1958	66–52	71–57
Generation X	1959–1973	51–37	56–42
Generation Y (millennials, Peter Pan)	1974–1988	36–22	41–27
Generation Z	1989–2003	21–8	26–13

Source: Own elaboration.

Silent generation (1914–1928)

With the European countries immersed in World War I, the Spanish economy entered a growth phase from provision of raw materials to the countries at war, but the benefits were not equally distributed; on the contrary, speculation made big fortunes at a time of high inflation and impoverishment of the population. The majority of people born at that time were illiterate and forced to work from a very early age. In this scarcity framework the younger generation became part of the masses of young people who lined up with the movements that were fought in the Spanish Civil War (1936–1939), trailing behind the previous generation. The trauma of war itself, plus the dictatorship that followed for almost half a century, converted this generation into a silenced generation, more than a silent one.

Francoist generation (1929–1943)

During this period, wartime children were born. During the full primary collectivization process, due to the Civil War, this generation lived in extreme situations. The violence and suffering of war and hunger and the defeated people's fear of political repression remained engraved on their minds. This was the first of the generations to be indoctrinated under Spanish Catholicism principles (Díez-Nicolás, 2008), but it was also the generation that transmitted the antebellum ideological polarization, which would be maintained throughout the lifetime of this generation. For some it would mean immediate access to power and to positions of political responsibility within the regime; others would work in underground movements, reorganizing banned political parties and trade unions. The latter would later become the protagonists and leaders during the process of transition to democracy, occupying high positions in the first democratic governments.

Baby boomer generation (1944–1958)

The children belonging to this generation suffered the worst effects of the postwar period (shortage and repression) as well as the small benefits that stemmed from the economic recovery and termination of the regime's international isolation (Díez-Nicolás, 2008). A minority went to university and many actively participated in juvenile movements opposing Franco's regime from the end of the 1960s, but breaking with the previous generation's ideological and organizational principles. Affected by changes after the 1968 student movement, they would embrace new ideologies, such as pacifism, feminism, environmentalism, and criticism of bureaucracy.

Generation X (1959–1973)

This is the economic development generation (Díez-Nicolás, 2008). Children and young people grew up with more material and economic security than previous generations, although they were still educated in ideologies and traditional values. There is massive access to university in the 1980s and women were totally accepted in the labor market. Television (especially advertising) would be an essential element in the construction of this generation's collective ideology.

Generation Y (1974–1988)

Also known as millennials, the boomerang generation, or Peter Pan generation (Shaputis, 2004), they were affected by important sociostructural changes (transition to democracy). Children attended a secular educational system, eager for democratization and social experimentation, and as youngsters grew under the cover of new freedoms and a maturing welfare state. Users of the first personal computers and video games, they became compulsive fashion, music, and fast food consumers, rejecting the ideological polarization of earlier generations. But they reached the labor market in the middle of a crisis, blocked and with devalued rights, which delayed them from an independent living (Shaputis, 2004) and made them feel "outraged" (Feixa & Nofre, 2013) because they did not get what they believed they had been promised.

Generation Z (1989–2003)

This generation is the result of opulence in a society with no material difficulties, marked by deeper social policies and the extension and expansion of rights. Individuals live in increasingly diverse families and management of multiculturalism is a daily challenge in their schools. They were socialized in conspicuous consumption and superfluous goods with high expectations, especially in the last cohorts, whose first socialization occurred in the middle of the economic bubble. As digital natives (Prensky, 2001; Tapscott, 1998) they adapted more quickly to new technologies than their parents did.

Dialectic materialism – post-materialism

One of the fundamental components of people's attitudinal systems are the values that change as the generations flow. The most accepted theory regarding this social change is by Inglehart (1977), which is about the empirical basis for the World Values Survey. The central hypothesis is simple: Western societies' value systems changed from materialistic values, which seek economic and personal security, to post-materialistic or expressive values, which give priority to the quality of life. These are more frequent in more developed societies, in social classes with better economic positions, and in younger generations.

The intergenerational values change theory includes two hypotheses. The hypothesis of scarcity considers that "the priorities of an individual reflect the socio-economic environment: we give a greater subjective value to things when there is a relatively low availability" (Inglehart, 1998, p. 42). Therefore, in societies where material needs are satisfied, there is a greater probability of the appearance of other more self-expressive types of needs. The second hypothesis depends on a sociology principle, the socialization process that makes "social" pervade "the individual," gradually shaping the individual's subjectivity. This process is particularly intense during childhood and adolescence, when learning and life experiences crystallize and become part of individual personality structure (Erikson, 1980). Because of this, according to Inglehart (1977), changes in value systems are gradual and usually occur when a younger generation (socialized in a highly developed socioeconomic context) replaces an older generation (socialized in scarcity and deprivation) and becomes society's adult population. One could, therefore, expect to find large intergenerational differences between young and elderly people's values in developed societies.

Environmental values are among post-materialistic values, not only as awareness and concern for the environment (cognitive/evaluative), but also in mobilization and activism (praxis). My research seeks to verify if this prediction has indeed come into effect and whether more environmental values are found in younger generations.

The problem of environmental attitudes

Studying environmental attitudes and their conversion into environmental behavior poses a lot of problems. Most literature reflects the poor predictive ability of values regarding environmental behavior (Williams, 1974), although certain scales (Schwartz, 1977; Schwartz & Howard, 1980) allow researchers to verify—to a limited extent—some connection between them (Stern et al., 1985; Thøgersen, 1996). In other approaches, some authors (Dunlap & Catton, 1979; Dunlap & Van Liere, 1978) recommend studying values and their influence on environmental concern. Others suggest changing the study of attitudes for that of lifestyle, sometimes linked to the concept of cultural capital (Rosa et al., 1988; Stern & Aronson, 1984), and others linked to marketing (Boyd & Levy, 1963; Corraliza et al., 2006; Corraliza & Martin, 2000). And, finally, others criticize the use of environmental awareness as a term due to the difficulty in making the concept applicable because of its multidimensionality (Diekmann & Preisendörfer, 1992) and they come to the conclusion that these are the costs related to environmental behavior which, to a large degree, determine it (Diekmann & Preisendörfer, 1998, 2003).

Methodology

The methodological design includes both quantitative and qualitative techniques. The main source was a survey conducted in 2012, in the region of Extremadura (n = 1,932), among a sample of three-generation families (all of which included living grandparents).[2] The sample was selected in a stratified way depending on the size of the place of residence and through stratified random routes. All members of the family unit above the age of 12 were interviewed. The sampling error for the assumption of simple random sampling for $p = q = 50$ was ±3.2% for the family sample and ±2.2% for the sample of people, for a 95% confidence level. Many questions were consistent with those in the World Values Survey and other surveys about environmental attitudes, in order to create comparable variables.

To identify each generation's environmental profile three ratings were created that express individual degrees of relationship with the environment:

1. The environmental concern index comprised 15 questions related to global and local environmental problems. The answers were given different values for the responses "very concerned," "rather concerned," "not very concerned," and "does not know/does not answer."
2. The environmental engagement index consisted of 13 questions referring to 13 environmental conflicts and measured citizens' political commitment and active involvement in environmental conflicts on three levels: "know about the conflict," "have participated in it," and "recognize that environmentalists are right." These options were valued in terms of "yes" or "no" and coded with 0 and 1 respectively; the minimum and maximum values for each conflict are between 0 and 3.
3. The environmental attitude index was created from 13 questions relating to everyday environmental behaviors including saving energy and water, reusing materials and objects, and separating wastes. Different values were given for the answers to the questions, depending on the level of involvement in environmental improvement: whether they are done "normally," "sometimes," "never," and "doesn't know/doesn't answer."

From the sum of the three indexes I created an index called general pro-environmental profile (GPP) that expresses survey participants' levels of concern, commitment, and environmental attitudes concisely, in just one term. This index ranges from 0, representing the lowest environmental profile level, to 100, the highest pro-environmental profile.

2 The survey was conducted by the research group Análisis de la Realidad Social, Extremadura University.

The fieldwork was completed by carrying out 46 semi-structured interviews with members of families consisting of three generations. The interviews were carried out separately, face to face, in the interviewees' homes, both in rural and urban areas. Following Taylor and Bogdan (1987), in qualitative research it is not important to seek representation of the whole population; what is important is the potential of each "case" in assisting the researcher in developing theoretical impressions regarding the social life of the area studied. Nevertheless, variables were taken into account in the selection of interviewees regarding sex, age, the family's socioeconomic situation, and family role (grandparents–grandchildren).

Results

Socioeconomic characterization of the generations

Table 2 contains the socioeconomic characterization of the generations studied. In evolutionary terms, improvement in family members' living conditions is obvious. Older generations have a low level of income and education; members of younger generations have a higher level of education and live with families who have medium or high incomes.

When assessing their ideological position (based on the standard left/right dichotomy, where the right is represented by positive values and the left by negative values), a strong lean toward the right is seen in older generations, while from Baby boomers the lean is more toward the left, although there has been a gradual decline in leanings from generation to generation.

In short, younger generations live with families with more resources, have a higher level of education, a greater cultural capital, and ideologically are situated in progressive positions. It is the developed society model that complies with the scarcity hypothesis predictions, where material needs (economy and security) are satisfied and where other kinds of post-materialistic needs are more likely to appear.

Table 2. Sociodemographic profile of the sample

	Silent generation	Francoist generation	Baby boomers	Generation X	Generation Y	Generation Z
Age						
Born between	1914–28	1929–43	1944–58	1959–73	1974–88	1989–2003
Age group in 2011	96–82	81–67	66–52	51–37	36–22	21–8
Age group in 2016	101–87	86–72	71–57	56–42	41–27	26–13
Female population (%)	64.6	55.8	49.1	48.4	48.5	48.7

	Silent generation	Francoist generation	Baby boomers	Generation X	Generation Y	Generation Z
Study levels (%)						
No education or primary education only	96.7	93.5	67.2	25.0	12.9	44.7
High school	0.0	4.2	14.5	37.2	40.5	52.1
University	3.3	2.3	18.3	37.9	46.6	3.2
Income per month (%)						
Less than 600 euros (€)	30.0	26.7	5.0	1.1	3.3	0.0
600–1,000€	53.3	41.1	34.6	14.5	15.4	8.0
1,101–1,800€	6.7	17.1	32.6	38.8	45.0	30.5
1,801–3,000€	10.0	12.8	17.1	35.2	30.3	43.9
More than 3,000€	0.0	2.3	10.7	10.4	5.9	17.6
Ideology						
Inclination	+23.4	+17.3	–26.9	–19.7	–23.5	–16.6

Source: Own elaboration.

Environmental generations

Among the expressed values, which may be defined as materialistic or post-materialistic values, I found ecological and pro-environmental values. In this section the environmental profile for each generation is analyzed by a combination of variables, which range from environmental image and individual responsibility for conservation, to the indicators mentioned in the methodology section.

A gradual change has been found in the environmental image that generations have (Table 3). With regard to the environmental representations of the interviewees, the bucolic-romantic view has declined, which identifies environment with pleasant green landscapes, and awareness is growing regarding the problems caused by industrial development. When respondents have to choose between dichotomous positions (economic development versus the protection of nature) it is surprising to find that, at the time of an economic crisis with high unemployment rates, there is no majority support for economic growth and employment, especially in younger generations, who are more seriously affected by unemployment. This pro-environment character in younger generations is confirmed when they are asked about individual responsibility regarding environmental degradation. The more recent the generations are, the greater their awareness regarding individual responsibility in these processes. Thus, these data seem to suggest a modification in theories about intergenerational value changes.

Table 3. Representations and environmental values of the generations (%)

	Silent generation	Francoist generation	Baby boomers	Generation X	Generation Y	Generation Z
Environmental concept						
Contamination cities	10.0	12.6	17.0	18.0	15.4	28.7
Pleasant green landscapes	56.7	31.4	36.6	29.7	33.2	19.1
Natural disasters	3.3	9.2	4.4	1.8	2.8	4.8
Protection of nature	6.7	18.4	21.2	24.8	28.9	27.1
Attitudes regarding development						
Protecting the environment should be a priority even if jobs are lost	25.0	35.9	44.8	57.0	63.1	88.3
Growth and employment are priorities even though there is a negative effect on the environment	75.0	64.1	55.2	43.0	36.9	11.7
Anthropogenic impact						
Human activity is in harmony with the environment	38.5	10.8	10.6	1.3	1.5	4.8
Environmental degradation can be stopped if we change our lifestyle	34.6	53.2	57.8	63.6	68.1	66.2
Human activity has a permanent negative effect on the environment	26.9	36.0	31.6	35.1	30.4	29.0
Action capacity						
Control of the environment is above my ability at an individual level	59.1	46.4	40.0	33.9	31.4	25.9
My actions can make a real difference to the environment	40.9	53.6	60.0	66.1	68.6	74.1

Note: A normal question format was included for the definition of the environmental concept held by a population. The question was: When the environment is discussed, which of these things do you think about? (1) contamination in the city; (2) beautiful green landscapes; (3) earthquakes, floods, and other natural disasters; (4) protection of nature; (5) the state of the environment that our children will inherit; (6) the quality of life where I live; (7) our individual responsibility in environmental improvement; (8) the use of natural resources to give us a good quality of life; (9) none of these; (10) does not know/does not answer.

For my analysis the answers were chosen which most agreed with the question, in order to make the differences clearer.

Source: Own elaboration.

Environmental indicators

I have shown that environmental attitudes are not always consistent with what people put into practice and that people's habits and behavior cannot automatically be interpreted regarding environmental awareness, knowledge, and concern. This mismatch between thought and action can be examined more closely with the indicators created for this study.

Figure 1 shows the weight that different indicators have on the environmental profile of successive generations.

The index that measures habits related to waste separation, saving energy and water, and the recycling and reuse of materials and products (environmental attitude index) clearly appears to have more weight for all generations: Between 61% and 68.4% of the surveyed population say that they put these behaviors into practice. However, this indicator showed a rise in tendency throughout the generations, reached its peak in Generation X (68.4%), then showed a decline in values in generations that followed.

Regarding a subjective concern for both global and local environmental problems (environmental engagement index; EEI) (climate change, biodiversity loss, use of pesticides, genetically modified organisms, noise pollution, etc.), a similar trend is observed, although in this index the highest proportion occurs in Generation Y (48.1% show concern), with a slight decline in Generation Z (45.1%), which is the generation in which, according to Inglehart's thesis, more ecological awareness would exist.

Another similar trend is observed with activist commitment (EEI), measured by participation declared in environmental conflicts (attending protests, signing petitions, donations, environmental group membership, etc.). Once again my data contradict Inglehart's thesis when he says that "the materialistic–post-materialistic priorities evaluation has proven to be our best predictor of participation in both the ecologist and the pacifist movements" (Inglehart, 1991, p. 442).

Figure 2 summarizes this situation for the different generations in the general pro-environmental profile (GPP). The trend in GPP climbs from the Silent generation to Generation X and Generation Y, where it plateaus, and then declines slightly in Generation Z. All have a low environmental profile. Remember that the GPP moves between 0 and 100—the highest value (41.2%) does not even reach 50%. The typical deviations show that the Baby boomer generation has the most representative average (sd = 10.5), while Generation Z has the greater typical deviation (sd = 13.2).

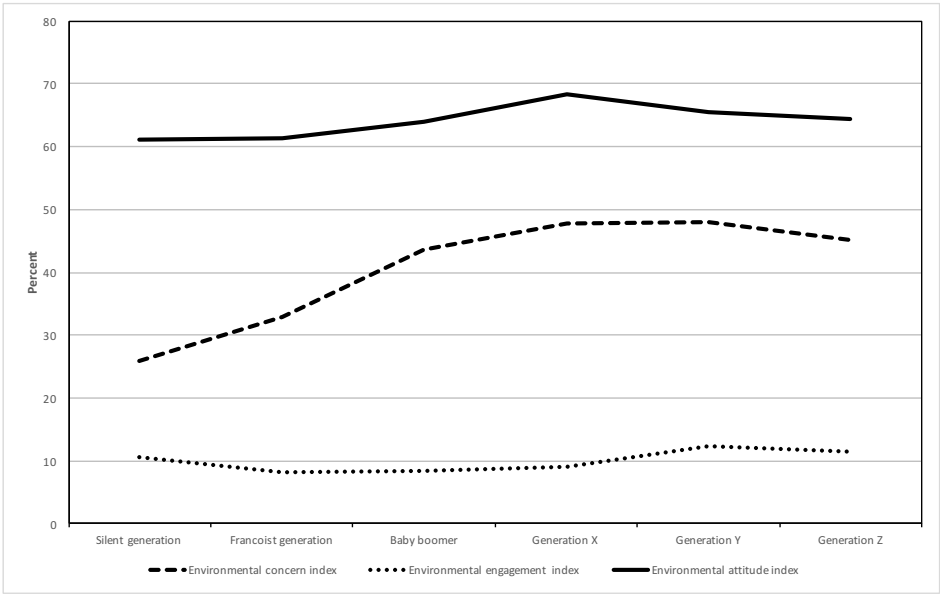

Figure 1. The weight of indicators in the environmental profile

Source: Own elaboration.

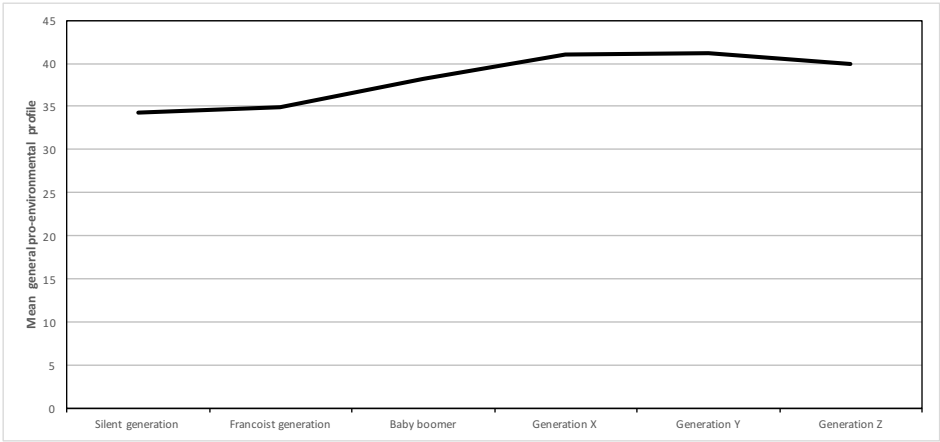

Figure 2. General pro-environmental profile

Source: Own elaboration.

Conclusions

From the indicators and with the help of qualitative approximation based on the interviews, the environmental profile of the Spanish generations can be defined.

Silent generation

Socialized in scarcity, the Silent generation had behaviors based on saving and reduction in consumption, which had positive environmental effects, but which were not based on environmental ideologies. Therefore, this is a generation with no environmental awareness but with behaviors that indirectly have positive environmental effects. I call this environmental profile "materialistic base."

Francoist generation

Compared to the previous generation, there was an important increase in environmental concern without any big differences in socioeconomic socialization. But this greater concern for environmental problems is not translated into a greater political commitment and, together with maintaining savings habits and reducing consumption, similar to the previous generation, gives the impression that their behavior is very different from the post-materialistic values, even though this results in positive environmental effects. In the same way as the Silent generation, the Francoist generation's environmental profile is still based on materialism.

Baby boomer generation

Also called the protest generation, with the Baby boomer generation there was a turn to the left in the position of most of the country, which formed the backbone for large sociopolitical change. Socioeconomic improvements in living conditions (especially in the latest groups) and a rise in concern about environmental problems have not been expressed in the same way, neither in commitment nor in ecological activism, although there has been a rise in pro-environmental habits and behavior compared to the previous generation. Low militancy and political participation in the defense of environmental interests indicates that the habits and attitudes of Baby boomers are more the result of materialistic than post-materialistic values. In terms of environmental values, this is a "hinge" generation.

Generation X

Born in a time of full economic development and socialized with their basic needs satisfied, Generation X maintains the Baby boomers' positions, being the last generation to include all the indicators used in the analysis. Being to a certain degree the most post-materialistic of all, this is the generation which, to a greater extent, fits into Inglehart's theses.

Generation Y

Generation Y is the first cohort born in democracy and socialized in favorable socioeconomic conditions. This is the first generation in which there is a noticeable decline in changes regarding expression of environmental values. If environmental behavior (environmental attitude index) increased in previous generations, albeit based on materialism, these attitudes decline in Generation Y; however, there is a significant rise in political–environmental commitment and activism. It is a generation that is marked not only by post-materialistic values, but also by postmodernism and the sociocultural implications: The major ideological proposals (including environmentalism) have no practical expression; they are like simple stories on the ideas consumer market. One must not miss any "interesting" mobilization if it fits with one's ideological spectrum, but without necessarily having to put it into practice in daily life. In Spanish we would be talking about a "just for show/phony" environmentalist generation.

Generation Z

The last few cohorts of Generation Z were born at a time of material opulence and conspicuous consumption. Their environmental behavior shows values which, far from being post-materialistic, are a little below those of generations immediately before them. Although they are globally "greener" than their parents and grandparents, their behavior is no more so than Generation X and Generation Y. Because of this decline in all of their environmental profile indicators, I call this the low-cost post-materialism generation, adapting the term first used by Diekmann and Preisendörfer (2003). That is to say, Generation Z have a pro-environmental awareness, but it is only applied to pro-environmental habits if there is a low or no cost.

Discussion

The generational analysis clearly shows how, with the arrival of new generations, their members come into society with a higher level of education, greater cultural resources, and a better socioprofessional situation.[3] There are bases for material progress which represent the thesis by Inglehart on the appearance of post-materialistic values and, with them, pro-environmental values.

3 I do not engage in the widespread debate over the past few years, which always reappears when there are economic crises: according to which, younger generations are going to be worse off than previous generations for the first time. Over long periods of time, the course of history systematically proves this to be wrong, but I have avoided this debate in my analysis.

However, the environmental profile of generations shows disparities and inconsistencies between theory and practice, between ideological discourse and lifestyle, between attitude and behavior—to be precise, between what is said and what is done.

Therefore, while I find a more environmental way of thinking in more recent generations, at least statistically, this rise in awareness does not appear in effective environmental behavior, which is the opposite of intergenerational value change theory predictions. In terms of trends, the decline in environmental behavior among young people has been demonstrated in research conducted in other countries. This is the case in Grønhøj and Thøgersen (2009) when comparing environmental exchanges between parents and children in the United States (California) and Denmark. And Wray-Lake et al. (2010) found that younger generations in the United States are not as willing to endorse environmental behavior to the extent young people did during the decade of the 1970s. Of course we could consider a hypothesis arising from that, and assume that they may adopt different habits when they get older as a result of their socialization and cultural capital. But that would just be a hypothesis that would only be verifiable in the future.

The weight of the components (concern, commitment, and attitude) that make up the general pro-environmental profile also reveal interesting results that again create difficulties for the intergenerational value change requirements. First, because these components maintain a similar dynamism between them when, according to the theory, the younger the generations are, the bigger the changes one might expect. Second, and more importantly, my data show that it is possible to find behavior and habits with positive environmental effects that are not based on post-materialistic values.

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Hunting and Monitoring: Community-Based Research in Xerente Indigenous Land, Brazilian Cerrado

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Abstract

Community-based research that involves participatory monitoring has been increasingly used in studies on hunting activity in traditional societies of the Neotropics, particularly in the rainforest environment. We present the results from a year-long study of participatory monitoring of hunting in 10 villages in Xerente indigenous land in the Brazilian Cerrado, an initiative to build a sustainable-use program for local hunting. Fifty-two hunters recorded data on 390 hunts involving 451 kills and 5,878 kg of estimated biomass from 34 game species. Medium- and large-sized mammals were the most hunted species, while hunting activities were predominant in forest environments. Indigenous hunting techniques associated with collective hunts using fire are no longer used, and the use of traditional weapons such as the bow and arrow is now uncommon; firearms were the main weapon used. The data revealed current patterns of wildlife use as well as hunting activities. The implications of these results for future research on the management and conservation of wildlife hunting in Xerente indigenous land are presented. We present our findings to facilitate improved preparation of new monitoring programs in traditional societies that live in the Cerrado.

Keywords: conservation, game hunting, participatory monitoring, traditional people

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Introduction

Hunting is an important practice for forest dwellers in the Neotropics, providing important food sources for subsistence and helping maintain cultural practices and socioeconomic systems (Robinson & Redford, 1991; Shepard, 2014). The sustainable use of wildlife is essential to the long-term use of this resource (Constantino et al., 2008). Many of these groups have adopted management schemes based on continued resource evaluation through community-based natural resource monitoring programs as a strategy for sustainable wildlife management (Berkes, 2004; Brown, 2003). This strategy has, in many cases, contributed to effective results in sustainable wildlife management, as well as promoting local empowerment of the community (Constantino et al., 2012). Furthermore, it has been important in countries with low research investment where participatory systems have proven to be faster and more efficient in influencing decision-making processes (Brown, 2003; Constantino et al., 2012; Moller et al., 2004).

One of the fundamental principles of community-based natural resource monitoring programs is the self-monitoring of harvest by resource users themselves (Danielsen et al., 2005), where they are trained for this function. In this paper we use the term "participatory monitoring." Participatory monitoring programs have been increasingly used in studies on hunting activities of indigenous and non-indigenous traditional societies in the Neotropics (Constantino et al., 2008; Hill et al., 1997; Luzar et al., 2011; Noss et al., 2005; Ohl-Schacherer et al., 2007; Pezzuti et al., 2004; Read et al., 2010; Vieira et al., 2015). Accordingly, part or most of the data on hunting activity has been collected by the hunters themselves, or by other community members. These programs target the collection of indicators which enable assessment of resource use in space and time, with the participation of experts in the area and the local population (Ferraz et al., 2008; Luzar et al., 2011). In addition, this provides great benefits to research because, when using participatory monitoring, spatial coverage and range is increased by several orders of magnitude over what is typically feasible for an individual researcher during a single season of fieldwork (Luzar et al., 2011; Shepard et al., 2012).

In turn, the use of participatory monitoring has made it possible to evaluate the impacts of hunting on wildlife populations, spatial and temporal patterns, and cultural use of the resource. It has also enabled forecasting of hunting impact scenarios, and interactions between anthropogenic and ecological aspects of game hunting in computational modeling (Iwamura et al., 2014; Shepard et al., 2012).

Many studies on community-based monitoring of hunting activities have taken place in the Neotropics, particularly in the Amazon Basin (Bodmer & Puertas, 1999; Constantino et al., 2008; Lopes et al., 2012; Luzar et al., 2011; Ohl-Schacherer et al., 2007; Pezzuti et al., 2004; Vieira et al., 2015). In contrast, few studies regarding

natural resource use and monitoring have been carried out within the Cerrado, the second-largest biome in Brazil. In addition, this typical Brazilian habitat is currently subjected to the highest rate of destruction in the country, having lost half of its original cover to pasture, crop fields and other anthropogenic land uses (Klink & Machado, 2005). Only 1.5% of its total area is protected (Trolle et al., 2006). The area of Xerente indigenous land (XIL) preserves a significant area of this biome and has high potential for maintaining the biodiversity of one of the world's biodiversity hotspots (Myers et al., 2000).

In this paper we present the results of a year-long participatory monitoring of hunting study in 10 villages in XIL, an initiative to build a sustainable-use program for local hunting and a way of obtaining information on the exploitation of local game. We also show the importance of these results in revealing the current patterns of use of the local wildlife, and the implications participatory monitoring of hunting has for future management and conservation plans in XIL and for other traditional groups that exploit the Cerrado biome.

Akwẽ-Xerente people

The Xerente belong to the Jê linguistic family and are speakers of the *Akwẽ* language. They make up the subgroup *Akwẽ* along with the Xavante and Xacriabá people, which are known as the central Jê groups. Their contact with non-indigenous society dates back to the sixteenth century and began to intensify in the eighteenth century (Farias, 1994). This period was characterized by fierce conflicts between the Xerente and non-indigenous people, which ended in 1851 with a settlement in the town of Tereza Cristina or Piabanhas (the present city of Tocantínia) (Giraldin & Silva, 2002). The first Xerente territory was demarcated in 1972, followed by demarcation of the Funil territory in 1991.

The *Akwẽ*-Xerente people exploit their surrounding environment for subsistence through hunting, gathering, fishing, family agriculture, and raising of livestock (such as chickens, pigs, and cattle). Some individuals have jobs as teachers, health workers, employees of the National Indian Foundation (FUNAI), drivers, merchants, and city officials. Those who manage to enter higher education receive scholarships. Other sources of income include the sale of handicrafts and surplus fishing, collecting, family farming, and breeding animals.

Methods

Study area

XIL (9° 34′ 37.4″ S, 48° 06′ 38.3″ W) is located in the municipality of Tocantínia, Tocantins state, and covers 183,542 hectares (Figure 1). The population in 2010 was 3,017 people (IBGE, 2010) distributed across 62 villages.

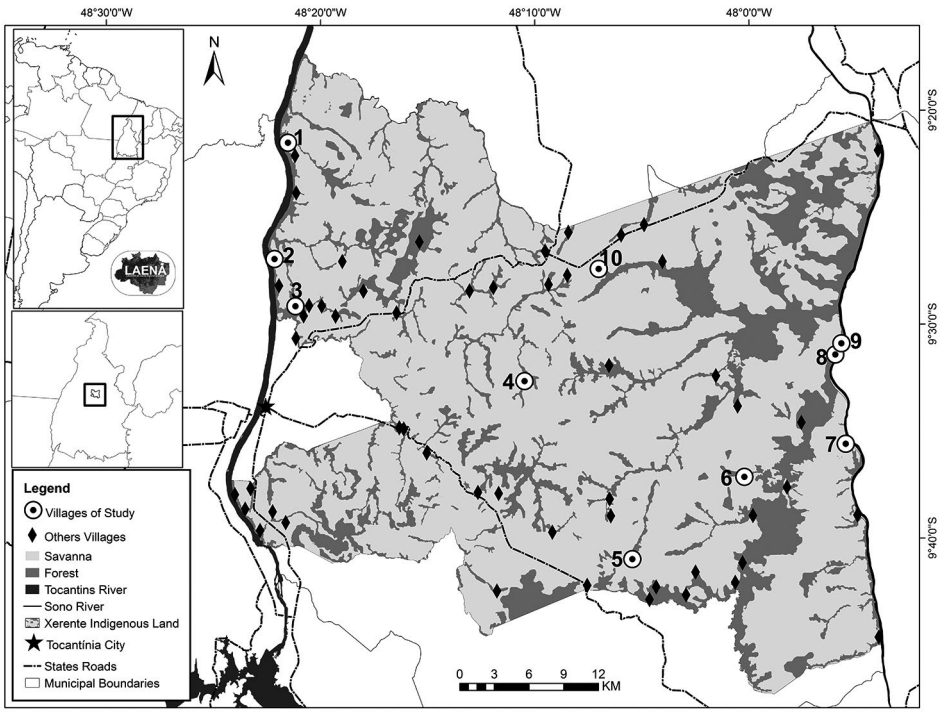

Figure 1. Location of Xerente indigenous land and villages participating in the study: (1) Bela Vista, (2) Porteira, (3) Salto, (4) Cahoeirinha, (5) Brejo Cumprido, (6) Ktẽpô, (7) Rio Sono, (8) Sangradouro, (9) Brejo Novo, (10) Bupré

Source: National Indian Foundation, Brazilian Institute of Geography, and Statistics and United States Geological Survey.

XIL lies within the Cerrado biome. The Cerrado is 1.86 million km^2 in area, possessing the richest flora among the world's savannas (>7,000 species) and high levels of endemism (Klink & Machado, 2005; da Silva & Bates, 2002). The biome is characterized by various vegetation types: *cerrado* (dense, typical, and sparse), *vereda* (a seasonally flooded area dominated by palm trees), rocky fields (savanna environment) and *cerradão* (typical forest patches of *cerrado*), and gallery and riparian forests (Ribeiro & Walter, 2008). There are 194 mammalian and 830 bird species

known, and the biome is the third-most diverse area in Brazil after the Amazon rainforest and Atlantic Forest. In general, mammal fauna essentially comprise small-sized animals: 85% of species have a body mass no greater than 5 kg and only five species weigh more than 50 kg (Marinho-filho et al., 2002). The climate is humid with a moderate seasonal water deficit, an average daily temperature of 28 °C and 1,700–1,800 mm average annual rainfall.

Implementation of participatory monitoring of hunting

For implementation of participatory monitoring of hunting we chose 10 villages (out of 62) representative of the age range of the villages and straight-line distances (km) from the nearby town of Tocantínia (Figure 1, Table 1). The center of each village was recorded with a GPS (global positioning system) device and distances were measured using ArcGIS 9.3.2 software. Some Xerente helped in village selection. Work in selected villages was authorized by signed consent presented by the village chief.

In each village, hunters older than 18 years were invited to participate on a voluntary basis, and those who accepted signed an informed consent form agreeing to participate. Hunters with whom we had previous contact helped in the selection of additional collaborators.

Data collection and analysis

Hunters were instructed to fill monitoring data sheets with the following information for each hunting event: (1) date, (2) village, (3) hunter, (4) type of environment, (5) hunting technique, (6) hunting gear, (7) hunting with or without success, (8) number of kills per species, (9) weight (kg) of each animal killed, and (10) sex of each animal killed. Practice runs were conducted individually or in groups. Each hunter received 20–50 kg spring scales to measure the weight of kills.

The first author remained in the villages for six consecutive months to support the hunters with their monitoring activity in order to ensure the quality of their data collection. We also conducted semi-structured and open interviews with hunters in order to obtain additional data on wildlife use (e.g., hunting techniques, food preferences, and taboos).

The distinct vegetation types in which hunting occurred were grouped into the following environments: *cerrado*, forest (riparian and gallery forest and *cerradão*), and *vereda*. Aquatic environments were classified as clearings and marginal vegetation (riparian vegetation, sandbars, and rocky outcrops) on the banks of the Tocantins and Sono rivers (Figure 1). Species names in the native language were identified with the help of the Xerente people and a Xerente-Portuguese/Portuguese-Xerente dictionary (Krieger & Krieger, 1994).

The total number of kills and biomass obtained (kg) for the 10 monitored villages was estimated using the average kills and biomass per hunter who returned complete data sheets (n = 48). These values were then multiplied by the total number of hunters in these villages. The sex ratio of eight species was calculated as the number of males for every 100 females.

Results

Fifty-two out of 55 hunters agreed to collaborate in the study. Three individuals were not indigenous hunters. However, as they lived in the villages and were married to Xerente women they were included in the study. Data collection took place from March 2014 to February 2015. Two hunters did not return their monitoring sheets and a further two did not return all of their sheets due to their absence from the villages during collection periods (during the first six months and at the end of the study). Some Xerente hunters have cell phones or smartphones with internet access, allowing data sharing through phone calls or social media. The 50 participating hunters represented 91% of all hunters in the 10 monitored villages (Table 1).

Table 1. Villages included in participatory monitoring of hunting in Xerente indigenous land, in order of total estimated obtained biomass, March 2014 – February 2015

Village	A	DC (km)	NPH	TNH	NHE	NKA	OBW (kg)	EOB (kg)	TEO (kg)
Salto	22	8	14[a]	15	119	135	1,865	345	2,211
Porteira	74	13	12[b]	14	90	108	853	258	1,111
Bela Vista	84	22	7	7	68	71	902	63	965
Rio Sono	114	48	6[c]	6	31	39	352	83	435
Brejo Cumprido	34	31	3	3	21	24	305	106	412
Cahoeirinha	9	18	1	1	18	23	202	88	289
Brejo Novo	14	48	2[d]	3	25	31	170	58	228
Ktẽpô	9	37	1	1	7	8	140	0	140
Sangradouro	14	48	4	4	10	11	81	0	81
Bupré	15	28	1[c]	2	1	1	6	0	6
Total	–	–	51	56	390	451	4,876	1,001	5,878

Note. A = age of village; DC = distance from Tocantínia city; NPH = number of hunters participating in monitoring; TNH = total number of hunters; NHE = number of hunting events (successful hunts only); NKA = number of killed animals; OBW = obtained biomass weight; EOB = estimated obtained biomass (see Table 2); TEO = total estimated obtained biomass.

[a] One hunter was not indigenous. [b] Two hunters were not indigenous. [c] One hunter did not deliver all his monitoring sheets. [d] One hunter did not deliver his monitoring sheets.

During the monitoring period, 451 animals were killed in 390 successful hunts, totaling 4,876 kg of biomass (*n* = 371 weighed animals). However, 80 animals were not weighed, so for these cases the species' mean body mass was used, resulting in a total estimated biomass of 5,878 kg. At least 47 hunts were unsuccessful, but this is an underestimate as most hunters did not correctly record these events; therefore, unsuccessful hunts were not considered in the results.

Using data from 48 hunters who completed all data sheets, we estimated the total number of kills and obtained biomass for the 10 study villages. The average number of kills and biomass per hunter was 9.2 and 120 kg respectively. Multiplying these values by the total number of hunters in the villages gives an estimate of 506 kills and 6,600 kg of obtained biomass for all villages.

Salto village had the highest number of participating hunters, which also resulted in the largest number of hunting events, kills, and obtained biomass (Table 1). Non-indigenous hunters were responsible for 11.3% (*n* = 44) of all hunting events, 14.4% (*n* = 65) of all kills, and 15.7% (924 kg) of obtained biomass.

Thirty-four species were killed including 23 species of medium to large mammals, nine species of bird, and two species of reptile (Table 2). Six species killed are considered vulnerable: *Lycalopex vetulus* (hoary fox) (MMA, 2014), *Myrmecophaga tridactyla* (giant anteater) (IUCN, 2014; MMA, 2014), *Ozotoceros bezoarticus* (pampas deer), *Puma yagouaroundi* (jaguarundi) (MMA, 2014), *Tapirus terrestris* (tapir), and *Tayassu pecari* (white-lipped peccary) (IUCN, 2014; MMA, 2014). *Leopardus* sp. (wild cat), hoary fox, and *Tupinambis* sp. (tegu lizard) were not consumed for their meat by hunters. A young individual of *Tamandua tetradactyla* (collared anteater) and one *Mazama gouazoubira* (brown brocket deer) were captured to be raised as pets (*xerimbabos*). Fourteen species were killed by both non-indigenous and Xerente hunters, while jaguarundi, *Procyon cancrivorus* (crab-eating raccoon), and *Sapajus apella* (tufted capuchin) were killed only by the non-indigenous hunters.

Table 2. Species recorded in participatory monitoring of hunting in Xerente indigenous land, in order of total estimated obtained biomass, March 2014 – February 2015

Species name (popular name)	Xerente name	NKA[b]	OBW (kg)	EOB[d] (kg)	TEO (kg)
Tapirus terrestris (tapir)[a]	Kdâ	9(2)	1,278	160	1,438
Pecari tajacu (white-collared peccary)[a]	Kuhârê	51(9)	750	47	797
Hydrochoerus hydrochaeris (capybara)	Kumdâ	14	558	40	598
Ozotoceros bezoarticus (pampas deer)	Aze	29	294	211	505
Mazama gouazoubira (brown brocket deer)[a]	Ponkẽrê	34(4)	456	44	500
Tayassu pecari (white-lipped peccary)[a]	Kuhâ	15(5)	227	224	451
Mazama americana (red brocket deer)[a]	Ponẽ	13(1)	343	30	373

Species name (popular name)	Xerente name	NKA[b]	OBW (kg)	EOB[d] (kg)	TEO (kg)
Cuniculus paca (paca)[a]	Krawa	55(4)	299	43	342
Dasypus novemcinctus (nine-banded armadillo)[a]	Wrãku	42(15)	160	17	177
Myrmecophaga tridactyla (giant anteater)	Padi	6	106	57	163
Dasyprocta sp.[c] (agouti)[a]	Zâwri	54(3)	129	22	151
Rhea americana (greater rhea)	Mã	3	47	33	80
Nasua nasua (coati)	Wakõ	18	47	19	66
Penelope superciliaris (rusty-margined guan)[a]	Akkapre	41(7)	36	10	46
Tamandua tetradactyla (collared anteater)[a]	Patrê	9(2)	28	8	36
Euphractus sexcinctus (yellow armadillo)[a]	Wrãpakrda	7(2)	26	0	26
Paleosuchus palpebrosus (caiman)	Kuihâ	2	21	0	21
Dasypus septemcinctus (long-nosed armadillo)	Sipsĩmrê	13 (6)	8	12	20
Coendou prehensilis (prehensile-tailed porcupine)	Samrõ	4	9	4	13
Crax fasciolata (bare-faced curassow)	Akka	5	12	0	12
Cerdorcyonthous (crab-eating fox)	Wapsã wara	2	9	0	9
Sapajus apella (tufted capuchin)	Kro	(3)	0	9	9
Cabassou sunicinctus (naked-tailed armadillo)	Wrãknõ	5	8	0	8
Leopardu ssp. (wildcat)	Pattêrê kumto	1	0	6	6
Lycalopex vetulus (hoary fox)	Wapsã wara wasterê	1	6	0	6
Puma yagouaroundi (jaguarundi)	Pattêrêwakú	(1)	6	0	6
Procyon cancrivorus (crab-eating racoon)	Wapsã pra po	(1)	0	5	5
Arara arauna (blue-and-yellow macaw)	Soĩte	3	4	0	4
Cariama cristata (red-legged seriema)	Wakrdi	2	3	0	3
Aramides sp. (wood-rail)	Kratdu	2	3	0	3
Crypturelllus undulatus (undulated tinamou)[a]	Nõzâkmõ	3(1)	2	0	2
Tupinambis sp. (tegu lizard)	Asadâ	1	1	0	1
Crypturellus parvirostris (small-billed tinamou)	Amtrorê	1	0.5	0	0.5
Amazonas sp. (parrot)	Wa	1	0.5	0	0.5
Total		451	4,877	1,001	5,878

Note. NKA = number of killed animals; OBW = obtained biomass weight; EOB = estimated obtained biomass; TEO = total estimated obtained biomass.

[a] Species also killed by non-indigenous hunters. [b] Numbers in parentheses refer to total killed by non-indigenous hunters. [c] Two species, *Dasyprocta prymnolopha* and *D. iacki*, occur within the study area (MJP, unpublished data); however, their identification at the species level in the survey was not possible. [d] Mean biomass calculated by specimens weighed in the survey for the following species: white-collared peccary (n = 44), capybara (n = 14), agouti (n = 46), rusty-margined guan (n = 32), bare-faced curassow (n = 5), paca (n = 48), coati (n = 14), nine-banded armadillo (n = 38), pampas deer (n = 17), brown brocket deer (n = 30), red brocket deer (n = 12). For all other species see Emmons & Feer (1990), Nowak (1999), Peres & Palacios (2007), and Sick (1986).

Medium- and large-sized mammals were the most hunted, comprising 87% (*n* = 392) of total kills and 97% (5,718 kg) of total estimated biomass. Birds comprised 12% (*n* = 56) and 2% (137 kg) of total kills and total estimated biomass, followed by reptiles with 1% (*n* = 3) and 1% (22 kg), respectively. In terms of biomass, the most representative species was the tapir (*n* = 1,440 kg). In numbers, *Cuniculus paca* (paca) (*n* = 55), *Dasyprocta* sp. (agouti) (*n* = 54), *Pecari tajacu* (white-collared peccary) (*n* = 51), and *Dasypus novemcinctus* (nine-banded armadillo) (*n* = 42) were the most representative. The species most killed were primarily those with a smaller mean body biomass (Figure 2).

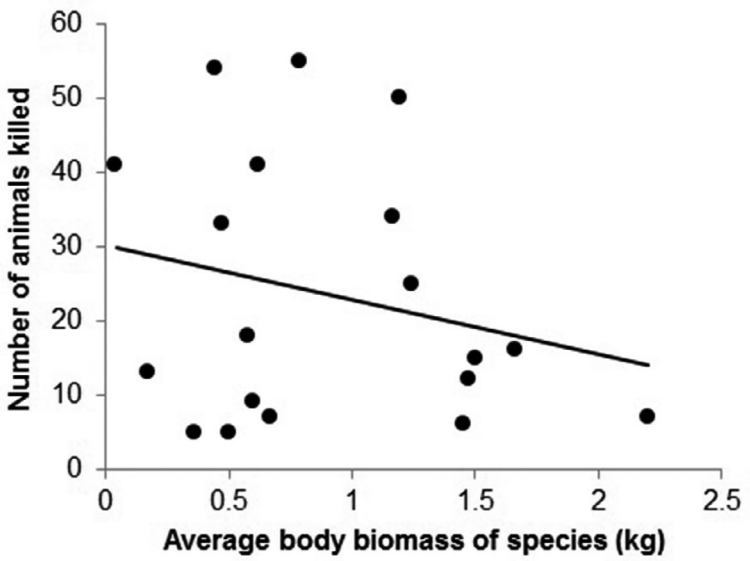

Figure 2. Relationship between number of killed individuals and mean (values transformed in log) body biomass of hunted species recorded in participatory monitoring of hunting in Xerente indigenous land, March 2014 – February 2015

Note. Only species accounting for more than 1% of the number of animals killed and obtained biomass (*n* = 19) were included. See Table 2 for the references used for mean body biomass.

Table 3 shows data on hunting events for each environment. Most (*n* = 259, 66%) hunting events took place in forest environments, which provided the largest number of kills (*n* = 311) and biomass (3,890 kg). Cerrado, the prevailing environment in XIL, was the second-most exploited with 20% (*n* = 79) of all hunting events, 86 kills, and 1,022 kg of biomass produced.

Table 3. Exploited environments recorded during participatory monitoring of hunting in Xerente indigenous land, in order of total estimated obtained biomass, March 2014 – February 2015

Environment	Hunting events (*n*)	Animals killed (*n*)	Total estimated obtained biomass (kg)
Forest	259	311	3,890
Cerrado	79	86	1,022
Marginal vegetation	12	13	444
Vereda	24	25	292
Farm	14	14	209
Water	2	2	21
Total	390	451	5,878

Nine hunting strategies were recorded during the participatory monitoring of hunting study: waiting, walking, walking with dog, canoe, canoe with dog, hole, sweep, *trabuco*, and opportunistic kills. Each technique with its corresponding number of hunting events, kills, and biomass per environment is given in Table 4. See Box 1 for a brief explanation of each hunting technique.

The walking technique was the most used (n = 164, 42%), was responsible for the most kills (n = 194), and ranked second in returned biomass (2,092 kg). Its application was prevalent in forest environments (n = 83). Waiting was the second-most used technique (n = 139, 35.6%), returning the second-largest number of kills (n = 166) and most of the biomass (2,393 kg). This technique was used almost exclusively in forests (n = 131).

Table 4. Hunting techniques recorded during participatory monitoring of hunting in Xerente indigenous land, in order of estimated obtained biomass, March 2014 – February 2015

Technique				Events per environment (*n*)				
	HE (*n*)	KA (*n*)	TEO (kg)	*Cerrado*	Forest	Farm	Marginal vegetation	*Vereda*
Waiting	139	166	2,393	5	131	3	–	–
Walking	164	194	2,092	57	83	1	–	23
Canoe with dog	11	11	430	–	–	–	11	–
Sweep	19	19	365	–	19	–	–	–
Walking with dog	15	17	201	5	9	–	–	1
Trabuco	15	15	138	–	12	3	–	–
Opportunistic	18	18	124	12	4	2	–	–
Canoe	8	10	94	–	–	–	8	–
Hole	1	1	40	–	–	1	–	–
Total	390	451	5,878	–	–	–	–	–

Note. HE = hunting events; KA = killed animals; TEO = total estimated obtained biomass.

Box 1. Brief explanation of each hunting technique used by hunters in Xerente indigenous land

Waiting: The hunter uses a laced network on a tree or builds a perch and stays in the treetop waiting for the target species. Areas next to the feeding (fallen fruits are preferred) or drinking trails of the target species are chosen to employ this technique. Night kills are made with the help of a flashlight.

Walking: The hunter walks and tracks the traces (footprints, burrows, smell, feeding areas) left by the animal until finding the target species. This technique is predominantly performed in the morning, and is done with the help of a flashlight at night. Mainly motorcycles, but also bicycles and motor vehicles, are used to access locations further away.

Walking with dog: Dogs are used to follow signs of prey and pursue them. Once the prey is located, the dog's barking indicates they have cornered their prey (*acuarem*) and the hunters follow the barking and attempt to kill the animal (Alves et al., 2009).

Canoe: This technique is predominantly performed at night, when the hunter slowly steers a canoe along the major rivers to get close to animals that are near the riverbanks.

Canoe with dog: Dogs move along the riverbanks while the hunter follows them in a canoe. The aim is for the dogs to detect the prey and chase it into the water. Once the prey is in the water, the hunter gets close with the canoe and kills the animal.

Hole: Holes are strategically dug along animal trails to trap prey. When an animal falls into a hole, it is easily found and killed.

Sweep: The hunter chooses a trail to use. He removes leaves and sticks from the soil—a cleaning or sweep of the trail. The purpose of this is to avoid producing any sounds that could alert the target species while the hunter is walking along the trail. The trail is perpendicular to paths used by the animals, locally denominated *carreiro* or near to feeding sites. Once the animal's approach is detected, the hunter goes to the location where the animal will most likely be visible and attempts to kill the animal.

Trabuco: A *trabuco* is a type of trap in which a home shooting device is installed on the ground with a line tied to the trigger of the device. This line is placed across the prey's trail, so when it touches the line, the device is triggered and fired into the animal.

Opportunistic kills: If a hunter is preoccupied with other activities such as fishing or walking and stumbles across an animal he will attempt to kill it, if he is armed.

Firearms (rifles) were the most widely used weapon (n = 372, 95% of hunting events). In nine hunts rifles were used in combination with bow and arrow, in one hunt with a machete, and another with an ax. Remaining kills were done with a club (n = 7, 2% of hunting events), machete, and bow and arrow (less than 1% each). Animals (n = 5) captured by hand in five hunting events were all *Dasypus septemcinctus* (long-nosed armadillo), except for one brown brocket deer which was run over by motorcycle.

Of the 451 animals killed, sex was identified in 90% (n = 406) of the individuals, providing a sex ratio for the most commonly killed species (Table 5). The sex ratio was close to 1:1 for most species; however, it was female-biased for the agouti and pampas deer, and male-biased for the white-lipped peccary.

Table 5. Number of dead individuals by sex and sex ratio of species most killed ($n \geq 15$) recorded in participatory monitoring of hunting in Xerente indigenous land, March 2014 – February 2015

Species name (popular name)	Dead (*n*)	NI (*n*)	Sex of killed animals (*n*)		Sex ratio
			Females	Males	
Cuniculus paca (paca)	55	2	24	29	121
Dasyprocta sp. (agouti)	54	1	34	19	56
Pecari tajacu (white-collared peccary)	51	–	27	24	89
Dasypus novemcinctus (nine-banded armadillo)	42	3	17	22	129
Mazama gouazoubira (brown brocket deer)	34	1	17	16	94
Ozotoceros bezoarticus (pampas deer)	29	–	21	8	38
Nasua nasua (coati)	18	–	10	8	80
Tayassu pecari (white-lipped peccary)	15	1	3	11	367
Total	298	8	153	137	–

Note. NI = number of individuals where sex was unidentified; Sex ratio = the number of males for every 100 females.

Discussion

The predominance of medium and large mammals killed is a common pattern found in both indigenous and non-indigenous groups in the Neotropics (Jerozolimski & Peres, 2003; Leeuwenberg & Robinson, 1999; Redford & Robinson, 1987). In our study, most animals killed were small, such as the paca and agouti (Figure 2, Table 5), indicating that these are the most abundant species in XIL, and may reflect patterns found in the Neotropics, where density is inversely related to body mass (Robinson & Redford, 1986). However, the Xavante Indians, who have cultural similarities to the Xerente (Maybury-Lewis, 1965) and also inhabit the Cerrado biome, mainly hunt animals of larger body biomass (e.g., tapirs, peccaries, and deer) (Leeuwenberg & Robinson, 1999).

This difference in prey size of hunted species between indigenous groups may be related to differences in study methods. Data on the Xavante study was collected through hunting recall interviews, and smaller species may have been incompletely remembered and not considered in the results (Leeuwenberg & Robinson, 1999). Our study, on the other hand, used participatory methods which allowed a more complete record of hunted fauna. This suggests that this alternative may generate more accurate data on the exploitation of natural resources.

Non-indigenous hunters killed a smaller number of species, which is probably related to the small number of hunting events, as there was no significant difference in hunting techniques and equipment between them and the Xerente (MJP, personal observation). These hunters seem to prefer slightly larger prey. Indigenous and non-indigenous hunters usually differ in game choice (Redford & Robinson, 1987); however, as the non-indigenous hunters in this study are married to indigenous women and live in Xerente villages, they shared game meat with the families. Therefore differences in game choice are not expected.

Food taboos, despite not being the main focus of this study, show great cultural complexity and are important elements that influence the local management of exploited species (Colding & Folke, 2001). For example, the tufted capuchin occurs at a relatively high density in XIL, at about 30 individuals per square kilometer (MJP, unpublished data). The low number of this species killed ($n = 3$) is possibly due to primates rarely being consumed among the Xerente for cultural reasons; the tufted capuchin is usually eaten only by elders and children. Similarly, the consumption of primates by the Xavante Indians was not documented by Leeuwenberg & Robinson (1999) but was observed by Silvius (2004). For the Xerente, this is related to food taboos. Dead animals that were not used as food by hunters for personal reasons were consumed by other Xerente.

The high values in terms of kills and biomass in forested areas reflect the fact that most hunts occurred in this environment (forested areas cover almost twice the area of all the other environments combined). Similar proportions were observed in the number of kills and biomass (Table 3). The Xerente have occupied open areas for hundreds of years and their historical preference was for hunting in open *cerrado* environments, employing large collective hunts using fire to trap large quantities of prey, as observed among the Xavante (Leeuwenberg & Robinson, 1999; Welch, 2015). However, the Xerente have virtually abandoned this traditional strategy. According to Xerente hunters, XIL does not have large enough areas and is virtually an isolated fragment in an anthropogenic landscape dominated by farms, which limits the use of fire in hunts. Another factor that may be related to the preference of forest environments for hunting is that animals are more abundant in forest patches than in savanna environments (Read et al., 2010). For example, the paca, a typical forest species (Eisenberg & Redford, 1999), is currently the preferred species for consumption among Xerente hunters (MJP, personal observation).

The variety of hunting techniques used by the Xerente (Box 1) demonstrates their knowledge and skill, and allows diversification of hunting strategies within a heterogeneous landscape throughout the year. These techniques are also widely used both by indigenous and non-indigenous groups (Alves et al., 2009; Constantino et al., 2008; Pezzuti & Chaves, 2009; Pezzuti et al., 2004), and may have resulted from long-term contact between the two societies. Despite the relative abandonment of their traditional hunting techniques, the Xerente still hunt using their ecological

and biological knowledge of the target species to choose which hunting techniques to use and in which environments. Hunting with canoes, for example, is a strategy used to kill species associated with riparian habitats. According to Alves et al. (2009), these abilities and experience are part of a broad depth of knowledge and cultural background that is essential to their survival.

The reduced use of bow and arrow for hunting is also evidence of transformation in traditional hunting systems among the Xerente. Even when used, it was usually combined with rifles, with a single exception. The adoption of shotguns by Xerente hunters follows the same pattern found in Neotropical regions (Jerozolimski & Peres, 2003) and has been observed among other indigenous groups (Constantino et al., 2008; Prado et al., 2012). Shepard et al. (2012) stated that firearms have become widely available to several indigenous territories in the Amazon, and, despite making hunting more efficient, has changed the relationship between indigenous peoples and wildlife.

The apparent balance in the sex ratio of killed species suggests that Xerente hunters are not selective in this regard. Bias in the sex ratios of agouti and white-lipped peccary may indicate a natural population pattern, as sex identification of this species at time of kill is difficult (Bodmer & Robinson, 2004). In the case of pampas deer, there is an apparent selectivity for female kills because many hunters avoid killing the males, claiming that the smell of their meat is unpleasant. This apparent female-biased sex ratio can affect the demographic structure of a population by reducing the population's replacement rate (Souza-Mazurek et al., 2000). Since we do not have information on the population parameters of hunted populations in the study area, the possible impacts of selective hunting should be viewed with caution, as this species may have a higher proportion of females (Braga & Kunyioshi, 2010) to males (Rodrigues, 1996) in the population.

The number of villages and hunters participating in this study represented a good sample of the entire XIL. The proportion of hunters that returned all hunting sheets was satisfactory and enabled reliable estimates of total kills and obtained biomass for participating villages. Hunters were highly interested in collaborating, even with no payment for data collection, which was also the case with the Izoceño Indians in the Bolivian Chaco (Noss et al., 2004). Incomplete data for unsuccessful hunts may have occurred for cultural reasons. Hunters may have been reluctant to admit failure, considering that good hunters tend to be highly respected in Xerente society (MJP, personal observation). This demonstrates that cultural aspects should be carefully addressed in community-based research and management-related activities (Luzar et al., 2011).

Implications for conservation

Participatory monitoring of hunting provided an important data set on hunting activities and wildlife use that will help outline future conservation and management plans in XIL. Our findings highlight species that deserve special attention in these future strategies, such as the more intensely harvested, and the most vulnerable and threatened species. Changes in traditional hunting activities should also be considered, as firearms have a higher impact on wildlife than traditional weapons (Shepard et al., 2012).

It should be pointed out that XIL is often subject to illegal hunting. This activity is almost impossible to monitor and, consequently, the overall impact of hunting activity within XIL is not known. An additional threat comes from agriculture-based development around XIL. These projects are fostered by the federal and state governments and the private sector. They advocate for the construction of state highways crossing XIL to facilitate marketing of products. This will increase access to the territory by illegal hunters, placing local wildlife under greater pressure. The management and conservation of wildlife within XIL must be supported by enforcement agencies and the implementation of measures to prevent increasing impacts of human activities in general, and particularly in the context of the new road construction.

Considerations

Participating hunters were reasonably literate (either in Portuguese or their native language), facilitating an understanding of the study's purposes and all training activities. Noncompliance with data recording for unsuccessful hunts is an issue that must be addressed in future research. This may be achieved through a complementary method for measuring the proportion of unsuccessful hunting. Xerente hunters have access to technologies such as smartphones and their use in future natural resource monitoring programs should be explored due to the valuable contribution these devices can make to a monitoring system (Liebenberg et al., 2017).

This study was the first to use participatory monitoring methods to address hunting activities in the Cerrado biome of Brazil. Considering the Xerente people as an example of a traditional society that exploits the Cerrado, findings and data presented here could help in the development of other monitoring programs that would contribute to a better understanding of the patterns of wildlife use.

Conclusions

Medium- and large-sized mammals were the most hunted species, and sex ratio for most species was balanced. Hunting activities were predominant in forest environments and different hunting techniques were employed. Firearms were the main weapon used. The traditional collective hunting strategy of using fire to trap large quantities of prey is no longer carried out, and traditional weapons such as the bow and arrow are seldom used. However, knowledge about habitat use and trophic relations, especially the dietary habits of most game species, are crucial for the success of Xerente hunting activities. The involvement of hunters as monitors resulted in a solid data set about hunting activity in the monitoring period, demonstrating that participatory monitoring of hunting has great potential for continuous assessment of wildlife use in XIL. The large voluntary participation of most hunters demonstrates their interest in monitoring game use and reflects true concern about wildlife stocks. This reaffirms the potential of community involvement in research on the use of wildlife.

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Engaging with Human Identity in Social-Ecological Systems: A Dialectical Approach

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Abstract

Vexing problems of global environmental change call for better conceptual and analytical approaches for understanding human behaviors, factors influencing these behaviors, and the causal pathways through which these shape social and environmental outcomes. While human identity meanings provide key analytic objects in the interrogation of these dynamics, identity-based research has been truncated by a historic overemphasis on social factors and a lack of critical engagement with the ecological context of these processes.

Adapting Giddens's concept of structuration, we draw on recent advances in social-ecological systems scholarship and human structural ecology to propose a new conceptual approach for understanding human identity processes and their relation to social-ecological structure. Resituating the human person within complex social-ecological systems, we suggest some causal pathways through which ecological (in addition to social) elements are active in the emergence of human identity and, conversely, the ways in which identity-based behaviors interact dialectically with social-ecological structure to produce outcomes significant along both social and ecological dimensions. Finally, we explore some implications of this reframing for the interrogation of society-nature dynamics and for empirical research engaging with social-ecological change and resilience.

Keywords: identity, social-ecological systems, structural human ecology, structuration

Introduction

The dominance of human influence on environmental processes calls for better conceptual and analytical tools for understanding how human behaviors emerge and the pathways through which these interact with and shape environmental

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outcomes. Fundamental to human behavior are questions of identity—the ways in which people understand who they are, their role in society, and their relation to their broader environment. Systematic analysis of the processes of identity formation and maintenance—and the social origins and consequences of these processes—sparked rich debate throughout the twentieth century beginning with the work of Mead (1934) and Blumer (1986) on symbolic interactionism and, later, related work on structural identity theory by Stryker (1994), Stryker and Burke (2000) and others. Within these discourses, interrogation of the causal mechanisms by which human identities are formed, elaborated, and verified within social structure have produced important insights into human behaviors and how these intersect with social institutions. We are here primarily concerned with the behavioral manifestations of these self-held meanings and values—how they shape the practical engagement of the human person within real-world systems—and so we refer to Archer's (2000) definition of identity as the "constellation of commitments" that comprise the individual self, resulting from the individual's interaction with society and the numerous negotiations by which identity meanings are hammered out. The transactional relationship through which these identity meanings are formed, maintained, and modified may be understood to occur through symbolic exchanges in which behaviors, discourses, and symbols become normative and are given social value. In this way, the performance of identity through symbolically meaningful—and normatively consistent—behaviors enables the individual to create and verify his or her identity through interactions with others (Blumer, 1969; Burton et al., 2008). For example, role-based identities of farmer, wife, husband, doctor, patriot, and so forth all carry with them sets of normative behaviors that will vary—in form, strength, or salience—according to the identity in question and the context in which it is performed (Burke & Stets, 2009). Contemporary identity theory has spent a fair amount of time elaborating the relationship between identity and identity performance through interactive social relationships (such as through the successful performance of role-based interactions between teacher and student, parent and child, or husband and wife, as evaluated by successfully embodying these roles exhibited through appropriate behaviors). The performance of these normative behaviors is the social mechanism by which individuals demonstrate their identity, not only as a teacher (for example) but as a good teacher. In this way, the performance of these identity-based behaviors takes on a symbolic dimension, and the performance of identity through symbolic exchanges constitutes the basis of interactional identity theory (Blumer, 1969; McCall & Simmons, 1978).

The content of these normative behaviors and their attributed symbolic value in identity processes are, of course, fluid and continually modified through identity performance and symbolic transaction. While these dynamic processes may operate dyadically (between individuals), they also take place between the individual and the broader structure of society—its institutions, norms, and so on—within which the individual operates. Giddens's (1984) work on structuration has been particularly

influential here in helping to conceptualize the ways in which the performance of human identity derives from, but also shapes, structure. Structuration suggests that the individual human agency operates in constant dialectical interaction with social structure. The individual selects (consciously or unconsciously) from among a possible range of identity meanings, values, and socially significant symbolic and normative behaviors. These selections are constrained by social forces that privilege some elements more than others, guiding the formation of individual human identities. The individual, while not fully free, nevertheless retains a degree of agency, variously reproducing, rejecting, and negotiating the influences of this broader social structure. Insofar as existing identity categories and meanings are taken up by the individual and inform the performance of their identity through normative behaviors, the individual functions to reproduce social structure. Where the individual rejects or modifies these identity categories, their content, or the set of available normative behaviors, we begin to see the interplay between agency and social structure (such as where an individual contests that "being a good daughter" must necessarily entail certain sets of given behaviors). While these agential responses may not persist, or may be resisted in society, there are times when they are taken up by others in society and may act back against structure and modify it (such as where broader sections of society might seek to redefine the filial duties of a daughter to her parents). Through this dialectical interaction between structure and agency both are continually produced, reproduced, and modified, and thus are mutually constituted.

Although identity scholars have differed in their relative emphases on social structure versus agency, or the mechanisms by which meanings are socially constructed and how these constructions function in identity processes, there is general agreement that the primary, perhaps exclusive, modes of exchange are situated within the realm of social interaction. Whether, how, and to what degree the biophysical or ecological setting of human action in general—and the character of specific settings in particular—are also operative in the identity processes remains an open debate; the relevance of environmental variables, even where not openly rejected, remain implicit and underexplored (Krogman & Darlington, 1996). Burke and Stets (2009), for example, acknowledge that biophysical elements provide resources and physical settings for the functioning of systems of interaction but seem to uncritically lump these elements together under the rubric of social structure, implying that ecological and social elements are functionally indistinguishable in identity formation and maintenance processes. Neglecting to differentiate between the social and ecological components of structure and the various processes that each is subject to necessarily hinders the interrogation of their differential influences on, and responses to, human identity processes (Weigert, 1991). Furthermore, casting environmental elements in overly socialized terms has kept identity theory largely isolated from parallel discussions on the human dimensions of ecological change, furthering the historical rift between the social and biophysical sciences (Freudenburg et al., 1995; Hawley, 1944).

Theoretical advances in two closely related sets of literature—social-ecological systems scholarship and work on structural human ecology (the latter dealing with questions of structure and agency within human-ecological systems; see Dietz & Jorgenson, 2016)—have provided potentially useful conceptual approaches for understanding complex interactions between social and ecological processes that may be usefully employed to revisit the potential role(s) played by ecological elements within human identity research (Dietz & Jorgenson, 2016). Social-ecological systems thinking conceives of social and ecological elements—involving socioeconomic and political as well as biophysical, geochemical, and climatic elements among others—as conjoined and interacting, rather than analytically or functionally separate. Such approaches emphasize, for example, feedback processes between social and ecological events and signals (Folke, 2006) and interscalar interactions between larger, macrostructural processes and smaller, nested cycles (Cash et al., 2006) to understand how these interactions function to shape system complexity and the ability of these systems to negotiate change pathways through time (Carpenter and Folke, 2006). While these conceptualizations of social-ecological coupling have furthered our understanding of complex systems, advances have come about imperfectly and unevenly, arguably privileging ecological processes and insights while not doing due diligence with regard to social elements and processes (Duit et al., 2010). Critics point to the underdeveloped incorporation of key concepts of human ontology and thus its insufficient engagement with values, interpersonal commitments, and the role played by human agency in shaping system outcomes (Stedman, 2016). For example, while resilience scholarship emphasizes surprise and nonlinearity in system functions, it tends to attribute these to the emergent properties of complex, multiscalar drivers and interactions that are—or assumed to be—generally deterministic (Davidson, 2010). While we suggest that this critique may be an overgeneralization and that recent scholarship has begun a more socially informed engagement with human elements in social-ecological systems (e.g., Berkes & Ross, 2013; Burns & Rudel, 2015; Ingalls & Stedman, 2016; Marshall, 2010; Marshall & Marshall, 2007), resilience thinking nevertheless retains some simplifying assumptions with regard to the myriad commitments, motivations, and values that guide human decision-making or the staggering capacity of human agency to shape not only the impacts of change drivers but also the nature of the drivers themselves (McLaughlin & Dietz, 2008). We suggest that the exploration of how human identity processes articulate with social-ecological systems may provide useful insights both for a historically oversocialized human identity theory and for potentially overecologized complex systems' scholarship.

In this paper we suggest a new conceptual approach for interrogating the role(s) of human identity processes in negotiating environmental change, and for exploring the ways in which these processes play out across social and ecological domains within complex systems. We advance a more ecologically informed engagement with identity theory and demonstrate how identity processes interact with

ecological system elements and produce material outcomes in real-world social-ecological systems. Our purpose, therefore, is twofold: (1) to overcome identity theory's overly socialized framework by inserting a more ecologically conscious approach and (2) to demonstrate that identity processes represent a set of important and commonly overlooked cognitive and behavioral linkages between social and ecological system elements. Accomplishing this twin purpose involves exploring some of the ways in which ecological elements play an active role in identity processes that, in turn, function to mediate diverse social processes which impact ecological system components. We build this case in the following fashion: In the first section, we explore some ways in which the ecological elements and processes form important components in the structure within which human identity operates, playing an important role in shaping the emergence of particular identities by setting parameters around the range of human experiences in particular places and thus the symbolic meanings that can be supported. In the second section, we will engage with how the performance of human identities through normative behaviors has not only symbolic, but also real-world consequences for the ecological as well as social elements of structure.

Social-ecological structure and the formation of human identity

In order to conceptualize how the social-ecological system participates in the construction of human identity, we must resituate the individual person within a broader conceptualization of the human person as both a social and corporeal (ecological) being. Identity processes, while also social, are negotiated by the embodied individual who operates within a real world "that is there" that includes not only symbolic elements but also material ones (Mead, 1934) that impinge upon the human person in different but closely interrelated ways. The impacts of ecological elements that shape human identities are felt both as direct biophysical prompts as well as those higher-order place meanings that are shaped through the lens of social experience, construction, and associated normative demands. This suggests two closely interrelated pathways by which biophysical or ecological elements of the environment are formative in the development and maintenance of human identities, each depending (albeit in different ways) upon the particular character of the environment.

The first of these pathways deals with the mode of interaction between the human as biological organism and the environment within which it lives, moves, and seeks to secure its existence. The biophysical character of the particular environment circumscribes possible modes of engagement by variously fostering and inhibiting particular human behaviors. At the most basic level, the ecological and material world impinges on the individual through physical prompts and sensory cues, such

as gravity, weather, edibility (Archer, 2000), perceptual constraints (Cheng et al., 2003; Tuan, 1974), and evolutionarily derived psychological cues (Kellert & Wilson, 1993). These environmental (and other) prompts attain the status of what Durkheim (1982) refers to as the "morphological facts" underpinning social functions, forming a structure that favors certain forms of engagement, constrains others, and thereby shapes the nature of routine behaviors associated with (for example) procuring food, shelter, and the other fundamental necessities (what Bourdieu, 1998, refers to as the habitus of the individual). This day-to-day engagement with the material world has, for most of human history, occupied the majority of humanity's time and attention and plays an important role in shaping those self-definitions that are salient in the formation of identity (Clayton & Opotow, 2003).

These physical and ecological constraints on, and enablers of, human behaviors provide an important pathway by which ecological system elements begin to actively shape what sorts of self-held meanings are hindered or facilitated within particular environments (Archer, 2000; Sack, 1997; Stedman 2003). To take a simple (if extreme) example, an individual may much more easily identify as a fisherwoman/man in a coastal environment than in a desert. While this primary pathway might be said to represent the most direct relationship between the individual and his or her biophysical environment, the social and ecological elements are inextricable, and continually interpenetrating (Freudenburg et al., 1995), problematizing a direct or unmediated causal interaction (a mistake made by environmental determinism; see Peet, 1985). The attributes of the physical or ecological environment that impinge directly on the human person are thus also mediated through social structure in important ways. The environmental constraints and enablers of agricultural production, for example—influencing what sorts of agriculture, and thus what sorts of farmers are probable, or even possible, within particular landscapes—are also shaped by the interplay of the physical environment with available technologies, transportation networks, and market forces that may extend (or limit) the range of ecologically possible modes of engagement (see, e.g., Hedrick, 1966; Lobao & Meyer, 2001; Moran, 2011).

While biophysical prompts are certainly most accessible to the individual through sensory perception and inhabitation in the material world, they accumulate at higher social levels to produce emergent social responses to environmental conditions. This suggests a second pathway by which the biophysical elements of environment help to form human identity: through the way in which the environment shapes the social construction of landscape meanings and the normative implications of those meanings (Sack, 1997; Stedman, 2003; Stokowski, 2002; Tuan, 1974). For example, dramatic landscape features such as soaring mountain ranges or deep canyons facilitate some kinds of human uses more than others but also give rise to particular labels and associated institutional management and regulation—for example, as national parks (Runte, 2007)—that permit or prohibit different

uses and associated meanings by virtue of these designations. Society's collective engagement within and between particular environments interacts with other social forces to code meanings onto the physical landscape and, thus, to socially construct it. Greider and Garkovich (1994, p. 1) nicely articulate the significance of this attribution of symbolic meaning which provides a lens through which the individual views the meanings and significance of their landscape. They write, "the real estate developer, the farmer, the hunter are definitions of who people are, and the natural environment—the physical entity of the open field—is transformed symbolically to reflect these self-definitions." What is especially significant about the social construction of the landscape is not only that it shapes perception but also that it represents, in a very real way, a system of encoded norms for those who inhabit those landscapes (Massey, 1994). "This is farm country" is not only a descriptive statement characterizing the setting and the identity of people within the landscape, but also a prescriptive statement regarding what sort of activities and behaviors are normatively "in place" (versus "out of place," Sack, 1997; see also Cresswell, 1996). These "rule-embedded landscapes" play a direct role then in shaping the identity of persons within them by variously proscribing and prescribing particular behaviors and by socially constraining the suite of possible identities available to individuals within those landscapes.

Notwithstanding the important role that this social construction of nature plays in the formation of these meanings and shaping of human perceptions, it is worth noting here—pursuant to the principal thrust of this paper—that the social constructionist perspective has tended to go too far in its emphasis on these constructions, undervaluing their ecological basis (Stedman, 2003). For example, Greider and Garkovich write, "of course humans reside in a natural 'world that is there,' but this world is *meaningless*" (1994, p. 2, emphasis ours), neglecting the possibility that this natural world plays an active role in shaping the meanings that are brought to it. They write, further, "the open field is the same physical thing, but it carries multiple symbolic meanings that emanate from the values by which people define themselves" (1994, p. 1). While this is clearly the case, it is equally clear that there are limits to the range of possible meanings. It makes a great deal of difference that the open field is an open field and not a forest and, further, that it is a particular kind of field with specifiable material properties of soil, slope, drainage, view, and others—all of which bracket the range of its possible uses and the attributed meanings it can hold: simply put, these features rule out altogether some uses or meanings, impede some, and facilitate others. To whatever degree theory has presented us with an overly socialized framing of these constructions it has led us away from the possibility of recognizing—and thus analytically engaging with—the very real biophysical and ecological elements which set the boundaries for those constructed meanings. We cautiously suggest that the social constructivists have often been unable to see the (material) forest for the construction of their trees.

We advance here an alternative framing of the social construction of landscape meanings that situates social construction within real biophysical spaces. Attributed meanings must be constructed in reference to the content of the particular landscape, the character of which allows only a limited set of possible meanings and, moreover, lends itself more readily to some of those meanings than to others. We also highlight possible indirect effects: the material reality provides the grounding for subsequent socially structured elements (e.g., lakeside resorts rather than industrial facilities) that further shape these experiences and meanings.

Let us consider two examples that might illustrate the ways in which ecological parameters shape human identities both through the biotic prompts of the environment as well as the social meanings attributed to particular ecological environments. Modes of agricultural production in the United States have changed considerably since the late nineteenth century, due to technological advances in productive practices and transportation networks, national agricultural policies, and the opening of large areas of the American Midwest (Lobao & Meyer, 2001). Agricultural changes that have resulted in increasingly large farm parcels utilizing a limited number of cultivars have played an important role in shaping what it means to be an American farmer (Albrecht & Murdock, 1984). The central importance of producing commodities for largely nonlocal markets, and the economies-of-scale advantages afforded to conglomerate farms have resulted in increasingly large operations managed by an ever-decreasing number of individuals. These structural changes have fostered the emergence of productivist farmer identity types, whose self-held conceptions of what it means to be a farmer emphasize commodity production (especially emphasizing staple food products) and economic efficiency (Fitchen, 1991; see also similar examples from Europe—Burton et al., 2008; Burton & Wilson, 2006).

While these agricultural changes are clearly social phenomena, their patterning across the landscape has also been shaped by ecological parameters. In the American agricultural experience the flat, relatively unvaried, deep and fertile topsoils of the Midwestern plains have allowed for parcel conglomeration and the mechanization of field crop production that could not have occurred elsewhere to nearly the same degree (Lobao & Meyer, 2001). By contrast, the shallow soils of the northeastern United States have limited the productivity (especially in comparative terms) of commercial grain and other commodity harvests (Bills, 2001; Hedrick, 1966), while the heterogeneity of its landscapes has inhibited parcel conglomeration, presenting economies-of-scale disadvantages (Andersen, 1932; Bills, 1990). In these areas, productivist farmer identities have become increasingly strained due to the interactive effects of agricultural restructuring and biophysical conditions (Fitchen, 1991; Ingalls, 2012).

The "Northwoods" area of Wisconsin provides a second example. Once heavily forested with evergreen trees with important biophysical properties (they floated well and were thus able to be moved to downstate processing facilities via the abundant river network in the region—yet another ecological reality that shaped development; Fries, 1989), these areas were cleared during the late nineteenth century, leaving behind poor soils and few livelihood alternatives. While the government of Wisconsin actively promoted agriculture in that area to support development and local economy (Carstensen, 1958), these efforts ultimately proved unsuccessful (Williams & Van Patten, 2006) largely because of the poor soils which would not support agricultural land uses (Gough, 1997) and harsh winters that limited growing seasons. The failure of agriculture to establish in this area allowed for the reforestation of the landscape. This is coupled with the incredible abundance of surface-water resources (north-central Wisconsin contains one of the richest densities of lakes in the world; Attig, 1984; Magnuson et al., 2006) that fostered the growth of a substantial tourism sector for people seeking "escape" and natural environments. These forested and lake-rich landscapes, rather than their agricultural alternative (which could not be so readily supported by the ecological conditions of the system), have in recent decades seen the rapid proliferation of second homes and other residential developments (Green et al., 2005; Schewe et al., 2012). Amenity-rich areas such as these that offer mountains, lakeshores, coastlines, and forests are commonly chosen for the siting of second homes. Remoteness from modern society, a sense of being in nature, and ideals of simplicity and space for pause and reflection all figure prominently as motivations for second home development in these landscapes (Stedman, 2006). By removing themselves from the demands of modern life—in which many people emphasize their inability to express self-held meanings which they consider core to their identity—and resituating themselves in these "natural places," individuals are given greater freedom and scope for the elaboration and expression of these core values (Williams & Van Patten, 2006).

What is important for our purposes here is that self-held meanings and identities are created and reinforced in these areas in part due to the particularistic ecological character of the landscapes. While the constructed meanings of these places are clearly social, those meanings depend upon certain kinds of social experiences that are enabled by the particular biophysical elements in the landscape, all of which change through time.

These pathways represent two possible ways in which the ecological elements of the social-ecological system shape human identities: While the biophysical prompts of the environment shape what sorts of behaviors are possible or enabled in those contexts, the social construction of those landscapes—and the sets of social institutions that arise in response—affects what sorts of behaviors are appropriate or expected (even legal) in those places and functions to support a particular range of identities.

By shaping particular behaviors, and allowing for the attribution of particular social meaning to those behaviors, these processes play a role in directing the formation of the values and self-held meanings of the individuals.

The performance of identity in social-ecological systems

In the section above, we dealt with some ways in which ecological elements—as a necessary counterpart to social elements in broader structure—may function to shape human identity processes. In what follows, we will consider the inverse of this relationship, looking at how the performance of human identities acts back upon the environment to shape social-ecological systems and change.

While there is clearly a symbolic dimension to human behaviors that results from identity-based commitments and self-perceptions, these behaviors are not only symbolic, they are also practical actions in a world of real material objects (Archer, 2000) and thus their performance has material implications for ecological (as well as social) system elements. Any human activity that entails practical engagement with the ecological world will inevitably effect change on that world. While this direct causal relationship between human activities and the elements and processes of the biophysical world is self-apparent, what has been less obvious—or rather, what has been obfuscated in identity discourse because of a systematic privileging of social interaction over other forms of exchange—is how the performance of identity affects these ecological elements and processes.

To return to the example of the agricultural productivist identity type, wherein primary commitments prioritize maximizing commodity production in the service of profit (versus, say, placing a primary value on the nonproductive aspects of farm land, such as habitat management), the performance of these identity meanings entails particular modes of agricultural practice that maximize productivity and economic efficiency and thereby verify productivist identity meanings to themselves and to others who share similar understandings and hold similar self-definitions of what it means to be a farmer (Burton & Wilson, 2006; Goldschmidt, 1978). Agricultural behaviors consistent with productivist farmer identities may include large-scale monocultures, intensive nutrient management through inorganic fertilizers, chemical-based pest management regimes, and the cultivation of all available lands within the farm for the purpose of maximizing agricultural productivity and, in so doing, verify the farmer's identity claims. While the successful performance of these behaviors has social and symbolic value (that is, these done well signify the farmer as a "good farmer"), ecological impacts are equally significant. These include impacts on soil conservation and erosion, floral and faunal biodiversity within monocultural fields, cultivar diversity (possibly reduced due to a focus on high-producing or

genetically modified varieties), pesticide impacts in fields and nontarget habitats, and nitrogen and phosphorous loading in surface water and groundwater (see, e.g., Altieri, 1999; Matson et al., 1997). While economic motivations for these agricultural practices are important, they often persist despite strong economic disincentives or countervailing social pressures that would otherwise prompt behavior change (Burton & Wilson, 2006; Fitchen, 1991; Ingalls, 2012).

While the relationship between identity performance and the impacts of that performance on social-ecological structure may be more apparent in the case of productive natural resource–based occupational identities (as in the agricultural examples above), the performance of nonproductive (consumptive) identities also impacts directly on the biophysical elements of the landscape. In our earlier example—that of second home and residential development within high-amenity areas in the Northwoods of Wisconsin—we observed that people locate to particular areas (whether seasonally or permanently), which they perceive as being able to support their own self-definitions. These movements themselves—purposive relocation to landscapes which support these core values of identity—represent one aspect of the performance of these identities and have a direct impact on the biophysical elements of these landscapes, affecting ecosystem processes in numerous ways (Hall & Müller, 2004). The forests and lakes of this landscape, and the experiences offered there, contribute mightily to the "up north escape" identity of the landscape (Stedman, 2000) and those using it. We need to ask, however, how the behaviors associated with the performance of these place-based identities in turn reshape the character of the landscape. The region has seen rapid development of second homes, especially around lakes, with resultant increased population density (Carpenter et al., 2007; Gonzalez-Abraham et al., 2007). This in turn has led to great concern about the impacts of increased development and indices of potential disturbance (Racey & Euler, 1983). While concerns have been raised about the effects of development on lakeshore flora (Clark & Euler, 1984; Dwyer & Childs, 2004) and fauna (Clark et al., 1984), probably the strongest voices have been around effects of increased development on water quality (e.g., Dillon et al., 1994; Hendry & Leggatt, 1982), leading to discussion of potential policy actions (e.g., Meyer et al., 1997; WDNR, 1996). A more subtle form of action is at work here as well. The emphasis on the recreational "escape," "up north" identities also has the potential to crowd out alternative identities—such as those based on livelihoods—asserting that some meanings and associated development (e.g., those tied to recreation) better "fit" the landscape (Creswell, 1996). This possibility has led to lively debates about scenarios for the future of the region (e.g., Peterson et al., 2003).

The effects of identity performance on social-ecological structure result not only from the actions of individuals but also from the social institutions that emerge from, and are supported or contested by, these self-held commitments. We noted this previously when dealing with the normative outcomes of the social construction

of landscapes but revisit it here to point out that these normative valuations are not only the product of social-ecological structural elements but also the outcome of individual and collective identity-based commitments that compete within an uneven playing field. Some socially constructed meanings attain normative status and form the logics of social institutions and normative place-claims, while other claims are marginalized (see, e.g., Castree, 2004; Massey 1994). These meanings—emergent from the interactive and power-filled relations between social-ecological structure and individual and collective identity commitments—act back again on the social-ecological system with material outcomes in ecological as well as social processes.

Conclusion: Identity and social-ecological structure in dialectic

In the sections above, and for the purpose of building our argument, we have artificially teased apart the emergent and interactive relational processes between social-ecological structure and human identity. In closing, we bring these back together and suggest a reformulation of Giddens's (1984) concept of structuration that recognizes the ineluctability of both social and ecological elements. This may provide a more productive way forward as we explore the implications of human identity processes within real-world systems. Such a (re)formulation allows us to accomplish two objectives: in the first place, it resituates ecological system elements as important forces in the formation of human identity meanings while, in the second place, it may provide new explanatory variables in the interrogation of the ways in which the performance of human identity is not only socially significant but also results in real-world environmental outcomes, and that the two of these are structurally interrelated in human-ecological systems. Invoking the language of structuration—suggesting a more ecologically informed reconceptualization, perhaps "social-ecological structuration"—we describe the social-ecological elements of the system as shaping, influencing, constraining, and enabling—but not determining—leaving room for the powers of human agency as the individual innovates, imagines, and modifies their behavior in response to these structural social-ecological elements and processes and, through this agential action, shapes and modifies the system. Human agency thus emerges as an element in the system that derives, in part at least, from sets of self-held beliefs, commitments, and self-perceptions. Such a framing articulates well both with the coupled-systems approach to understand complex system functions and with approaches to understanding the dialectical relation between individuals and structure currently being advanced within structural human ecology (see, e.g., Dietz & Jorgenson, 2016, and others in that issue).

While we have here focused our attention on building the conceptual apparatus for cross-walking between identity theory and coupled-systems approaches to understanding nature-society relations, we have not yet made explicit the linkage between the functions of identity processes within social-ecological systems and how these processes condition the resilience of these systems to change—a dominant interest in coupled-systems scholarship. The scope for developing this link is, we suggest, far reaching, important, and currently underdeveloped within resilience science. Signals of ecological disturbance and change, for example, are interpreted and mediated not only through scientific, economic, or other lenses but also through the filters of individual perception with regard to the symbolic and psychosocial import of these changes. Threats to place-based meanings brought about by social and ecological changes, for example, have been posited to instigate agential action to combat these threats (Stedman, 2002), suggesting an important identity-based feedback process that may play a role in resilience.

More work remains to be done in exploring the empirical basis—and myriad empirical manifestations—of the relationship between identity processes and social-ecological system functioning and resilience, and in elaborating specific causal mechanisms linking these. We anticipate that further exploration of the mechanisms and processes of identity formation in the exchange between human individuals and social-ecological contexts will yield promising new ways of analyzing complex structural change and, we hope, foster creative interaction between disparate streams of theory which run through the social sciences on one hand and the biophysical sciences on the other.

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Hydraulic Fracking, Shale Energy Development, and Climate Inaction: A New Landscape of Risk in the Trump Era

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Abstract

With the recent election of Donald J. Trump to the Presidency, fossil fuel interests are poised to advance their entire energy agenda on a number of key fronts. Not only has Trump taken steps to increase oil and gas fracking, create more energy infrastructure projects, ramp up foreign fossil fuel exports, resurrect the Keystone XL and Dakota Access pipelines, and bring back coal production to Appalachian communities, but he has also worked to dismantle most of the signature policies of the Obama administration to fight the effects of climate change. More importantly, he has surrounded himself with cabinet members and advisors who are not just indifferent to environmental problems, but openly hostile to their remediation through government regulations and policy-making. In this critical essay, we draw on sociological research to highlight some of the ongoing technological risks and socio-environmental impacts surrounding unconventional gas and oil development (UGOD) and high-volume hydraulic fracturing (HVHF) operations. We briefly address how these hazards are likely to be exacerbated by the policies and cabinet appointments of the Trump administration—as well as the larger congressional Republican energy and environmental agenda—over the coming months. Finally, we conclude with some observations on the future direction of US energy policy in the Trump era and the amplified risks posed by the prospects of a new Third Carbon era driven by fracking and other methods of unconventional energy production.

Keywords: hydraulic fracturing, fracking, shale energy, unconventional oil and gas development, energy policy in the Trump administration

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Introduction

One of the first executive actions of Republican President Ronald Reagan after taking office in January of 1981 was to order the dismantling of the 32 solar energy panels that his predecessor, President Jimmy Carter, had installed on the roof of the White House in 1979. The move was intended to signal not only a sharp ideological departure from the energy policies of the Carter administration, but the beginning of a full-scale political backlash against the role of the federal government in regulating environmental pollution. History repeated itself on 20 January 2017, when newly elected Republican President Donald Trump, as one of his first executive actions, ordered the removal of the policy page on climate change issues that his predecessor, President Barack Obama, had ordered published on the White House website during his second term (Parker, 2017). In its place was the Trump administration's new "America First Energy Plan," a short and strident declaration calling for an end to the "burdensome regulations on our energy industry" and the elimination of "harmful and unnecessary policies such as the Climate Action Plan and the Waters of the U.S. rule." More specifically, the Trump energy plan vowed to "embrace the shale oil and gas revolution" by taking advantage of the "estimated $50 trillion in untapped shale oil and natural gas reserves, especially on those federal lands that the American people own" (White House, 2017). Nowhere in the document are any references made to the controversial technological practices that will be used to extract these energy deposits from deep beneath the surface of the ground and oceans, nor any mention of the potential social or environmental costs associated with the invasive industrial techniques—more commonly known as hydraulic "fracking"—required for shale energy development (Bamberger & Oswald, 2014; Finkel, 2015).

The controversy over unconventional gas and oil development (UGOD) and high-volume hydraulic fracturing (HVHF) represents one of the most contentious arenas of social and environmental conflict in the US today (Bamberger & Oswald, 2014; Crowe et al., 2015; Evensen et al., 2014; Gullion, 2015; Hauter, 2016; Ladd, 2013, 2014, 2017; Malin & DeMaster, 2016; Wilber, 2015). Proponents trumpet fracking as an economic "game changer" that creates jobs, personal wealth, tax revenues, rural revitalization, and energy independence from foreign oil. Other supporters, including some environmental groups, view natural gas fracking as providing a cleaner "bridge fuel" to a renewable energy future that will lower carbon emissions, as well as reduce the planetary risks posed by climate change (Cosgrove et al., 2015; Gold, 2014; Wright, 2012; Yergin, 2011). While these discursive claims have been challenged (Ladd, 2016; Ladd & Perrow, 2016), they represent some of the key hegemonic narratives that the fossil fuel industry and its allies have advanced over the past decade to legitimate the socio-environmental risks and profits associated with UGOD/HVHF. For opponents, however, fracking represents myriad threats

to water quality, aquifers, public health, rural landscapes, roads, property values, animals, farm communities, and nature-based tourism, among other problems (Eaton & Kinchy, 2016; Finkel, 2015; Ladd, 2017). "Fractivists" and other environmental advocates view gas and oil fracking as not just another risky and inefficient energy source that keeps the nation chained to the fossil fuel treadmill driving climate change, but a dangerous and unregulated technological process that is linked to "every part of the environmental crisis, from radiation exposure to habitat loss" (Steingraber, 2012, p. 175).

As a result of the rapid development of fracking technology and its ancillary infrastructure—well pads, access roads, pipelines, compressor stations, wastewater processing, export facilities, and more—shale gas and oil production has risen 12-fold since 2005. During President Obama's two terms in office from 2009–16, over 80,000 new shale wells were drilled and fracked as a cornerstone of his administration's "all of the above" energy policy. As a result, the US is projected to be a net exporter of natural gas, and perhaps the world's largest gas and oil producer, by as early as 2020 (Boudet et al., 2016; Ladd, 2016). Furthermore, the US Energy Information Administration (EIA) has estimated that some additional 630,000 new onshore wells may be required to extract all the technically recoverable reserves of oil and gas beneath the nation's landscape (Hauter, 2016, p. 7). Presently, over 15 million Americans live within a mile of a fracked oil or gas well (Gold, 2014).

Given the boom–bust cycles of resource extraction and the Treadmill of Production contradictions associated with oil and gas development (Freudenburg & Gramling, 1993; O'Conner, 1994; Schnaiberg, 1980), many observers have called attention to what is perhaps the major economic paradox of the fracking frenzy today—that is, the extent to which the boom in exploration, drilling, and shale extraction has resulted in a short-term oversupply of oil and gas, as well as lower prices in the marketplace (Christopherson, 2015). With the recent election of Donald J. Trump to the Presidency, however, fossil fuel interests now see a chance to advance their entire energy agenda on a number of key fronts. Throughout the 2016 Presidential campaign, Trump vowed to unnerve and undermine the prevailing "liberal elites" of Washington ("Draining the Swamp"), and is moving rapidly to deliver on that pledge. Not only has Trump vowed to increase oil and gas fracking, create more energy infrastructure projects, ramp up foreign fossil fuel exports, resurrect the Keystone XL and Dakota Access pipelines, bring coal production back to Appalachian communities, and revitalize the dormant nuclear power industry, but also dismantle most of the signature policies of the Obama administration to support renewable energy and fight the effects of climate change (Fountain & Goode, 2016). The number of active drilling rigs in the US has been rising since the election and the Interior Department is considering opening up public lands around some two dozen national monuments to drilling, coal mining, or other development (Bias, 2017). More importantly, Trump has surrounded himself with cabinet members

and advisors who are not just *indifferent* to environmental problems, but openly *hostile* to their remediation through government regulations and policy-making. Indeed, not since the Reagan years of the 1980s and the Bush years of the early 2000s has the hydrocarbon and petrochemical interests of the Energy-Industrial Complex had a potentially greater political ally in the White House.

Assessing the consequences of shale energy development and hydraulic fracking are issues of critical importance for environmental sociology, particularly given its prominent focus on technological risk, social impacts, and the role of energy resources in societal-environmental interactions (Dunlap, 2015). In recent years, the field has generated an impressive research literature that helps situate fracking in the context of other energy-related controversies, including nuclear power (Perrow, 1999), uranium mining (Malin, 2015), oil spills (Ritchie et al., 2012), drilling rig disasters (Freudenburg & Gramling, 2011), coal production and mountain top removal mining (Bell & York, 2010, 2012), as well as anthropogenic climate change (Dunlap & Brulle, 2015).

In this critical essay, we draw extensively on sociological research to highlight some of the ongoing technological risks and socio-environmental impacts surrounding UGOD and HVHF operations. We then turn to a preliminary discussion of how these existing threats and environmental inequalities are likely to be exacerbated by the policies and prospective cabinet appointments of the Trump administration—as well as the larger congressional Republican energy and environmental agenda—over the coming months. Finally, we conclude with some observations on the future direction of US energy policy in the Trump era and the inherent risks posed by the prospects of a new Third Carbon era driven by fracking and other methods of unconventional energy production.

Fractured communities: Risks and impacts associated with unconventional gas and oil fracking

Patented in the late 1940s by Haliburton but only commercially viable on a broad scale for little more than a decade, hydraulic fracking refers to a controversial well stimulation and completion technique where millions of gallons of water, sand, and chemicals (many of which are toxic) are injected under extreme pressures into deep underground shale deposits to fracture non-porous source rock formations and release the trapped natural gas or oil to the surface (Cable, 2012; Ladd, 2013, 2014). Combined with innovations in seismic mapping and multidirectional drilling, fracking has allowed for dramatic increases in the amount of oil and natural

gas that can be extracted from previously inaccessible shale formations. These technical processes have been aided by the confluence of assorted laws, subsidies, and infrastructural developments to increase energy production (Hauter, 2016).

The multiple technological risks and impacts associated with UGOD have raised serious concerns among citizens, elected officials, and scientists alike; over 450 community bans against fracking have been passed in 24 states, including cities like Pittsburgh, and statewide moratoriums are in effect in New York, Vermont, and Maryland (Klein, 2014). To date, nearly 700 peer-reviewed publications have provided empirical evidence of the environmental, health, and social consequences of the fracking boom taking place in over a dozen US shale regions (Finkel & Law, 2016; Ladd, 2017). Potential and known health impacts occur at every stage of UGOD, including emission of air pollutants such as hydrogen sulfide, nitrogen oxides, volatile organic compounds, particulate matter, sulfur dioxide, and ground level ozone from well venting, flaring, heavy truck exhaust, and diesel powered generators (Paulson & Tinney, 2015). In particular, citizen concerns over fracking have revolved around its potential to contaminate local ground and surface waters through methane migration, fracking fluids, wastewater injection, radioactive gases, carcinogenic compounds, corrosive salts, or radioactive elements like cesium and uranium. Fracking fluids, for example, typically include friction reducers, surfactants, gelling agents, scale inhibitors, acids, corrosion inhibitors, antibacterial agents, and clay stabilizers, among other hazardous compounds, and are known to pose threats to plants, fish, aquatic life, and land animals (Gullion, 2015). Research has also shown exposure to fracking fluids to be associated with cancer, reproductive disruptions, skin, eye, and respiratory symptoms, impairments of the brain and nervous system, gastrointestinal and liver disease, as well as psychosocial stress (Finkel & Law, 2016; Sangaramoorthy et al., 2016).

One of the most contentious issues surrounding fracking comes from the serious groundwater contamination risks posed by the underground disposal of its wastewaters through deepwell injection methods. Typically, between 15–80% of the water used in fracking operations is forced back up to the surface of the well each time it is fracked—which can be up to a dozen times over the life of a well. In the US, 2.4 billion gallons of wastewater are injected daily under high pressure into any of the 187,570 disposal wells that accept oil and gas waste across the country. It is difficult to track the disposal of what the industry calls "produced water," which can contain over 300 toxic or hazardous compounds, including salt brines, heavy metals, radioactive materials, hydrocarbons, and volatile organic compounds such as benzene, toluene, ethylbenzene, xylenes, and hydrogen sulfide (Finkel, 2015; Gullion, 2015; Heinberg, 2013; Johnston et al., 2016). Moreover, wastewater injection has also been directly associated with increased seismic activity and more than a thousand earthquakes in such states as Oklahoma, Texas, Colorado, Kansas, and Ohio (Raynes et al., 2016).

Beyond concerns over water quality, issues of water quantity have been viewed by local residents and officials as key impacts associated with UGOD, particularly the drawing down of local aquifers, surface waters, or public water systems to provide the roughly 2–7 million gallons of water required for each fracking episode (Ladd, 2013). With so many western states like California often experiencing severe drought conditions and declining water availability due to climate change and related weather events, many critics have assailed the oil and gas industry for its enormous consumption of the scarce water resources needed for drinking, farming, and other daily tasks (Hauter, 2016; Kinchy et al., 2015).

One of the major challenges for understanding the environmental and public health threats from fracking is the tangle of laws that inhibits public visibility and research on these issues. Despite regulations in most states requiring the disclosure of various industrial chemicals, the so-called "Haliburton Loophole" (lobbied for by then-Vice President and former Haliburton CEO Dick Cheney) allows oil and gas operators to claim that their fracking additives are "proprietary secrets" that are exempted from reporting under the Safe Drinking Water Act (SDWA). Given too that UGOD is exempt from other federal provisions of the Clean Water Act (CWA), Clean Air Act (CAA), Solid Waste Disposal Act (SWDA), Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Emergency Planning and Community Right to Know Act (EPCRA), the National Environmental Policy Act (NEPA), as well as several Environmental Protection Agency (EPA) regulations related to hazardous waste disposal, the degree of water and soil contamination caused by fracking is largely unknown to the public (Heinberg, 2013; Kreuze et al., 2016).

Other key impacts of shale development include increased chemical spills, noise, dust, light pollution, road damage, auto accidents, and transportation congestion associated with the increased daily traffic of the hundreds of heavy diesel trucks used to transport the required water, chemicals, sand, drilling equipment, and other production components to rural well sites (Heinberg, 2013; Ladd, 2014; Perrow, 2015; Theodori, 2013; Wilber, 2015). Indeed, fracking has drawn extensive criticism because of its greater social impacts than those incurred through conventional methods of energy development—particularly those related to the industrialization of rural areas, cost of living increases, differential economic benefits from signing royalties and leasing contracts, tensions between surface and mineral rights owners, increases in transient workers, crime, prostitution, rape, substance abuse, housing shortages, psychosocial stress, and diminished social capital (Brasier et al., 2011; Ellis et al., 2016; Hauter, 2016; Malin & DeMaster, 2016; Sangaramoorthy et al., 2016; Willow, 2014). Finally, other recent research suggests that natural gas fracking is not a "climate-friendly alternative" to coal and oil that will reduce our overall greenhouse gas footprint, nor will it help avert the growing threat of global warming and climate change that its advocates claim. When the expected growth (over

150%) of methane emissions from shale gas production is factored in over the next two decades, combined with the average methane loss/leakage to the environment that occurs with all US natural gas production (6–12%), the overall hidden climate footprint of shale gas fracking is arguably *worse* than coal or oil over its well-to-consumer life cycle (Hauter, 2016; Ladd, 2016).

In sum, the fracking of a shale region's biophysical landscape for oil and gas development inherently creates a system of differential socio-environmental impacts for local stakeholder groups and residents. Depending on how these impacts are experienced over time, place, and audience, mediated by conflicting discursive frames of assorted institutional and residential voices, these synergistic forces can produce the fracturing of a community's ecosystem, sense of place, and social fabric, as well as its patterns of political mobilization and democratic governance (Ladd, 2017). Given the serious risks associated with UGOD and fracking cited in the sociological/social scientific literature, we briefly address how these hazards are likely to be exacerbated by the policies and cabinet appointments of the Trump administration, as well as the larger congressional Republican energy and environmental agenda, over the coming months.

A new landscape of risk

While environmental disputes over UGOD have been growing since the release of Josh Fox's documentary *Gasland* in 2010 (Vasi et al., 2015), opposition to fracking did not emerge as a national campaign issue until the 2016 Democratic Presidential race between Bernie Sanders and Hillary Clinton. During a primary debate in Flint, Michigan, Sanders pledged to oppose fracking, while Clinton said she would be in opposition only if a locality or state were against it, releases of methane or water contamination were present, or fracking operators refused to report what chemicals they were using (Leber, 2016). Clinton's stance signified a significant departure from her previous enthusiastic support for natural gas fracking as part of the Obama administration's mixed resource use policies for maximizing domestic energy production and maintaining the fossil fuel treadmill.

On the day before the Democratic National Convention, 10,000 citizens and activists—including tribal members from a number of prominent western indigenous nations—mobilized in Philadelphia to support the "March for a Clean Energy Revolution" through the streets of the city. The protest march called on political leaders to support a national ban on fracking, keep fossil fuels in the ground, ensure environmental justice for all, and work for a quick and lasting transition to a 100% clean energy economy (Ladd, 2017). While the march did not persuade

the Democratic Party to endorse a moratorium on fracking, the party platform did call for a greater reliance on clean energy sources and support for the COP 21 Paris Climate Accord, among other measures.

Laying the groundwork for the November election, however, the party platform, passed at the Republican National Convention in Cleveland, took aim at "environmental extremists," called the environmental movement "a self-serving elite," and promised to move responsibility for environmental regulation from "the federal bureaucracy"—particularly the EPA—to the states where few fiscal resources and commitments to government oversight exist (Mufson, 2016). Indeed, the Republican energy plank, emphasizing climate change denial, industry deregulation, and increased fossil fuel production, played a prominent role in motivating Donald Trump's political base to turn out for the Presidential election in states like Louisiana and Texas (Hochschild, 2016).

With the Republican Party now in control of the executive and congressional branches of government, as well as federal judicial appointments and the majority of state governments, Americans are already witnessing a wholesale abandonment of the bipartisan energy policies and regulatory regimes that have been in place since the 1970s. Trump's inner circle on environment and energy issues, including Secretary of State Rex Tillerson, (former ExxonMobil CEO), Secretary of Interior Ryan Zinke (former Montana Congressman), Secretary of Energy Rick Perry (former Texas Governor), Secretary of Agriculture Sonny Perdue (former Georgia Governor), and most importantly, Administrator of the Environmental Protection Agency Scott Pruitt (former Attorney General of Oklahoma), all represent longtime climate change deniers and fossil fuel industry advocates, as well as steadfast opponents of international environmental accords like the Paris climate agreement, federal protections for public lands, or independent scientific research that addresses atmospheric or ecological threats. Indeed, Myron Ebell (Director of a Washington, DC libertarian advocacy group financed by the coal industry), who was chosen by Trump to lead the administration's transition team at the EPA, called the environmental movement "the greatest threat to freedom and prosperity in the modern world" (Rauber, 2017a: 21). Since taking office at the EPA, Scott Pruitt (who as the Oklahoma Attorney General sued the EPA over a dozen times on behalf of state industries fighting to evade federal environmental regulations) has worked to unwind several Obama administration–era climate policies, moved to kill or delay regulations limiting toxic air emissions and water pollution from coal-fired power plants, advocated repeal of the Clean Water Rule, and supported a rollback of regulations to prevent groundwater contamination and methane releases from hydraulic fracking (Rauber, 2017b). Summing up the new Trump regime in Washington, the *New York Times* observed that, "Across the federal government, lobbyists and lawyers who once battled regulations on behalf of business are now helping run the agencies they once clashed with" (Tabuchi & Lipton, 2017, p. 1).

As of September 2017, the Trump administration is rapidly advancing an agenda that represents a virtual carbon copy of the wish list of the fossil fuel industry, including:

- constructing the Keystone XL and Dakota Access pipelines, as well as dozens of oil and gas export facilities in North American coastal communities
- abandoning the COP 21 Paris Climate Agreement
- reducing/blocking funding for the EPA, National Oceanic and Atmospheric Administration (NOAA), and climate research at the National Aeronautics and Space Administration (NASA)—alongside extensive staff cuts
- scrapping the Clean Power Plan
- rescinding the Obama administration's ban on drilling in the Alaskan Arctic, as well as regulations to limit methane leaks from wells and pipelines
- increasing drilling and fracking on public lands and national monuments
- increasing coal production and "clean-coal" technology.

Clearly, these proposed carbon-intensive policies cannot be understood in isolation from the neoliberal deregulatory trends of the past three decades, nor detached from the surge of campaign money unleashed by Citizens United into the coffers of Congressional representatives in key energy states (Perrow, 2015). The enactment of the larger Republican environmental agenda will mean an expansion of offshore and arctic drilling, tar sands development, mountaintop removal coal mining, and other risky energy development policies, while rolling back existing federal programs that encourage energy conservation, environmental justice, and scientific research, as well as those that provide tax incentives and credits for solar, wind, and biomass production—all being carried out, ironically, in the name of US "energy independence." After a two-year downturn in oil and gas prices, US production is on the rise again, with the number of US drilling rigs growing from 450 in April 2016 to 602 as of March 2017 (Bias, 2017).

Given the deep ties of his advisors and cabinet officials to hydrocarbon interests, President Trump—who called climate change a Chinese hoax—is currently presiding over what one researcher called "the most anti-science administration in American history" (Proctor, 2016: 4). The President has so far only filled one of 46 vacant science and technology positions in his administration and the Department of Energy has told staff in its climate office not to use phrases like "climate change," "emissions reduction," or "Paris agreement." In fact, one out of four Trump administrative appointees at agencies dealing with environmental regulations has ties to the fossil fuel industry, while half have no experience in the area in which they now work (Rauber, 2017b, p. 21). Joining other protest declarations from dozens of professional and business interests across the nation, over 420 environmental sociologists signed and released a statement in February 2017 denouncing Trump's cabinet picks and anti-climate policies (Hirji, 2017).

It is axiomatic to environmental sociologists that energy matters—arguably now more than at any time in recent US history. At its roots, the controversy over fracking can be seen as a subset of the larger conflict over the future direction of American (and global) energy policy, as well as the resources, technologies, and industry elites who will shape US political and economic interests well into the twenty-first century. As observers have noted since the Arab oil embargoes of the 1970s, the nation continues to stand at a critical historical crossroads defined by two mutually exclusive and environmentally distinct energy futures. The question remains the same. Will the US fossil fuel industry and its allies be permitted to expand its hegemonic control over an emerging "Third Carbon Era"—a future defined by unconventional fossil fuel dependence, intensive hydraulic fracking for shale deposits deep beneath the earth and oceans, industry deregulation, and the continued control over the energy sector by essentially the same transnational corporations that control the market today? Or will the democratic majority create the political mechanisms necessary to initiate the transition to a clean energy society defined by curtailing energy consumption, replacement of fossil fuels with renewable resources, efficient technologies, and green economic policies over the next two decades (Ladd, 2016)?

As the environmental storm clouds gather over the nation's capitol and beyond, the contested terrain of risk and benefit associated with increased hydrocarbon production and hydraulic fracking will continue to divide the nation like never before, especially in regions with large shale deposits, energy infrastructures, water shortages, and growing populations (Food and Water Watch, 2015; Thetford, 2013). All told, we believe that the study of unconventional shale development offers fertile ground for environmental sociologists and other researchers who want to better understand one of the leading sources of conflict today that is fracturing both the community and the ecosystem on which humans depend.

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The Treadmill of Alternatively Fueled Vehicle Production

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Abstract

This paper examines the extent to which alternatively fueled vehicles (AFVs) act as a counterforce to traditional fuel consumption in the United States. I estimate a time-series cross-sectional Prais-Winsten regression model with panel-corrected standard errors to explore how increases in the proportion of AFVs influences fuel consumption rates per vehicle. Findings indicate that AFVs are increasing the average fuel consumption rates of vehicles. Using an additional time-series cross-sectional Prais-Winsten regression model with panel-corrected standard errors, I demonstrate that at least part of this correlation is due to AFVs' positive relationship to travel. I explain this phenomenon using the treadmill of production theory (a prominent theory in environmental sociology), and argue that AFVs up until this point have been used to expand development, and in turn environmental impacts. Furthermore, I argue that the inability of AFVs to replace traditional fuel consumption demonstrates a paradox in their application that can be explained through the treadmill of production theory.

Keywords: alternatively fueled vehicles, ecological paradoxes, fuel consumption, treadmill of production

Introduction

It is often assumed by nations and international organizations that alternative resources directly substitute their fossil-fueled-based counterparts (National Renewable Energy Laboratory, 2013; UNEP, 2011). Whether or not this is the case has been a key concern for social scientists, as it is often noted due to the many complexities embedded within modern socioeconomic processes that new resources aimed at substituting conventional goods do not result in their expected outcome (McGee, 2015; York, 2006). For example, York (2012) found that alternative forms of energy have an unexpected impact on fossil fuel sources of energy. Specifically,

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he noted that while the expectation is that one unit of alternative energy displaces a proportional unit of fossil fuel, in actuality, alternative sources of energy only minutely displace fossil fuel sources. Outcomes such as these have been referred to as "paradoxes" (McGee 2015; York 2006), and can be explained using prominent theories in environmental sociology (see Foster, 1999, 2000; Schnaiberg, 1980; York, 2004).

One such theory, which I will be using in this analysis, is treadmill of production theory (ToP), which was developed by Allan Schnaiberg (1980) to explain the socioeconomic processes that drive ecological destruction. ToP is often employed as a theoretical explanation for empirical evidence of increased anthropogenic environmental degradation (see Besek & McGee, 2014; Clausen & York, 2008; Clement & Schultz, 2011; Jorgenson & Clark, 2012; York et al., 2003). Additionally, it is commonly juxtaposed against another prominent theory in environmental sociology: ecological modernization theory (EMT) (Mol et al., 2009), where researchers assess whether various socioeconomic processes are leading to further environmental harm (explained by ToP) or environmental reform (explained through EMT). A strong correlation between socioeconomic development and increased environmental degradation is often seen as evidence of ToP, while the opposite is argued to be evidence of EMT. However, as EMT and ToP theorists have noted, the empirical goal of EMT is to analyze specific instances of environmental reform, and not necessarily the broader connection between socioeconomic development and ecological processes (Mol et al., 2014; York, 2004; York & Rosa, 2003). As a result, many debates between EMT and ToP have focused on different processes and levels of socioeconomic development. The present study seeks to apply a different approach to this long-standing debate by exploring a specific instance of environmental reform and assessing its ability to counteract environmentally hazardous processes. Specifically, here I ask if there is a paradox in the production of alternatively fueled vehicles (AFVs) in the United States.

I estimate time-series cross-sectional Prais-Winsten regression models with panel-corrected standard errors to explore (1) how increases in the percentage of AFVs across the United States from 2003 to 2014 affect the fuel consumption rates of all vehicles and (2) how increases in the proportion of AFVs affect the travel rates of vehicles. In the first model, I find that a one-unit increase in the proportion of AFVs increases the rate of fuel consumption per vehicle. In the second model, I find that increasing the proportion of AFVs is correlated with increased miles traveled per vehicle, which offers insight into my first finding. I contextualize this phenomenon using ToP, and argue that this instance of environmental reform does not counteract the treadmill of production. I juxtapose this finding against EMT in a slightly more nuanced way than traditional studies exploring these theories (Besek & McGee, 2014; Clausen & York, 2008; York et al., 2003) by empirically examining a specific instance of environmental reform and contextualizing it as a facet of ToP.

Previous discussions on alternatively fueled vehicles

Previous studies of AFVs have predominantly focused on two phenomena—the integration of AFVs into the larger vehicle fleet and the environmental consequences of AFVs. A common thread between these types of analyses is the ability of AFVs to act as a counterforce to climate change and other environmental impacts deriving from gasoline- and diesel-based vehicles. For example, Tran et al. (2013) quantify the conditions that may trigger widespread adoption of AFVs, and identified the barriers that exist for early and mass adoption of AFVs. The authors note that for early adoption, a major barrier, particularly for battery-electric vehicles, is price premiums and the lack of available charging facilities. They find that the integration of AFVs is largely dependent upon a vehicle market that values carbon reduction, which they note is currently not the main motivation behind early adopters, as most consumers are influenced by the financial rather than environmental benefits of AFVs. In a similar vein, Zhang et al. (2011) explore factors that could "speed the diffusion of AFVs," finding that market pull factors such as "word-of-mouth" have a positive impact on the potential diffusion of AFVs. However, the authors also find that government mandates on fuel economy standards aimed at reducing carbon emissions decreases the diffusion of AFVs due to increases in the market share of fuel-efficient vehicles. Egbue and Long (2012) argue that an additional hurdle to the widespread distribution of electric vehicles is consumers' hesitancy to adopt "unproven" technology. They contend that this hurdle limits the effectiveness of AFVs to reduce greenhouse gas emissions from "conventional vehicles."

In studies emphasizing the environmental consequences of AFVs, scholars similarly focus on the ability of AFVs to reduce environmental degradation and compare the merits of AFVs to traditional vehicles. For example, Moriarty (1994) assessed the extent to which electric cars reduced greenhouse gas emissions in Australia, finding that if the electric grid could be made up of at least 15% wind energy, replacing traditionally fueled vehicles with electric cars would reduce greenhouse gas emissions relative to their petroleum-based counterparts. Additionally, Moriarty argued that ethanol from sugar cane had high costs per ton of CO_2 reduction and, when other trace gases were considered, showed no definite improvement over petroleum.

More recently, Lapola et al. (2010) found that carbon emissions derived from land-use change perpetuated by the growing demand for biofuels in Brazil would be low due to their replacement of rangeland. However, Lapola also argues that indirect land-use changes, especially those pushing the rangeland frontier into the Amazonian forests, could offset the carbon savings from biofuels, illustrating that growth in biofuel production can potentially yield little to no reduction in overall environmental degradation.

Other studies have used life cycle analysis to explore the varying environmental impacts of AFVs (e.g., Hill et al., 2006; Segal, 1995). For example, Ogden et al. (2004) performed a life cycle analysis of numerous categories of AFVs to assess the impacts of each fuel type, and found that hydrogen-based fuel had the lowest externality cost of all types of fuel. This was cited as a result of the life cycle cost of hydrogen-based vehicles as compared to newer gasoline-based vehicles, which does not include the cost of extraction. Other research has also found there may be additional individual health risks associated with AFVs. Specifically, Lapin et al. (2002) found that currently employed natural gas–fueled heavy-duty trucks have particulate exhaust emissions that engender mutagenic activity, which is known to cause serious human health risks.

It is clear based on these analyses that scholars are particularly interested in the ability of AFVs to replace traditional vehicles and reduce environmental degradation. Theoretically, these concerns and findings align with notions in ToP and EMT. A frequent debate among EMT and ToP theorists is the ability of existing political economic structures to incorporate meaningful environmental reform. The studies noted above acknowledge the potential environmental benefits of AFVs, as well as the socioeconomic barriers preventing their further application. The debate among ToP and EMT places these concerns in a broader theoretical context that provides new insights into the application of AFVs. Below I discuss the ToP/EMT literature in an effort to expand on the empirical approaches previously used in this debate.

The paperless office paradox: Treadmill of production versus ecological modernization theory

ToP argues that the inherent tendency of modern economies is to expand development by increasing resource extraction, which in turn increases environmental impacts (Gould et al., 2008; Schnaiberg, 1980; Schnaiberg et al., 2002). ToP was first developed by Allan Schnaiberg (1980) as a response to the massive increases in resource extraction and environmental destruction that occurred post–World War II. In assessing modern society's relationship to nature, Schnaiberg concluded that environmental degradation is intrinsic to capitalist society such that social inequalities are interwoven with each environmental concern, and that social and political responses to these production processes are ultimately futile and unpredictable (Schnaiberg et al., 2002). Furthermore, the environmentally destructive characteristics of capitalist production are unhindered by consumer and regulatory action aimed at reducing environmental impacts, as these attempts are contingent upon capital investments (Schnaiberg, 1980; Schnaiberg & Gould, 1994; Schnaiberg et al., 2002).

Gould et al. (2004) note that each round of investment in capitalist markets consistently increases levels of demand for natural resources for a given level of social welfare. Further, Gould et al. (2004) argue that such investments work to weaken employment circumstances for production workers and degrade the environment. This process is made successful by creating a consistent need for investments to employ workers, and continually extracting a variety of natural resources to produce new goods. ToP theorists argue that this level of dependency on capital reduces consumers' and politicians' ability to work in their best environmental interest (Schnaiberg, 1980). For example, strong environmental regulations from the political sphere are seen as antagonistic to workers, and therefore voters, as regulation can reduce the expansion of jobs by decreasing levels of extraction. This hinders politicians' ability to take regulatory action against environmental degradation.

Workers' and consumers' ability to reduce environmental impacts is weakened by their lack of influence in the fields of resource extraction and production. For instance, if a consumer refrains from participating in an environmentally hazardous market, and there are no environmentally sustainable alternative commodities within said market, they risk acquiring additional socioeconomic burdens that using that commodity may relieve. Additionally, due to the monopolistic nature of modern capitalist economies (see Baran & Sweezy, 1966), purchasing sustainable alternatives to environmentally hazardous goods often means purchasing products produced by the same companies. This widespread pattern of centralization makes the reduction of environmental impacts contingent upon producers' reallocation of profits. If, for example, a consumer purchases a sustainable product from a company that reinvests its profits into environmentally hazardous production, the overall benefit of such a choice may be reduced or inverted.

In opposition to ToP, EMT suggests that modern economies cannot only respond to escalating environmental catastrophe, but are also best equipped to deal with environmental problems (Mol et al., 2009). EMT often focuses on specific instances of environmental reform (Sarkis & Cordeiro, 2012; Wattanapinyo & Mol, 2013; Zhu et al., 2012), contending that the escalating presence of environmental policies and adoption of "green" techniques by businesses are signs of modern economies responding to environmental pressures. In response to these claims, ToP scholars have emphasized abstract socioeconomic processes that demonstrate consistent rises in environmental destruction (Besek & McGee, 2014; Clausen & York, 2008; York et al., 2003). For instance, York and Rosa (2003, p. 282) argue that EMT has failed to "explicate the theoretical expectation connecting emergent institutions of modernity with genuine environmental reform," that "case studies, clearly appropriate for in-depth understanding, must be representative of the general process being theorized if they are to validate theory," and that "a focus on individual organizations or industries cannot address critiques of EMT from political economy because the latter theories address economy-wide processes rather than processes

specific to any single sector or actor within an economy." In responses to these criticisms, EMT contends that these critiques are overtly deterministic and do not recognize the changing landscape of modern economies (Fisher & Freudenburg, 2001; Mol et al., 2009; Mol et al., 2014). Mol et al. (2014), in their most recent response to neo-Marxist criticisms of EMT, such as York and Rosa's (2003), argue that these critiques have helped to refine EMT, claiming that "more environmentally friendly and sustainable sociotechnical systems, institutions, policy arrangements and social relations are not only of key academic importance in themselves, but are central also to the identification and understanding of structural, anthropogenic drivers of environmental decay" (Mol et al., 2014, p. 12). These claims of Mol and colleagues suggest that in order to better comprehend environmental degradation, researchers must better understand environmental reform.

York (2004) demonstrates this point in an additional criticism of EMT, arguing that introducing sustainable alternatives to environmentally hazardous markets is simply a "treadmill of diversifying production," where manufacture of "sustainable" products is used to expand markets by meeting diversified consumer interests. This process renders ecologically sustainable resources more a reaction to unsustainable processes, rather than a counterforce, making the increasing prevalence of "ecologically conscious goods" within modern economies an expansion of overall production. In a more recent article, York (2006) further explores this phenomenon, along with the more widely known Jevons paradox (Clark & Foster, 2001), to question whether technological advances alone lead to conservation of natural resources. Here he contends that in addition to the Jevons paradox, which is a phenomenon where improved resource efficiency escalates the consumption of that resource, there is a paradox of substitution, where new resources fail to reduce existing ones. York calls this paradox the "paperless office paradox," in reference to Sellen and Harper's book *The Myth of the Paperless Office* (2003).

York (2012) empirically tests this paradox by exploring the extent to which alternative sources of energy displace fossil fuel sources of energy. He finds that the increased presence of alternative sources of energy, such as hydroelectric and nuclear, only minutely displace the production of fossil fuel energy sources, and argues that this goes against traditional assumptions regarding energy expansion. Based on his findings, York concludes that the shift away from fossil fuel energy use does not inevitably occur with the expansion of alternative sources.

McGee (2015) also hypothesizes there is a "paradox" within sustainable markets, finding that organic farming is increasing the emissions of greenhouse gases. McGee concludes that in attempting to expand the use of organic goods, agribusiness in the United States has watered down organic standards in such a way that organic farming no longer needs to rely on practices associated with climate change mitigation. As a result, the increase in organic farming produces a paradox, where organic expansion does not counteract the environmental impacts it is traditionally assumed to.

York's (2012) and McGee's (2015) findings regarding the paperless office paradox can comprehensively be understood as instances where novel technologies fail to produce their intended outcomes. Their empirical approaches are similar to those used by EMT, as they emphasize perceived instances of environmental reform; however, they contextualize their findings more in line with ToP. These approaches are new ways of exploring the long-standing debate between ToP and EMT regarding the effectiveness of environmental reform. As noted previously, the current literature on the production of AFVs has similarly emphasized the ability of AFVs to substitute traditional vehicles and promote environmental reform. To this end, the hypothesis developed below will place the relationship between AFVs and traditional vehicles within the context of the EMT and ToP debate, with the intention of elaborating on the structural barriers preventing further application of AFVs.

Hypothesis

I ask whether increasing the proportion of AFVs within the vehicle fleet increases or decreases total fuel consumption rates per vehicle. This question is articulated in the hypotheses below.

H1: Increasing the proportion of AFVs within the vehicle fleet reduces the total amount of fuel consumed by vehicles in the United States.

H2: Increasing the proportion of AFVs within the vehicle fleet increases the total amount of fuel consumed by vehicles in the United States.

H1 assumes that AFVs are operating as a counterforce to the treadmill of production and as a process of ecological modernization by reducing the amount of fuel that is consumed by vehicles annually at the state level. This outcome could be a result of multiple factors, such as AFVs having higher fuel efficiency or AFVs being associated with lower rates of travel. Additionally, this hypothesis assumes that AFVs are displacing traditional vehicles. In contrast to H1, H2 assumes that AFVs are acting as a facet of the treadmill of production and increasing the amount of fuel consumed by vehicles at the state level. Similarly, to H1, H2 could be a result of multiple factors, such as lower fuel efficiency among AFVs, the number of AFVs adding to the total number of vehicles in the vehicle fleet, or AFVs increasing travel.

To further understand the extent to which AFVs act as a facet of the treadmill of production or a form of ecological modernization, I pose the additional question of whether rises in the proportion of AFVs increase or decrease the number of miles traveled by vehicles at the state level. This question is articulated in the following hypotheses:

H3: Increasing the proportion of AFVs within the vehicle fleet decreases the number of miles traveled per vehicle in the United States.

H4: Increasing the proportion of AFVs within the vehicle fleet increases the number of miles traveled per vehicle in the United States.

H3 assumes that one way AFVs operate as a counterforce to the treadmill of production is by reducing the number of miles traveled by vehicles at the state level. Conversely, H4 assumes that one of the ways in which AFVs act as a facet of the treadmill of production is by increasing the number of miles traveled by vehicles at the state level. Although H1 and H3 both assume that AFVs operate as a counterforce to the treadmill of production, H1 can be confirmed while H3 is rejected and vice versa. For example, it may be the case that AFVs are on average more fuel efficient than gasoline and diesel vehicles, consuming less fuel per vehicle, but that travel is increased due to the increased fuel efficiency. This argument is similar to the rebound effect (see Greening et al., 2000; Small & Van Dender, 2005, 2007; Sorrell, 2007), which argues that consumption rates for gasoline grow due to lower cost from increased fuel efficiency and behavioral shifts in consumers. Likewise, H1 can be rejected while H3 is confirmed if AFVs act as a facet of the treadmill of production by increasing fuel consumption per vehicle due to lower fuel efficiency rates, but reduce the average amount of travel per vehicle as a result of minimal infrastructure for AFVs.

Data and methods

In order to test my hypotheses, I estimated three elasticity models (shown in Tables 3 and 4), which were created by taking the natural log of my dependent and independent variables. Elasticity models assume that a dependent variable is determined by a multiplicative combination of the independent variables. Multiplicative models intrinsically take into account one type of interaction among factors by recognizing that a change in one independent variable does not simply add to the dependent variable directly, but rather scales it relative to the values of the other factors. Additionally, each coefficient for my independent variables is interpreted as the proportional effect of a 1% change of the independent variable on the dependent variable.

Each model is estimated using a time-series cross-sectional Prais-Winsten regression model with panel-corrected standard errors (PCSE), allowing for disturbances that are heteroskedastic and contemporaneously correlated across panels (see Beck & Katz, 1995). Each model estimates the relationship from 2003 to 2014 across the United States (excluding the District of Colombia). I include state-specific and year-specific intercepts, meaning the fixed effects of this model are both unit and time specific. As such, this method estimates effects within states, rather than

between states, over time and controls for variation between states. Finally, I correct for autoregressive (AR1) disturbances within panels, treating the AR(1) process as common to all panels because there is no theoretical reason to assume the process is panel specific (see Beck & Katz, 1995). The model I estimate is:

$$y_{it} = B_1(x_{1it}) + B_2(x_{2it}) \ldots B_k(x_{kit}) + u_i + w_t + e_{it}$$

Here the subscript $_i$ represents each unit of analysis (states) and the subscript $_t$ the time period, y_{it} is the dependent variable for each state at each point in time, x_{kit} represents the independent variables for each state at each point in time, u_i is a state-specific disturbance term that is constant over time (i.e., the state-specific y-intercept), w_t is a period-specific disturbance term constant across states, and e_{it} is the stochastic disturbance term specific to each state at each time point.

The logic of my modeling approach is to observe how change in the number of AFVs effects change in the dependent variables. I chose to use a PCSE model with year- and state-specific intercepts because it allows me to specifically assess the effect of change from year to year within states as opposed to differences across states.

Dependent variables

The data for the dependent variables were obtained from the United States Office of Highway Policy Information (OHPI).[2] The data include annual motor fuel consumption rates for all civilian vehicles and the total number of vehicles. The data on motor fuel consist of gasoline, gasohol, diesel, ethanol (85% or higher), compressed natural gas, electricity, hydrogen, liquefied natural gas, and liquefied petroleum all measured in gasoline-equivalent gallons. The data for motor fuel consumption are estimated based on motor fuel sellers' federal and state tax returns. Specifically, OHPI (2015, pp. 2–11) states:

> The major component of the gross volume is the tax returns of sellers (depending on the point of taxation in the State, the sellers are: position holders at fuel terminals, wholesalers, or retailers). Include the gross motor fuel sales reported by these taxpayers, including fully taxed sales, exempt sales, volume subject to full or partial refund, and sales taxed at a reduced rate. Include gasoline volume subject to exemption due to actual loss or subject to loss or shrinkage allowance.

2 Office of Highway Policy Information, 2014, retrieved from www.fhwa.dot.gov/policyinformation/statistics.cfm, 2016.

It is also important to note that this methodology potentially underestimates the fuel consumption of electric vehicles, since a portion of electric fuel consumption derives from private residences. However, based on the findings discussed below, inclusion of these data would most likely further support the results of this analysis, as it suggests that the total amount of fuel consumption is underestimated.

The first dependent variable (Table 1) was calculated by dividing the total amount of fuel consumed by civilian vehicles by the total number of civilian vehicles, which includes all mid-sized automobiles, compact automobiles, full-size automobiles, subcompact automobiles, low-speed vehicles, motorcycles, sport-utility vehicles (SUVs), pickup trucks, full-size trucks, light-weight vans, mid-size vans, and mini vans.

The second dependent variable (Table 1) was also obtained from OHPI and measures the total number of miles traveled per vehicle. This variable was created by dividing the total number of miles traveled by the total number of vehicles. The data for motor fuel consumption, total number of vehicles, and miles traveled per vehicle rely on annual state reports, where each state follows established federal guidelines to maintain consistency across regions. The OHPI notes "these estimates may not be comparable to data for prior years due to revised estimation procedures." However, the most recent revised estimation procedure occurred in 2002 when an automated data submittal process was implemented by a web-based application, which was intended to ease the reporting burden and improve data accuracy. Thus the data used in this analysis are not subject to this particular inaccuracy.

Table 1. Summary statistics of dependent variables (unlogged)

Variable	Mean	Minimum	Maximum	Standard deviation
Fuel consumption per vehicle (gallons)	754.592	369.114	1,834.413	173.015
Miles traveled per vehicle	12,323	1,968	32,340	2,821

Source: Office of Highway Policy Information, 2014, retrieved from www.fhwa.dot.gov/policyinformation/statistics.cfm, 2016.

Independent variables

In order to accurately test the relationship between AFVs, fuel consumption, and travel per vehicle I employed a number of independent variables to control for the potential influence of related time-variant factors (Table 2). I controlled for the effect of change in the ratio of licensed drivers to vehicles, which helps to control for the impact of changes in the driving pool from year to year. The data for this variable also come from OHPI. I also controlled for the effect of changes in gross domestic product (GDP) per capita in 2009 constant US dollars to account for the

influence of changes in the economy. The data for GDP per capita were obtained from the Bureau of Economic Analysis.[3] While it seems appropriate in an analysis like this to control for year-to-year fluctuations in fuel prices, data at the state level were unfortunately not available. To address the potential influence of fuel prices, I controlled for the impact of tax rates on gasoline, which, coupled with my time dummies that controlled for general period fluctuation in my dependent variables, captured the effect of changes such as price over time. I also controlled for miles traveled per vehicle to assess how changes in the amount of travel by individuals over time affects gasoline consumption. Population data were obtained from the United States Census Bureau.[4] The main independent variable is percent AFVs (Tables 3 and 4), which accounts for the percentage of civilian vehicles that do not use gasoline out of the entire civilian vehicle fleet. Data on AFVs were obtained from the Energy Information Administration[5] and include the following fuel sources: ethanol (85 per cent or higher) (E85), compressed natural gas, electricity, hydrogen, liquefied natural gas, and liquefied petroleum, measured in gasoline-equivalent gallons. The Energy Information Administration's estimates on AFVs do not include gasoline or diesel-electric hybrids because the primary fuel sources for those vehicles are traditional fuels.

Table 2. Summary statistics of independent variables (unlogged)

Variable	Mean	Minimum	Maximum	Standard deviation
Percent alternatively fueled vehicles (E85)	.071	.0004	.393	.070
Percent alternatively fueled vehicles (no E85)	.019	.0002	.393	.028
GDP per capita (US dollars)	46,477	30,211	74,273	8,549
Ratio of drivers to vehicles	.744	.369	1.137	.102
Gasoline tax rate (US cents)	21.256	7.5	37.5	5.465

Sources: Bureau of Economic Analysis, www.bea.gov; Office of Highway Policy Information, 2014, retrieved from www.fhwa.dot.gov/policyinformation/statistics.cfm, 2016.

There are several inconsistencies in the data for AFVs that I addressed by assessing the robustness of my findings. First, data on the number of vehicles using E85 were unavailable before 2010. Due to the substantial number of AFVs that rely on E85, I found it appropriate to analyze the extent to which this data inconsistency potentially biases my results. In models not shown here (but can be obtained upon request), I assessed the effect of percent changes in AFVs without addressing this inconsistency in the data—in these models the effect of AFVs is the same (coefficients were still significant at $p < .01$ and the direction of the coefficients were the same). Additionally, in models not shown here I assessed the effect of AFVs from 2003

3 Bureau of Economic Analysis, www.bea.gov, retrieved April 2014.
4 United States Census Bureau, 2012 National population projections, retrieved from www.census.gov.
5 Energy Information Administration, www.eia.gov, retrieved April 2014.

to 2010 and from 2010 to 2014 separately. In each of these models, the effect of AFVs is the same. The models shown in this paper exclude E85 fuel entirely due to inconsistency in the data. It is also important to note that, according to the Energy Information Administration, due to the limited availability and economic viability of E85 fuel, the vast majority of AFVs owned by individuals use gasoline and diesel.

Results

The PCSE models used to test my hypotheses control for omitted factors that vary across states but are temporally invariant, such as the effects of the historical legacy preceding the periods examined here (e.g., the era during which a state introduced AFVs). The models, therefore, control for characteristics unique to each state. Additionally, the models control (via the time dummies) for cross-sectional invariant factors that change over time, such as fluctuations in international energy prices. Thus, results specifically show the effects of within-unit change in the independent variables on the dependent variables.

Table 3 presents the PCSE model that regresses total fuel consumption on percent AFVs, miles traveled per vehicle, GDP per capita, the ratio of licensed drivers to vehicles, and tax on gasoline. These models test my hypothesis that increases in the percent of AFVs will increase total fuel consumption against the null hypothesis, which is that there is no relationship between AFVs and total fuel consumption for vehicles, and the alternative hypothesis, which supports the conventional view that AFVs displace traditional fuel. Model A in Table 3 omits miles traveled per vehicle to assess the combination of both the potential direct effect of percent AFVs and an indirect effect of AFVs via its influence on miles traveled. Here I find the variable percent AFVs is associated positively with fuel consumption per vehicle ($p < .001$, two-tailed test). This indicates that the rise in percent of AFVs proportionally increases the amount of fuel consumption per vehicle. GDP per capita is also positive and significant in Model A ($p < .001$, two-tailed test), which demonstrates that growth in the economy through time increases total fuel consumption per vehicle. Additionally, a one-unit increase in the ratio of licensed drivers to vehicles is positive and significantly correlated with fuel consumption per vehicle ($p < .001$), which means that as the ratio of drivers to vehicles rises, there is an increase in the average amount of fuel consumed per vehicle. Thus Model A demonstrates that rises in the number of AFVs in the vehicle fleet over time within states increases total fuel consumption per vehicle, while holding constant changes in size of the economy, percentage of the population that has a driver's license, gasoline tax rate, and the general period fluctuation in total fuel consumption (Table 3). This finding supports hypothesis 2, that AFVs are adding to the consumption rates of total fuel consumption.

Model B (Table 3) is meant to further test my hypothesis, by controlling for miles traveled per vehicle in addition to the independent variables used in Model A. Here I find that percent AFVs is still significantly correlated with fuel consumption per vehicle; however, the effect of a one-unit increase in the percent of AFVs is much smaller. Similar to Model A, GDP per capita and the ratio of licensed drivers to vehicles are also positive and significant in Model B ($p < .001$, two-tailed test). The independent variable miles traveled per vehicle in Model B is positively correlated with total fuel consumption per vehicle ($p < .001$, two-tailed test). This means that, unsurprisingly, increases in travel per vehicle increase the amount of fuel consumed per vehicle. The change in the overall effect in percent AFVs when adding miles traveled per vehicle as an independent variable in Model B implies that the influence of AFVs on fuel is most likely heavily tied to AFVs' relationship to vehicle travel. The findings in Model B also confirm hypothesis 2.

Table 3. Prais-Winsten regression model with panel-corrected standard errors coefficients predicting gallons of fuel consumption per vehicle

Independent variables (logged)	Model A coefficients (standard errors)	Model B coefficients (standard errors)
Percent alternatively fueled vehicles	.032*** (.008)	.009** (.003)
Miles traveled per vehicle ('000s of miles)		.539*** (.058)
GDP per capita in constant 2009 dollars ($'000)	.894*** (.083)	.663*** (.044)
Ratio of licensed drivers to vehicles	.244*** (.032)	.116*** (.026)
Gasoline tax rate (in cents)	–.028 (.033)	–.012 (.044)
R^2	.886	.917
High variance inflation factor	4.42	4.41
N	600	600

*$p < .05$, two-tailed. **$p < .01$, two-tailed. ***$p < .001$, two-tailed.

Table 4 presents the PCSE coefficients for miles traveled per vehicle and is meant to explore my hypothesis that increasing the proportion of AFVs increases travel per vehicle. Here, percent AFVs is found to be positive and significant ($p < .001$, two-tailed test). Specifically, a one-unit increase in the percent of AFVs corresponds with a proportional increase in miles traveled per vehicle. This confirms hypothesis 4 by demonstrating that AFVs are increasing the average travel per vehicle in the United States. Furthermore, my analysis shows that increases in economic development lead to significant increases in miles traveled per vehicle. Rises in the gasoline tax rate as well as the ratio of licensed drivers to vehicles are also correlated with increases in the number of miles traveled per vehicle in the United States (Table 4).

Table 4. Prais-Winsten regression model with panel-corrected standard errors coefficients predicting miles traveled per vehicle

Independent variables (logged)	Coefficients (standard errors)
Percent alternatively fueled vehicles	.044*** (.008)
GDP per capita in constant 2009 dollars ($'000s)	.432*** (.077)
Gasoline tax rate (US cents)	.092** (.031)
Ratio of drivers to vehicles	.234*** (.024)
R^2	.857
High variance inflation factor	4.34
N	600

*$p < .05$, two-tailed. **$p < .01$, two-tailed. ***$p < .001$, two-tailed.

Discussion and conclusion

My analysis finds that AFVs are associated with increases in total fuel consumption per vehicle, as well as rises in travel rates per vehicle. These findings suggest that AFVs are expanding vehicle use in the United States rather than shifting fuel consumption away from traditional sources (e.g., gasoline and diesel). Consequently, this means that AFVs may be increasing environmental impacts produced from the vehicle industry. One lesson to be learned from this analysis is that the assumption that AFVs work to reduce the use of fossil fuels at this point is not true. While this is not to say there are no environmental merits to AFVs, it does demonstrate that current social and economic barriers prevent the widespread use of AFVs.

One interpretation of these findings is that the social and economic barriers presented by other scholars regarding further integration of AFVs into the vehicle fleet (see, e.g., Tran et al., 2013; Zhang et al., 2011) also work to produce a positive relationship between AFVs and travel. That is, unless there is greater support for alternative fuel stations, reduced price premiums for AFVs, and greater consumer concern for environmental impacts, AFVs will continually work to increase travel and consequently the environmental degradation produced by the vehicle industry.

These trends can also be understood as a facet of the treadmill of production, which suggests that the expansion of vehicle use through the production of AFVs is a result of increased supply for natural resources in the vehicle industry, enhancing demand. That is, as a niche market, AFVs are not used to replace traditional vehicles, but instead enhance vehicle use. Using this interpretation, one could imagine many scenarios in which AFVs expand total vehicle use. For example, individuals who traditionally refrain from using personal vehicles for travel due to their negative environmental outcomes may use AFVs due to their perceived environmental merits. Additionally, people who use traditional vehicles may use AFVs to expand their

travel via personal vehicles. In these scenarios AFVs adhere to York's (2004) notion of the "treadmill of diversifying production," where AFVs function as a reaction to the environmental impacts of traditional fuel consumption, and not a counterforce.

Similar to York (2012) and McGee (2015), my findings demonstrate a paradox in ecologically sustainable production. As York and McGee find with energy and agriculture respectively, alternative goods or resources do not have their assumed relationship with environmental degradation or traditional processes. Similarly, my findings suggest that AFVs do not have their expected relationship to traditional vehicles. While this relationship may change over time, it is worth noting that if the present barriers that prevent further integration of AFVs into the vehicle fleet persist, then the expansion of AFVs may continue to increase total vehicle use in the United States.

AFVs may also increase fuel consumption for vehicles similarly to the rebound effect (see Greening et al., 2000; Small & Van Dender, 2005, 2007; Sorrell, 2007), where consumption rates for gasoline grow due to lower cost from increased fuel efficiency. It is likely that rises in the number of AFVs is correlated with increases in fuel-efficient vehicles, such as electric-hybrid, which could intensify consumption of gasoline by reducing its cost. Furthermore, it is argued that the rebound effect is a result of increased travel: the findings here demonstrate a strong correlation between travel and AFVs, suggesting that increased travel perpetuates both phenomena.

In conclusion, these results coupled with the findings of Moriarty (1994), Segal (1995), Lapin et al. (2002), Ogden et al. (2004), Hill et al. (2006), and Lapola et al. (2010) suggest that the environmental impacts associated with AFV production are, at this point in time, additions to the vehicle industry's hazardous environmental output. This finding warrants further investigation into other paradoxes in environmentally sustainable production. Additionally, future research and policy should emphasize the types of barriers producing these outcomes and their potential remedies.

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Protected Area Establishment and Its Implications for Local Food Security

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Abstract

The establishment of protected areas can reduce access to natural resources for communities that depend on such areas for food, and can thus contribute to food insecurity. We studied the local food systems of two communities that surround a protected area in southern coastal Brazil and the relationship between the protected area and local food security. We randomly selected 34 households to perform 24-hour recalls of food intake and administered a questionnaire that addressed food security. Our key findings were: (1) the consumption of biological resources is based on cultivated, raised, and fished food items, which are locally purchased, produced, or caught by households; (2) food vulnerability is related to household income; (3) there is a greater reliance on resources from the protected area among households with livelihoods that depend on the local environment; (4) the restriction of access to natural resources and the potential replacement of diverse activities that generate food and income influence the diets of the affected families, which can also affect local food security in the long term.

Keywords: Atlantic Forest, biodiversity conservation, biological resources, food security, human ecological niche, local food resources

Introduction

Ecosystem biodiversity provides many goods and services that contribute to human well-being. The provision of natural food resources is one of those services (Blaney et al., 2009; Pimentel et al., 1997). The increase of human populations worldwide has created the challenge of meeting basic human needs for food resources while ensuring effective conservation strategies (FAO, 2014). In particular, biodiversity loss in tropical regions has often been associated with the intense use of forest environments and their resources (Faude et al., 2010).

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Protected areas can play a key role as a mechanism for biodiversity conservation by excluding the pressures that result from the heavy use of natural resources. However, considerable biodiversity occurs within landscapes that are connected to communities' farming and fishing systems. Policy interventions that only address the protection of biodiversity without due consideration of the social and economic needs of people can have limited outcomes (Sunderland, 2011). In developing tropical countries, many human populations that live near targeted conservation areas depend on biodiversity resources, including food, for their livelihoods. This condition can result in a complex scenario where landscape conservation is sometimes combined with maintaining people's livelihoods (Allendorf, 2010; Faude et al., 2010; Nepal, 2002). The implementation of protected areas and the loss of access to natural resources by local residents or those who live in the surrounding areas has been widely discussed (e.g., Allendorf, 2010; Blaney et al., 2009; Faude et al., 2010; Nepal, 2002). Local people's welfare can be significantly negatively affected by restricting their access to the landscapes that they previously used for resource harvesting (Blaney et al., 2009; Gbetnkom, 2008).

Biodiversity in terrestrial and aquatic habitats is an important component of smallholder production systems that provide food to people who live near protected areas, which contributes to their livelihoods (FAO, 2014). "Livelihood" refers to the activities, capabilities, relationships, and assets that permeate the life of a given population (Hanazaki et al., 2013; Hesselberg & Yaro, 2006). In turn, livelihoods influence the food security of local populations (Hanazaki et al., 2013; Hesselberg & Yaro, 2006); that is, food security is understood as sufficient and constant food access from physical, social and economic perspectives that satisfy food needs and preferences (Barrett, 2010; Hesselberg & Yaro, 2006). Changes in livelihoods, including legal restrictions due to biodiversity conservation strategies, can affect access to food, which modifies dietary patterns and sometimes contributes to food insecurity.

Studies of the diets of local human populations have analyzed both environmental sustainability and the components of local food security that relate to the availability of food items (DFID, 2000; Murrieta et al., 1999). In addition, the concept of the ecological niche has been widely applied as a useful tool in the analysis of the inclusion and importance of natural resources in the diets of human populations (Begossi & Richerson, 1993; Cavallini & Nordi, 2005; Hanazaki & Begossi, 2000, 2003; Hardesty, 1975; MacCord & Begossi, 2006; Silva & Begossi, 2009). The concept of the ecological niche, when applied to human groups, is delimited by the integration of physical, biological, and cultural factors that together establish the subsistence pattern of a group of people (Hardesty, 1975). The differences among human groups with respect to an ecological niche dimension (e.g., the food dimension) can help to explain the interaction of these groups with their environments (Begossi & Richerson, 1993; Cavallini & Nordi, 2005; Hanazaki & Begossi, 2000;

Hardesty, 1975) as well as the changes that may be experienced, as reflected by mutual influences between natural resources and diet (McCune & Kuhnlein, 2011). In addition, knowledge of the origin and significance of food resources and an understanding of local agroforestry systems can improve food security in areas that are of central importance for biodiversity conservation.

There is a need to understand the influence of biodiversity conservation policies on the relationship between local human populations and natural resources, and the implications on food security in the surroundings of a given protected area (Blaney et al., 2009; Ghimire, 1994). The present study focuses on understanding the local food systems of communities that surround a fully protected area in southern coastal Brazil and the relationship between the protected area and local food security. A former study analyzed the socioecological, sociocultural, and socioeconomic aspects of the region and identified the presence of traditional communities that surround the protected area; however, there is still a lack of knowledge concerning the relationships among livelihood activities, local resource consumption, and local food security (Foppa & Medeiros, 2011). Traditional communities can be defined as culturally differentiated groups that recognize themselves as being culturally differentiated; they have their own forms of social organization; they occupy and use territories and natural resources as a condition for their cultural, social, religious, ancestral, and economic reproduction; and they incorporate knowledge, innovations, and practices that have been generated and transmitted by tradition (Presidency of the Republic of Brazil, 2007). Our objective was to understand the impact on the surrounding communities of the restriction of access to natural resources in an established protected area. The study first included an analysis of the local diets followed by an analysis of how access to these natural resources is related to local food security.

Methods

Study area

In Brazil, protected areas are divided into two groups: the first includes parks and seeks the full protection of ecosystems by excluding all resource extraction by humans and allowing only indirect use of the land, reserving it mainly for research and environmental education activities. Public access is not allowed in these areas, and no gathering or consumption of natural resources is allowed. The second group includes sustainable use conservation units and seeks to balance nature conservation with the planned and regulated use of some of the natural resources, such as harvesting wild foods, fishing, and the use of non-timber forest resources. Sustainable use protected areas may consist of public or private lands. Hunting is permitted only under very strict circumstances (Presidency of the Republic of Brazil, 2000).

Acaraí State Park, which was recently created, is a fully protected area located on the coast of southern Brazil in the municipality of São Francisco do Sul, Santa Catarina State (26° 04′ 36″ S; 48° 38′ 17″ W) (Figure 1). The park was created to compensate for the installation of a steel plant with a high potential for negative environmental impacts (State of Santa Catarina, 2005). The park has an area of 6,667 hectares and aims to promote the conservation of a section of the Atlantic Forest, which has a hydric complex that is formed by freshwater and estuarine rivers, and to protect the breeding area of a number of important marine species in the Archipelago of Tamboretes (State of Santa Catarina, 2005). The ecosystems of the area can be divided into regions of mangroves, restinga (a set of physiognomically distinct marine and fluvial-marine influenced plant communities; CONAMA, 1996), dunes, and dense rain forest (IBGE, 2012). According to Brazilian legislation, state parks do not allow the direct use or extraction of natural resources (e.g., fishing and harvesting non-timber forest products). The protected area of Acaraí State Park can be accessed through the communities of Praia Grande, Tapera (São José do Acaraí), and Ervino, which represent approximately 42% of the surrounding population.

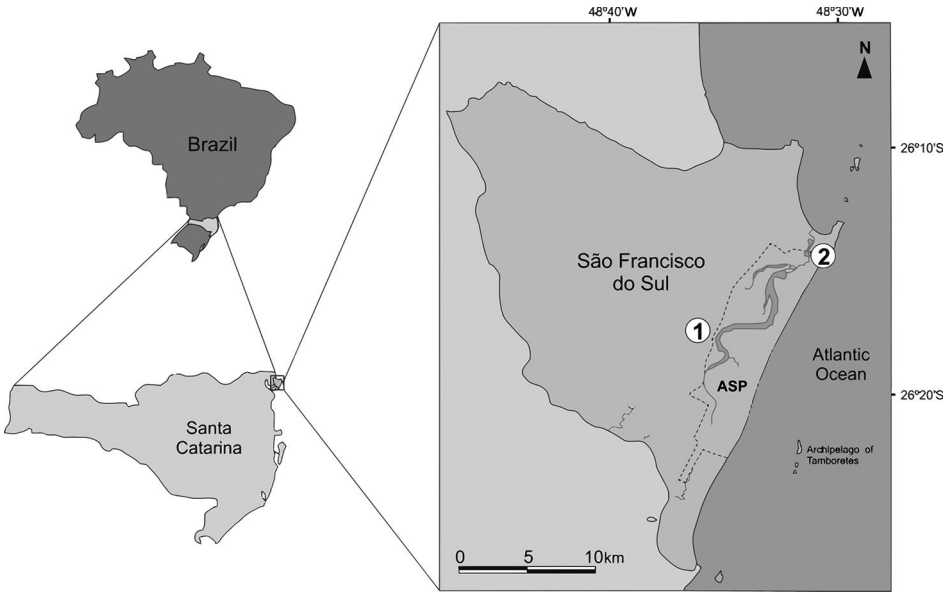

Figure 1. Location of Acaraí State Park (ASP, dotted line), São Francisco do Sul, Brazil, and the two communities, Tapera (1) and Praia Grande (2), that participated in this study

Source: Adapted from Foppa & Medeiros (2011).

This study was conducted in the communities of Tapera and Praia Grande. Tapera includes approximately 40 households that are characterized as traditional and have diets that are at risk due to the creation and implementation of Acaraí State Park (Foppa & Medeiros, 2011). In contrast, Praia Grande is characterized as a summer

tourism area with a strong tourism infrastructure, which includes shops and small markets, and it has few traditional inhabitants. The community of Praia Grande has households with higher incomes compared to Tapera, evidenced by better infrastructure of households and the quality and presence of goods such as clothing, appliances, and automobiles.

Prior to data collection about food intake, we interviewed adults who have lived in these communities for at least five years, to characterize them socioeconomically. Tapera has a higher proportion of inhabitants who were born in the municipality (49%, n = 35, people interviewed in Tapera neighborhood), and many are from local families (88%, n = 17). People from other municipalities and from outside of the region account for 63% (n = 107, total people interviewed) of the inhabitants. For non-natives, the average time living in these communities is 17 years, and is higher in Tapera (27 years, on average) than in Praia Grande. The average number of people per household is 2.63 (s.d. = 1.34) for Praia Grande and 2.66 (s.d. = 1.47) for Tapera.

Data collection

To assess the diversity of locally consumed biological resources, 20 households were randomly selected in each community. McCune and Kuhnlein (2011) suggest the use of a time lag during data collection to compensate for possible seasonal differences in the local items that are consumed. Thus, all of the households that were willing to cooperate were monitored during a summer (17–22 January, 2012) and winter (23–28 July, 2012) season. This study adopted the 24-hour food intake recall method (Albuquerque et al., 2010; Dufour & Teufel, 1995) for three consecutive days during each season, excluding holidays and recess days. The repetition of food intake recall seeks to minimize fluctuations that can be derived from events that can change daily routine activities. We used a script with food items for resource consumption, and we also registered the number, age, and gender of the people in each household, as well as the origin of the foods that were consumed. A priori defined categories helped to identify the different origins of the resources that were used as food, which included purchased outside of the neighborhood; purchased within the neighborhood; purchased from local production (i.e., items purchased from a relative, neighbor, or acquaintance who lives in the same community); and cultivated or bred, donated, fished, and self-produced items (food items whose main ingredients are local biological resources). To assess food security indicators, a supplementary questionnaire was given based on a technical report on the validation of methodologies for the analysis of food security or insecurity in Brazil (UNICAMP, 2003), which is linked to national policy evaluations to avert hunger. The questionnaire investigated food vulnerability for a period of three months prior to the interviews, and included questions about the variety and quantity (sufficiency) of food. The self-reporting of household income was divided into six

categories and placed informants on a scale of relative average income. Together with the consumption of food, family income was considered to be an important factor in predicting food insecurity (UNICAMP, 2003). The six income categories followed those defined by UNICAMP (2003): less than the minimum wage (R$622 per month, equivalent to approximately US$352, in January 2012), equal to one to two minimum wages, two to three minimum wages, three to five minimum wages, five to 10, and above 10 minimum wages. Edible plant species were collected or photographed in the environments near the households (Albuquerque et al., 2010) for identification, as were economically important fish species and aquatic invertebrates. Visits to local fisheries and the donation or sale of specimens by the households also allowed for the identification of fish species. No terrestrial animals, birds, or hunted game were consumed.

Data analysis

The food dimension of the ecological niche was measured in terms of the number of citations (abundance) and the number (richness) of local biological resources that formed part of the reported meals. Niche breadth, which represents the set of resources that are exploited by an organism or a population, was also measured (Begossi & Richerson, 1993). Thus, greater diversity may reflect greater niche breadth (generalist diet), whereas a lower diversity of consumed items reflects a narrower niche (specialist diet) (Cavallini & Nordi, 2005; Hanazaki & Begossi, 2003). Diversity indices were used to measure niche breadth for each community and to analyze diet overlap (Hardesty, 1975). Specifically, the standardized Levin's index (Bp) (Krebs, 1999) was obtained with ecological methodology software (Kenney & Krebs, 2000). The standardized index reaches a maximum value if the proportion of items consumed at meals is similar, which shows a more generalist diet. Values close to zero indicate that few food items are consumed at high frequencies, and most of the items are consumed at low frequencies (more specialized diets). Also, rarefaction curves (Peroni et al., 2010) were used, and the probability of interspecific encounter (Hulbert, 1971) was calculated using the software EcoSim 7.72 (Gotelli & Entsminger, 2012). The rarefaction curve allows the expected richness of biological resources that are consumed to be compared across the abundance of citations of consumption for different communities with different sample sizes. The probability of interspecific encounter is a simple index of diversity that shows the distribution of relative abundance of consumption of local biological resources. The overlap of food niche breadth was determined for summer and winter by calculating the percentage of niche overlap as described by Krebs (1999).

Spearman's correlation analysis (rs) was used to verify the association between household income and food vulnerability, as well as the relationship to food quantity and variety that was assessed in the supplementary questionnaire. Spearman's correlation was used because the Shapiro-Wilk test demonstrated that neither set of data followed a normal distribution (Wincome = 0.914, p = 0.011; Wfood vulnerability = 0.546, $p < 0.001$). Statistica 7.0 (Statsoft Inc., 2004) was used for the chi-square and Shapiro-Wilk tests and Spearman's correlation.

A canonical correspondence analysis was done to understand the ordination of the households. The ordination detects patterns of variation in the data due to environmental variations. For this analysis, the data of biological resources consumed (community matrix) and socioenvironmental data (environment matrix) were used, which characterize various aspects of each community's livelihood. The data in the socioenvironmental matrix represent the explanatory variables that might influence the set of response variables; in this case, the data on abundance of locally consumed resources. This analysis reflects the influence of socioeconomic variables in the consumption of natural resources. The environmental matrix used the average number of people who share meals in the households; income (expressed in six wage classes); presence or absence of fishing activities and livestock; and habitat use, which refers to the number of habitats (i.e., home garden, crop field, vegetable garden, orchard, or mixed habitat) that were used by each household. We used the Monte Carlo test to analyze the strength of the association among the axis with the environmental variables for 999 iterations (see Legendre & Legendre, 2012). These analyses were performed using the R package (R Development Core Team, 2012).

Results

Among the 20 selected households in each community, 18 in Tapera and 16 in Praia Grande completed the study, for a total of 34 households (six households were excluded from the sample because they did not participate in both rounds of data collection). Data were collected for 355 meals in the summer (165 in Praia Grande and 190 in Tapera) and 411 meals in the winter (188 in Praia Grande and 223 in Tapera). Altogether, 210 food items were listed in the analyzed meals. Most of the food items consumed during both of the sampled seasons, including industrial products, were purchased within the neighborhood (Figure 2). The meals of the 34 households consisted of breakfast, lunch and dinner; all of the households also had snacks between these three principal meals or even reported that at times they replaced dinner with several snacks. Within the meals, the most frequently consumed foods were coffee, bread, milk, rice, margarine, beans, beef, tomatoes, and bananas.

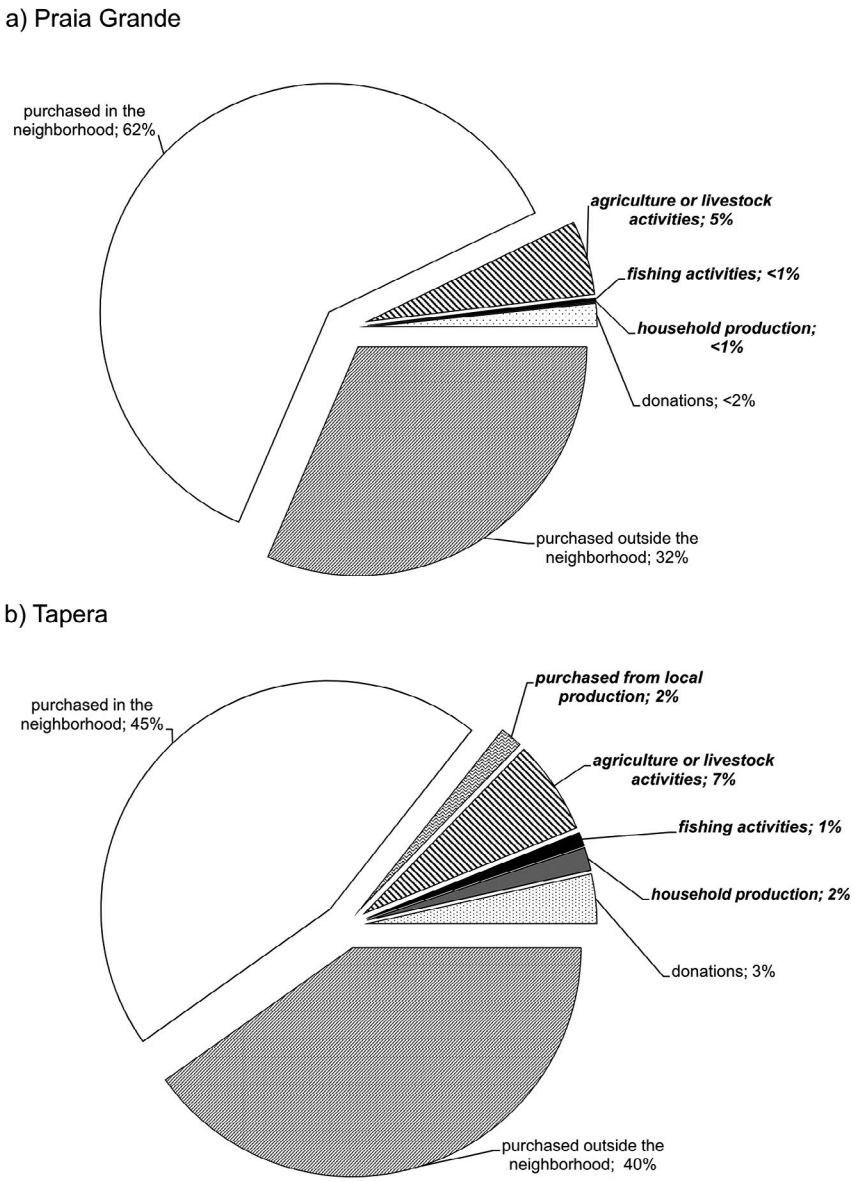

Figure 2. Resources consumed during the two studied periods (summer and winter, 2012) in the Praia Grande (a) and Tapera (b) communities

Note. Total citations for food items: Praia Grande = 2,630, Tapera = 2,691. The local sources of food (i.e., those that originated from livelihood activities) are shown in bold type.

The consumption of local biological resources in the region is based on foods that are cultivated, raised, or fished locally. Items that are purchased from local producers, as well as items that are produced by the households themselves, are also important in understanding the dynamics of use and dependence on local biological resources

(Figure 2). Considering these modes of procurement, 62 different items fall into the above categories (which is equivalent to 30% of all the ingested food items). Of these, 5 are purchased from local producers, 40 are locally cultivated plants or locally raised livestock, 11 are fished, and 10 are self-produced. The Praia Grande and Tapera households consumed 32 and 50 local items, respectively. The sources of local food resources reflect the activities and livelihoods of households that interact with the environment. Farming and livestock activities that are directed at subsistence or the processing of biological resources for food are performed on the borders of the protected area, and all of the cattle are kept outside the park. Fishing is the activity that is most directly linked to the protected area because it is still performed within the park boundaries, even though it is technically an illegal activity. When considering the samples of the two seasons separately, the contribution of local resources (not purchased) to the diet of Tapera households is 22%, but represents only 11% of the average Praia Grande diet. The variation in the diversity of local food resources is explicit in the rarefaction curve for these food items by season for the two communities (Figure 3). In addition, a more even distribution of the frequency of consumption of local biological resources was higher in Tapera for both seasons (probability of interspecific encounter (PIE) Tapera-summer, number of citations (Nc) = 68 = 0.936, 0.906 < CI 95% < 0.959; PIE Praia Grande-summer = 0.870; PIE Tapera-winter, Nc = 77 = 0.969, 0.954 < CI 95% < 0.980; PIE Praia Grande-winter = 0.937).

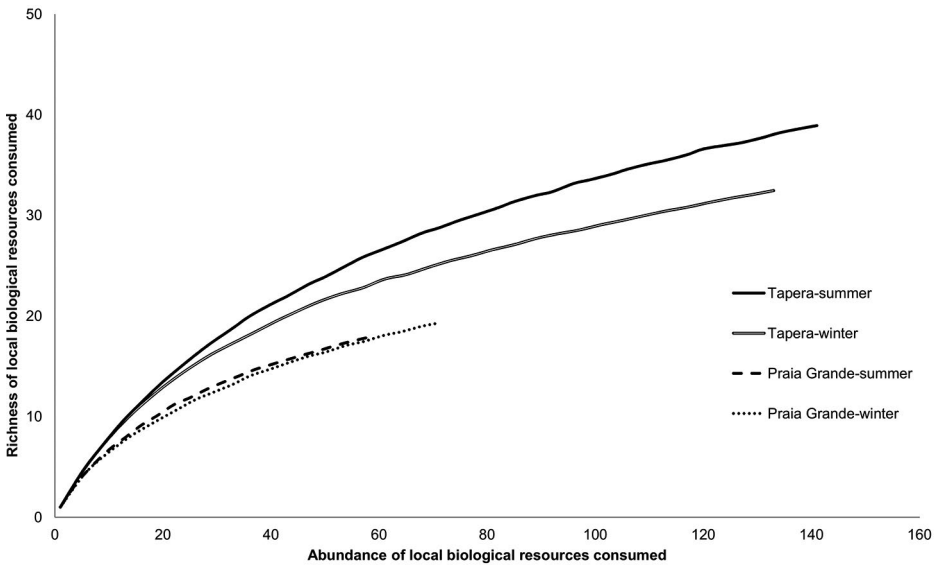

Figure 3. Rarefaction curves for the richness of local biological resources that were consumed during the studied periods (summer and winter, 2012) in Tapera and Praia Grande

Most of the locally produced foods that are consumed are cultivated or raised (Table 1), and households in Praia Grande demand more resources of this origin, while households in Tapera have greater means of procuring local food resources.

Table 1. Modes of procuring local food resources, by community

Modes of procuring local food resources	Praia Grande	Tapera
Agriculture or livestock activities	137	139
Fishing activities	4	26
Household production	3	44
Purchased from local production	–	39
Total	144	248

Note. Frequency of citations for biological natural local resources consumed in 353 meals of Praia Grande (18 households) and 413 meals of Tapera (16 households).

The main items that are locally produced include cultivated plants and the by-products of raised livestock. Among the cultivated plants, spices, such as *Allium fistulosum* and *Petroselinum crispum* (31%, n = 316 citations), are grown near the houses. The livestock by-products are mainly milk (13%, n = 316) and cheese (10%, n = 316). Cassava flour (*Manihot esculenta*), milk, cheese, and fish (*Mugil liza*) are produced or caught by household members or purchased locally. In Praia Grande, there were few citations for fish resources (0.2%, n = 2,630 citations), and the most commonly cited fish species were *Mugil curema*, *Menticirrhus littoralis*, and *Mugil liza*. *Mugil curema* contributes the most to this community (50%, n = 4). In Tapera, the most important fish resources are *Geophagus brasiliensis*, *Mugil liza*, *Centropomus undecimalis*, and *Micropogonias furnieri*. *Geophagus brasiliensis* is consumed only in this community and represented 20% (n = 20 citations) of the fish items that were reported in the summer period. *Mugil liza* was a major contributor to the total fish items in Tapera during both seasons. Together, *Geophagus brasiliensis* and *Mugil liza* account for 51% (n = 49 citations) of the fish resources that are used for food in Tapera, and these species sell the best in the community due to local preferences. Tapera households also collect aquatic invertebrates along the beach for food (e.g., the bivalves *Anomalocardia brasiliana* and *Donax* sp. and the crustacean *Emerita brasiliensis*). In Tapera, fishing activities depend on direct access to the protected area. The households interviewed in this community reported that all of the consumed fish species are caught exclusively from the freshwater river inside of the protected area. All of the species cited by the households in Praia Grande are caught from marine ecosystems.

The ecological niche for food dimension (standardized Levin's index, Table 2) shows that few local biological resources are consumed with high frequency. The households in Tapera demonstrated a preference for local resources only in the summer; therefore, the Levin index is smaller for this season than for winter. The local resources that are found within the protected area are *Geophagus brasiliensis* and *Micropogonias furnieri*. Compared to the households in Praia Grande, the households in Tapera use local resources more frequently and thus have a broader diet (see Table 2). Slightly more than half of the resources are shared between seasons.

Table 2. Ecological niche variables for the food dimension of local natural resources in the communities of Tapera and Praia Grande

Community	Season	Levin's index (Bp)	Niche overlap (%)	Frequently used items (> 0.05)
Praia Grande	Summer	0.335	53	6 (*n* = 19)
	Winter	0.341		3 (*n* = 20)
Tapera	Summer	0.344	58	5 (*n* = 40)
	Winter	0.445		6 (*n* = 33)

Note. The amplitude of the ecological niche food dimension is measured by the standardized Levin's index (Bp).

The canonical correspondence analysis (Figure 4) showed a significant influence of the habitat use (HABUSE) and livestock activity (LVSTAC) vectors on the ordination of the households and on the distribution of abundance of local items (Table 3). The accumulated variance in the first two canonical axes is 53.6%, which indicates the influence of environmental variables on the ordering of the households. The household ordering on the first axis returns groups two and five, which are influenced by the above variables. The ordering of Group 1 (t2, t30, and t31) is clearly related to the fishing activities vector (FISHAC), and to the species *Mugil liza*, *Micropogonias furnieri*, *Centropomus undecimalis*, *Mugil curema*, and *Eugerres brasilianus*. This group has only the consumption of fish resources (caught inside the protected area) in common. Although not a significant vector (see Table 3), Group 1 represents the households that depend on fishing for their food security and shares the same starting position as the income vector (INCOME). Axis 2 references the arrangement of Group 4, which is made up mostly of households from Praia Grande (Figure 4). Two households in this community use more than one habitat near their homes, while the others use only the local garden for local food consumption.

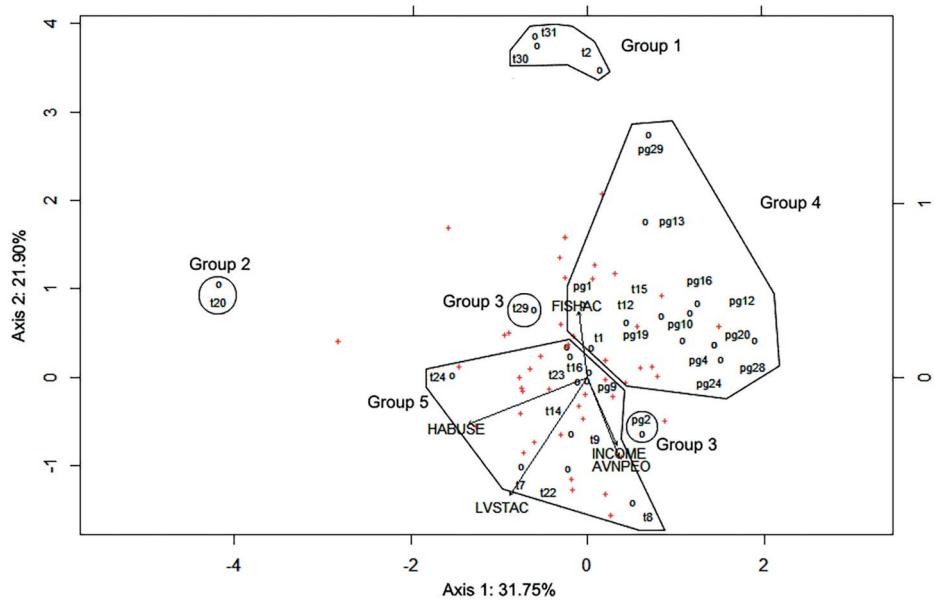

Figure 4. Scatterplot of canonical correspondence analysis; the first two axes represent the consumption of local biological resources with a socioenvironmental data matrix of 29 households from Praia Grande (pg) and Tapera (t)

Note. FISHAC = fishing activities (binary variable); LVSTAC = livestock activities (binary); HABUSE = habitat use (quantitative); INCOME = household income (ordinate); AVNPEO = average number of people present at each meal in the household (quantitative).

Table 3. Correlation coefficients between the first two axes of the canonical correspondence analysis with socioenvironmental variables, and between variables (r^2), with probability values (p) produced by Monte Carlo test after 999 iterations

Socioenvironmental variables	Axis 1	Axis 2	r^2	p
Habitat use (HABUSE)	-0.92866	-0.37093	0.5422	0.003*
Fishing activities (FISHAC)	-0.12800	0.99177	0.1433	0.384
Livestock activities (LVSTAC)	-0.54399	-0.83909	0.6635	0.001*
Income classes (INCOME)	0.40065	-0.91623	0.1789	0.265
Average number of people (AVNPEO)	0.33859	-0.94093	0.2386	0.142

Note. Values marked with * are significant after repetitions.

More than three-quarters of the households thought that their food was varied and sufficient (76%, n = 34 households). There is a positive association between low-income status and household food vulnerability (rs = 0.508, p = 0.002). In Tapera, 17% (n = 18) of the households reported that they frequently did not have enough to eat, which was always for economic reasons; 67% of the households in

this community earn less than twice the minimum monthly wage. The minimum wage was insufficient to cover basic expenditures for food and housing; according to DIEESE (2016) in 2012, the minimum wage should be more than three times this value. In Praia Grande, 6% (n = 16) felt that food was scarce. In the Praia Grande community, 75% of households earn at least three times the minimum monthly wage. Vegetables, meat, and children's food were the items reported as frequently missing from the basic diet in Tapera. In Praia Grande, canned foods, sausages, and dairy were reported as missing. The criteria for choosing food items included preference (41%, n = 5,321 citations), followed by no criterion (24%), and price (20%). The latter criterion had a higher influence in Tapera (36%, n = 2,691 citations). Individual preference accounted for 52% (n = 2,630) of the occurrences in Praia Grande. Finally, in Tapera there was a preference to buy locally produced items and to consume food that was produced by the household.

Discussion

Analyses based on ecological concepts can reveal spatial and temporal differences in the use of natural resources (Begossi & Richerson, 1993; Cavallini & Nordi, 2005; Hanazaki & Begossi, 2000). In human populations, household income also influences availability and access to resources (Begossi & Richerson, 1993; Hanazaki & Begossi, 2000; MacCord & Begossi, 2006; Nascimento et al., 2010; Silva & Begossi, 2009). Income was not significant within the studied communities; however, it is important to understand the context of the lower amplitude of food resources for households in Praia Grande. The Praia Grande households are in an urban environment, which allows them to consume more purchased items and makes their relationship to subsistence more economical than ecological (Nascimento et al., 2010; Reyes-García et al., 2005). The Tapera households experience greater economic fluctuation due to fewer income-generating opportunities (Foppa & Medeiros, 2011), which in turn increases their consumption of a variety of local biological resources, including those that are locally produced, resulting in a greater niche breadth.

Understanding the differences in the diets among the communities also improves the understanding of the relationship between humans and their environments (Begossi & Richerson, 1993; Cavallini & Nordi, 2005; Hanazaki & Begossi, 2000; McCune & Kuhnlein, 2011). The livelihoods of people in Praia Grande include food cultivation (such as home gardens, crops, orchards, and vegetable gardens) and livestock-rearing practices that, together with higher incomes, reduce their direct dependence on their environmental surroundings, including resources within the park boundaries. In Tapera, there is a clear influence of local biological resources on the observed diets because diverse farming habitats and livestock, fishing, and food production activities contribute to the local system of subsistence. A strong

interaction with the local environment leads to a greater richness of consumed local resources and a greater amplitude of the ecological niche food dimension for these items. The greater niche breadth that was observed in winter reflects the temporal generalization in the diets of the Tapera households. The low percentage of niche overlap in Tapera means that environmental changes during the year help to define the consumption of local items. A lower richness of consumption during winter may reflect a preference for foods that are found only during summer, which favors the increased intake of other local resources when the preferred item is absent (Begossi & Richerson, 1993; Nascimento et al., 2010). The preferred local resources include two species of fish that are caught in the freshwater river of the protected area: *Geophagus brasiliensis* and *Micropogonias furnieri*. Fishing for one of them (*Geophagus brasiliensis*) is considered to be a collective activity that is culturally important (Foppa & Medeiros, 2011), and it is highly dependent on the protected area environment.

The influence of local livelihoods on the use of resources highlights the direct dependence on the natural resources in each community (Begossi & Richerson, 1993; Salafsky & Wollenberg, 2000); however, we observed a predominance of non-locally produced items. The process of urbanization, and the reported decrease in activities such as small-scale farming and artisanal fishing may strengthen the inclusion of non-local products in the diet. Similar factors have also been noted in other studies (MacCord & Begossi, 2006; Murrieta et al., 1999; Silva & Begossi, 2009). However, some Tapera households share a strong relationship with the territory upon which they depend for their livelihood. Although only a few households are dependent on the protected area, fishing helps to build the local food scene because it is an important means of obtaining food. According to Godoy et al. (2005), few local human populations depend exclusively on biodiversity resources, and most have a more direct relationship with cultivated food and commercialized products, which is the case for the communities around Acaraí State Park. However, the creation of a protected area as a strategy for biological conservation can shift the degradation of environments and biodiversity to other unprotected areas because areas for cultivation and livestock are needed to offset the use of natural resources for subsistence and food (Godoy et al., 2005; Vadez et al., 2004).

Especially for Tapera families, who depend more on the use of resources and the environment, changes in access to resources could have major consequences. Increased urbanization and the restrictions imposed by environmental laws that limit the use of natural resources can contribute markedly to a progressive dependency on market products (as observed by Hanazaki & Begossi, 2000; MacCord & Begossi, 2006; Murrieta et al., 1999; Silva & Begossi, 2009). This can occur as a replacement strategy for fish species that are consumed and come from within the park, which could result in the gradual abandonment of traditional livelihood activities that lead to a decrease in food self-sufficiency (MacCord & Begossi, 2006; Murrieta

et al., 1999). Changes in dietary patterns can affect nutritional quality because new food items that are added do not necessarily replace the range of foodstuffs that were consumed previously (Silva & Begossi, 2009). Although there is a positive relationship between income and the consumption of calories in a diet (Fitzgerald et al., 1992), purchased commodities can contain fewer nutrients per kilogram consumed than the wild-captured foods that were formerly consumed, with potential negative health outcomes.

In other ecosystems of the Atlantic Forest and Amazonia, limited access to and use of natural resources interferes with the livelihoods and diets of local human populations (Hanazaki & Begossi, 2000, 2003; MacCord & Begossi, 2006; Murrieta et al., 1999; Silva & Begossi, 2009). Such changes can be dangerous because they lead to the abandonment of food systems based on resources from the local environments, and threaten the knowledge dynamics that are associated with these systems (Kuhnlein & Receveur, 1996). We observed there are stronger links to resources from the protected area in the community with livelihoods that interact more with the local environment (Tapera). However, this link was mostly related to fishing resources for a few households, which relates to the importance of managed habitats as sources of local food resources.

Ecosystems that are conserved by protected areas can be co-managed for better conservation outcomes and still deliver significant resources to local populations (Pimentel et al., 1997; Sunderland, 2011). However, local food security may be greatly affected if the process of establishing and managing a protected area severely limits access to subsistence sources that are related to natural resources and does not include proper planning for subsistence alternatives. Areas such as forests and associated ecosystems are important to food security because they are a source of resources and underpin an environment that is useful for sustainable agriculture (Sunderland, 2011).

In other developing countries, such as Thailand and Madagascar, the restriction of access to natural resources has had an unexpected result in terms of environmental conservation (Ghimire, 1994; Neef et al., 2003). According to Ghimire (1994) and Neef et al. (2003), the degradation of ecosystems and the loss of biodiversity continue at alarming rates in major parks in these countries because the conflicts between environmental protection policies and local human livelihoods have not been resolved cooperatively. The implementation of restrictive policies on access to biodiversity resources can ultimately lead local populations to seek alternatives to ensure their food security and livelihoods, thus increasing the pressure on the environments that surround the created protected areas (Ghimire, 1994; Neef et al., 2003). The creation of a protected area implies behavioral changes in the surrounding communities (Baird & Leslie, 2013). In the case of Acaraí State Park, the restrictions have the potential to diversify the livelihoods of the families that continue fishing as a source of food (who were formerly dependent on the park area). In a park in

Tanzania, Baird & Leslie (2013) found that the closer communities are to a park, the more diverse the livelihoods will be because the communities adapt to the changes that are promoted by the protected area. The diversification of livelihoods happens in response to the disturbances generated by the establishment of a protected area and the constraints and opportunities that arise over time (e.g., nongovernmental organization actions, tourism, expansion of protected area boundaries).

An alternative that has been explicitly considered by the managers of Acaraí State Park is the potential of community-based tourism to provide a source of employment and income. This is one of the public-use activities that aims to reduce the impact on natural resources, although it is not without its own set of impacts. Other alternatives may consider the proper use of the buffer zone, which is the zone around the protected area. An important point is that in the buffer zone of the park, commercial fishing (artisanal, practiced by professional fisherman using small vessels and in a family economy system; or industrial, practiced using small, medium, or large vessels for commercial purposes) is permitted, which may have an impact on the population of the fish fauna in freshwater environments inside the protected area.

Food insecurity in the studied area can be more intense for households that use local resources as food, as well as for the households that indicated vulnerability to food insecurity. Thus, it is worth emphasizing the importance of the multiple strategies that have been adopted by the households to ensure their livelihoods. For the households whose subsistence and livelihoods are linked even partially to local biological resources, the displacement of diverse activities that generate food and income can increase vulnerability and the potential for food insecurity (Foppa & Medeiros, 2011; Hanazaki et al., 2013; Hesselberg & Yaro, 2006) by decreasing the capacity to cope with social, economic, and environmental crises (Barrett, 2010; Hanazaki et al., 2013).

Conclusions

The influence of the different uses of habitats and livelihood activities shows the importance of strategies that comprise local ways of life in obtaining food and, consequently, in local food security. The differences in the amplitude of the ecological niche of the analyzed families have origins in the availability of and access to natural resources, the acquisition of industrialized products, economic activities, and socioeconomic differences. Ecological concepts help to support an understanding of the relationships among the people in their environment and allow for the differentiation of dietary patterns between the studied communities.

In the context of Brazilian protected areas and the restrictions that have been imposed within Acaraí State Park, joint actions between the park managers and the households that depend on subsistence resources could focus on use of the buffer zone as a source of livelihood resources. Local food systems were shown to exist in this study, confirming the connectivity between the protected area and productive systems and their significance to food security and biodiversity conservation. For the studied communities, fishing is important to the food security of some of the households that surround the protected area. Fish are the most influential resource in relation to the people and the protected area, which results in an increase in the use of resources in the region. A formal agreement with the households that depend on the environment and subsistence resources can ensure the continuity of these activities within the law.

It is necessary to monitor and control commercial fishing landings and monitor ichthyofauna in the interior water bodies and buffer zone, in order to evaluate the influence of commercial fishing inside the protected area on the stocks that local families depend on for subsistence. Studies in protected marine areas in Australia and the Mediterranean have shown that including local fisherman in coordinated management decisions about these areas demonstrates to them the costs and benefits of conservation and creates a network that can help to balance the trade-offs, which is a key to connecting the conservation of biodiversity and fishing goals (Weigel et al., 2014). Similar strategies could be adopted in Acaraí State Park. In addition, a more thorough evaluation is necessary to better understand the possibilities of creating and operating tourist activities as an alternative income source while maintaining the objectives of the fully protected conservation area.

Considering the integrity of the communities near Acaraí State Park, and the influence of conservation actions and use of environmental space in this region, it is imperative to regulate activities that will allow for the maintenance of the livelihoods of local human populations and, at the same time, clarify the rights of these people, which will create autonomy in their decisions related to using natural resources. The surrounding communities can benefit from this protected area as long as conservation efforts avoid drastic changes that undermine household food security.

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Social Well-Being and Pro-Environmental Behavior: A Cross-Lagged Panel Design

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Abstract

The main aim of this study was to investigate the bidirectional relationship between social well-being and energy conservation behavior as a form of pro-environmental behavior. Participants were 298 undergraduate and master's students at an Italian public university. We applied structural equation modeling with two waves of survey data from a cross-lagged panel design to investigate reciprocal relationships between latent variables representing social well-being and pro-environmental behavior. Results showed that pro-environmental behavior at baseline predicted later social well-being controlling for the effects of baseline social well-being. Conversely, social well-being at baseline predicted subsequent levels of pro-environmental behavior controlling for previous levels of pro-environmental behavior. Results were compared using multi-group invariance testing of paths across gender. These relationships did not differ between men and women. Together, these findings suggest that a bidirectional relationship between social well-being and pro-environmental behavior is supported.

Keywords: cross-lagged panel design, longitudinal studies, pro-environmental behavior, social well-being

Introduction

Behavioral and lifestyle choices are key to successful adaptation and mitigation of climate change (IPCC, 2014). Previous studies have shed light on a complex multifactorial process that includes personal and social influences on pro-environmental concern and behavior (Gifford & Nilsson, 2014). For instance, women tend to report stronger environmental concern and behaviors than men (Gifford & Nilsson, 2014; Hunter et al., 2004; Zelezny et al., 2000). The Intergovernmental Panel on Climate Change estimated that, in developed countries, lifestyle and behavioral changes could reduce energy demand by up to 20% in the short term

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and 50% in the long term (IPCC, 2014). Government agencies have encouraged manufacturers to improve the energy efficiency of household appliances. Indeed, much can be done to understand and address those behavioral and lifestyle choices which significantly influence energy consumption. However, in order to reduce the negative consequences associated with climate change, it is necessary to understand the processes that underlie pro-environmental behavior.

The field of conservation psychology has been proposed based on the recognition that the social sciences play a key role in achieving the goal of environmental sustainability (Clayton & Myers, 2015; Saunders, 2003). The ultimate outcome for conservation psychology research is conservation behavior. Conservation behavior is often perceived to have negative effects on an individual's quality of life: "People, it is argued, are being asked to give up a modern, high-technology existence for an austere, bleak but needed substitute" (De Young, 1990, p. 216). Although conservation behavior can be framed in self-sacrificial terms (e.g., Carmi, 2012), some scholars view well-being and conservation behavior as compatible or complementary (e.g., Brown & Kasser, 2005; Corral-Verdugo et al., 2011; Dietz et al., 2009; Xiao & Li, 2011). Suárez-Varela et al. (2016) reported that pro-environmental behavior in itself does not have a negative influence on well-being, suggesting that it can be framed in self-beneficial terms. Indeed, there is evidence that pro-environmental behavior can increase eudaemonic well-being (Venhoeven et al., 2013). Eudaemonic well-being is generally defined as striving to realize one's personal potential (Ryff & Keyes, 1995). Eudaemonic well-being is thus related to the pursuit of intrinsic goals such as self-actualization, positive close relationships, personal growth, sense of meaning in life, and participation in social communities. This aspect of well-being goes beyond hedonic approaches defined by the simple pursuit of pleasure (e.g., staying away from problems, being happy and relaxed). While there is evidence that hedonic values are negatively related to environmentally relevant attitudes, preferences, and behaviors (Steg, Perlaviciute et al., 2014), we expect that eudaemonic well-being may play a different role when it comes to its relationship with conservation behavior.

The positive relationship between eudaemonic well-being and pro-environmental behavior such as conservation behavior can be inferred from research on pro-social behavior. Pro-social behavior is supposed to have an enduring effect on well-being through different processes, such as giving meaning to life, contributing to a positive self, or providing a social identity (Son & Wilson, 2012). Pro-environmental behavior is viewed as a form of pro-social behavior (Steg & de Groot, 2010; Turaga et al., 2010; Venhoeven et al., 2013). Since engaging in pro-social behavior increases well-being if it provides meaning in life (e.g., "doing the right thing"), in their review, Venhoeven et al. (2013) hypothesized that pro-environmental behavior can enhance eudaemonic well-being if such behavior is perceived as a source of meaning in life.

Published studies on the relationship between well-being and pro-environmental behavior have focused on emotional well-being or psychological (eudaemonic) well-being (e.g., Venhoeven et al., 2013). In his mental health continuum model, Keyes (2002, 2003) conceptualizes three categories of well-being: emotional, psychological, and social. Emotional well-being corresponds to hedonic well-being, while psychological and social well-being represents two forms of eudaemonic well-being. Specifically, psychological well-being refers to the concept of private and personal development and self-realization, whereas social well-being indicates thriving in one's own public, social life. Factor analyses revealed that emotional well-being, psychological well-being, and social well-being formed three correlated but distinct factors (Keyes, 1998). There is evidence of a positive relationship between pro-environmental behavior and psychological well-being (Corral-Verdugo et al., 2011; Ganglmair-Wooliscroft & Wooliscroft, 2016; Suárez-Varela et al., 2016; Venhoeven et al., 2013). In addition, a link between positive emotions and environmentally responsible behavior has been proposed (e.g., Cloutier et al., 2014; Helliwell, 2014; O'Brien, 2008). Previous studies have shown that psychological factors correlated to well-being such as self-construal, sense of control, values, world views, goals, and felt responsibility (Gifford & Nilsson, 2014). To our knowledge, no study has investigated the relationship between social well-being and conservation behavior. Although, on one hand, community participation and involvement, and, on the other hand, intentional communities have been related to engagement in pro-environmental behaviors (e.g., Choi, 2008; Sanguinetti, 2012; Stem et al., 2003; Villacorta et al., 2003), we note that these constructs are different from social well-being. Social well-being can be defined as people's appraisal of their social relationships, circumstance, and functioning in social institutions and community (Keyes, 1998; Larson, 1993). There is evidence that men are more likely to have high-level social well-being compared to women (Keyes, 2004). Although pro-environmental behavior and pro-social behavior are different (Nolan & Schultz, 2015), to some degree they are compatible. Social well-being is relevant for pro-environmental behavior because it has to do with the feeling that one is a vital member of the community, contributing to the common good and believing in the progress and evolution of society. In addition, pro-environmental behavior, like other pro-social behaviors, can enhance the view that one is pursuing the right ends for society and the community, and that his or her actions are valued by society and contribute to the commonwealth (Corral-Verdugo et al., 2011; Suárez-Varela et al., 2016; Venhoeven et al., 2013). This leads us to the first hypothesis of our study:

Hypothesis 1: Conservation behavior will predict social well-being.

Most of the evidence that supports the finding that conservation behavior predicts well-being has been gathered from cross-sectional research designs. Thus, we cannot rule out the possibility that conservation behavior can both affect and be the result of well-being. Theoretical and empirical support for this alternative idea—that well-

being influences conservation behavior—can be found in research on pro-social behavior. First, there is evidence of a positive feedback loop between pro-social behavior and well-being (Aknin et al., 2012). Corral-Verdugo et al. (2011) also acknowledged the possibility that a positive feedback loop between conservation behavior and well-being may exist. Second, a substantial body of research shows that positive mood states influence pro-social behavior (Carlson et al., 1988). Specifically, the social outlook hypothesis posits that a positive mood associated with a favorable view of one's interpersonal relationships, community, society, or human nature increases the likelihood of pro-social behavior (Carlson et al., 1988). Finally, well-being may have an influence on sustainable consumer behavior (Fröhlich et al., 2012). Therefore, we should expect that social well-being, defined as the appraisal of one's circumstance and functioning in society (Keyes, 1998), might predict conservation behavior, leading to our second hypothesis:

Hypothesis 2: Social well-being will predict conservation behavior.

As stated above, most of the literature on the relationship between well-being and conservation behavior is based on cross-sectional (i.e., correlational) research, which is limited in its ability to identify bidirectional predictive relationships. Moreover, past work has not specifically measured social well-being. To address the limitations of previous studies, we used a longitudinal study and simultaneously took into account cross-lagged (i.e., longitudinal interplay between social well-being and conservation behavior) and concurrent associations (i.e., relationships between different variables measured at the same time), as well as stability of the constructs (i.e., relationships between the same variables measured at two points in time). Another reason why we used a longitudinal design is the risk for common method bias (Podsakoff et al., 2012). Specifically, when participants' reports of their internal states are collected at the same time as their reports of their behavior (as in cross-sectional studies), the observed correlations between these two types of variables are likely to be artificially inflated.

As stated earlier, there is evidence that men are more likely to have high-level social well-being compared to women (Keyes, 2004) and that women tend to engage in more environmental behaviors than men (Gifford & Nilsson, 2014; Hunter et al., 2004; Schultz & Zelezny, 1999). However, it is unclear whether these gender differences might influence the hypothesized relationships. Therefore, we propose a research question rather than a hypothesis:

Research question: Do the hypothesized relationships differ between men and women?

Method

Participants

Participants were 308 undergraduate and master's students (234 women, 74 men) at an Italian public university. At class sessions, after a brief description of the study objectives, students were invited to participate. There were considerably more women than men in our sample because women were concentrated in these degree programs. Students received course credit for their participation. We asked participants to fill out the same questionnaire at Time 1 (T1) and Time 2 (T2). We removed from the sample 10 participants because they failed to complete both the T1 and T2 questionnaire, leaving a final sample of 298 individuals (227 women, 71 men). Participants ranged in age from 21 to 62 years (M = 26.00, SD = 6.57).

Measures

The questionnaire included measures of social well-being and conservation behavior with sociodemographic questions (gender, age, education, and income). Table 1 displays the descriptive statistics and reliability of the social well-being and conservation behavior scales. For each scale, a latent variable was defined.

Table 1. Descriptive statistics, reliability estimates, and correlations among the study variables

Study variables	M	SD	α	CR	1	2	3	4	5
1. Gender	–	–	–	–	–	-.09	-.06	.15*	.13*
2. Social well-being (T1)	2.87	0.70	.89	.90		–	.69*	.20*	.22*
3. Social well-being (T2)	2.81	0.71	.91	.92			–	.25*	.28*
4. Pro-environmental behavior (T1)	4.22	1.23	.70	.80				–	.75*
5. Pro-environmental behavior (T2)	4.11	1.26	.76	.84					–

Note. N = 298. M = mean, SD = standard deviation, CR = composite reliability. For gender, 1 = male, 2 = female. * $p < .05$.

Conservation behavior

The conservation scale of the pro-environmental behavior scale (Markle, 2013) was used in this study to measure actual energy conservation behaviors (related to curtailment). This scale was chosen because it was found to have good psychometric properties and to cover different aspects of energy conservation behavior. The conservation scale includes seven items concerning the extent to which participants in the last month reduced their consumption of energy. All items were answered on a 5-point Likert-type scale (1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *usually*, 5 = *always*). The seven items of the scale are:

- How often do you turn off the lights when leaving a room?
- How often do you switch off standby modes of appliances or electronic devices?
- How often do you cut down on heating or air conditioning to limit energy use?
- How often do you turn off the TV when leaving a room?
- How often do you limit your time in the shower in order to conserve water?
- How often do you wait until you have a full load to use the washing machine or dishwasher?
- How often do you wash your laundry at a lower temperature?

Social well-being

The Italian version of the social well-being scale (Cicognani et al., 2008; Keyes, 1998) was used to measure social well-being. We chose this scale because: (a) this is the most widely used scale of social well-being; (b) it was found to have good psychometric properties; and (c) an Italian version was available. The scale included 33 items that participants rated on a 7-point scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *somewhat disagree*, 4 = *neither agree nor disagree*, 5 = *somewhat agree*, 6 = *agree*, 7 = *strongly agree*) to indicate how an item functioned in their social life. Negative items were reverse-coded. The scale included items related to social integration ("I feel close to other people in my community"), social acceptance ("People do not care about other peoples' problems"), social coherence ("I cannot make sense of what's going on in the world"), social contribution ("My daily activities do not create anything worthwhile for my community"), and social actualization ("Society isn't improving for people like me").

Procedure

To collect data, we used a website accessible only to participants. Participants were asked to read a consent form that explained the procedures of the study and their rights as participants (e.g., the voluntary and confidential nature of participation). Participants then filled out the questionnaire at their convenience. Two months later, participants completed a second questionnaire. Participants were contacted through the email address they had previously provided. We chose a two-month period because we could be properly sure that courses that participants were taking did not have an impact on our study. Moreover, within that period, in Italy, no major event occurred that could have affected our findings. Finally, a two-month follow-up may be justified since the predominant causal influence between determinants of pro-environmental outcomes and related outcomes is supported in a short-term perspective (Thøgersen & Ölander, 2002).

Statistical analysis

Missing data estimation was employed using maximum likelihood imputation procedure as recommended by Graham (2009). To measure reliability, we calculated composite reliability (Fornell & Larcker, 1981) in addition to Cronbach's alpha, because it is considered a lower bound on true reliability (Raykov, 1997). Both coefficients were calculated and reported. Cross-lagged path analysis was conducted using Mplus version 7 (Muthén & Muthén, 1998–2012). The WLSMV estimator (a robust weighted least squares estimator using a diagonal weight matrix) was used because of violation of the assumption of multivariate normality (DeCarlo, 1997). To test our hypotheses using a structural model, we included the following parameters: covariance among the latent variables; covariance between error terms of each indicator at T1 and the corresponding indicator at T2; auto-regressive effects (to control for baseline levels for each variable); and cross-lagged relationships to test the hypotheses (Cole & Maxwell, 2003). In the model we controlled for the effect of age and income. We did not include education in the model because it showed almost no variability.

Results

Preliminary analyses

Table 1 shows correlations and descriptive statistics for the study variables. The point biserial correlation coefficients show that gender did not correlate with social well-being, but gender (female) was positively associated with conservation behavior. Social well-being correlated positively with conservation behavior both synchronously and over time. The effect size of the correlations between social well-being at T1 and conservation behavior at T2 and between conservation behavior at T1 and social well-being at T2 is of medium magnitude (Cohen, 1988). Moreover, the correlations between social well-being and T1 and at T2 and between conservation behavior at T1 and at T2 were .69 and .75, respectively.

Tests of hypotheses

Figure 1 shows the hypothesized cross-lagged path model. The fit of the model was acceptable ($\chi^2(275) = 514.50$, $p < 0.001$; NNFI = 0.90; CFI = 0.92; RMSEA = 0.054). Consistent with our first hypothesis, individuals' own baseline levels of conservation behavior predicted follow-up social well-being controlling for the effects of baseline social well-being. In line with our second hypothesis, social well-being at T1 predicted subsequent levels of conservation behavior controlling for baseline levels of social well-being. Therefore, both hypotheses were confirmed. The model explains 67 per cent of the variance in both social well-being and

conservation behavior at T2. The standardized parameters are reflective of the proportion of unique explained variance in an outcome variable per independent variable. The standardized path coefficients (i.e., beta values) show that social well-being at T1 accounts for a small but significant proportion of the explained variance of conservation behavior at T2. Also, conservation behavior at T1 accounts for a small but significant proportion of the explained variance of social well-being at T2.

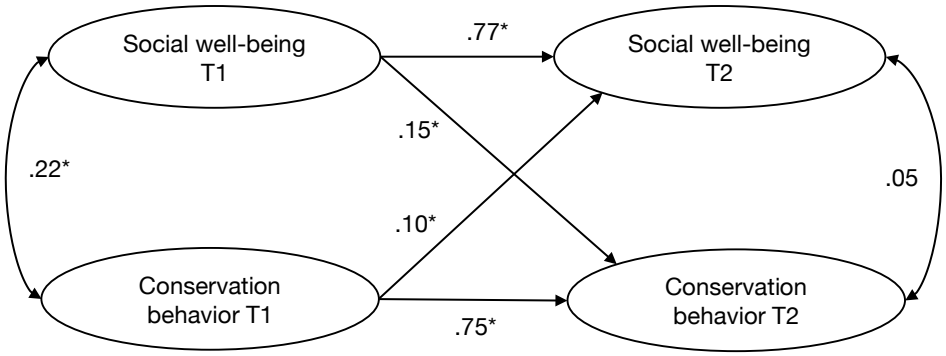

Figure 1. Cross-lagged relationships between social well-being and pro-environmental behavior at Time 1 and Time 2

Note. $\chi^2(275) = 514.50$, $p < 0.001$; NNFI = 0.90; CFI = 0.92; RMSEA = 0.054. Regression coefficients are standardized. * $p < .05$. The influence of age and income was controlled for.

Testing model invariance by gender

We tested for multi-group invariance to investigate whether differences between female and male participants existed with respect to the hypothesized cross-lagged relationships. Comparison of a model in which all the cross-lagged relationships were constrained equal across groups and one in which no constraints were imposed yielded a $\Delta\chi^2$ value of 0.69 with $\Delta df = 2$ ($p = .71$). The statistically nonsignificant $\Delta\chi^2$ value suggests that the cross-lagged relationships are equivalent across male and female participants.

Discussion

Our goal was to investigate the relationship between social well-being and conservation behavior. Although conservation behavior is often framed in terms of sacrifice and reduced well-being (e.g., Carmi, 2012; De Young, 1990), there is evidence that well-being and conservation behavior may be compatible or complementary (e.g., Brown & Kasser, 2005; Corral-Verdugo et al., 2011; Dietz et al., 2009; Venhoeven et al., 2013; Xiao & Li, 2011). We extended this reasoning further, and suggested that a relationship also exists between social well-being and

conservation behavior and that it may be bidirectional. Our findings confirmed the hypothesized bidirectional relationship: on one hand, conservation behavior predicted social well-being and, on the other hand, social well-being predicted conservation behavior.

The finding that conservation behavior was significantly associated with later social well-being, after controlling for previous levels of social well-being, suggests that conservation behavior could promote well-being. This finding is in line with the idea that acting pro-environmentally actually increases one's well-being rather than decreases one's well-being; in other words, doing "the right thing" for the environment, for the earth, and for human beings makes people feel good (e.g., Brown & Kasser, 2005; Suárez-Varela et al., 2016; Venhoeven et al., 2013; Xiao & Li, 2011). Our study contributes to and builds upon existing research on conservation behavior and well-being in that we examined the effect of social well-being. Based on the mental health continuum model (Keyes, 2002, 2003), well-being is defined as including three correlated but distinct factors: emotional, psychological, and social well-being. To our knowledge, social well-being (a category of eudaemonic well-being) had never been investigated in respect to conservation behavior. It is interesting to note that conservation behavior predicted social well-being even though our measure did not take into account the meaning associated with the behavior (i.e., "it is the right thing to do"). Indeed, Venhoeven et al. (2013) suggested for pro-environmental behavior to theoretically increase eudaemonic well-being, it is important to consider the extent to which people see pro-environmental behavior as the right thing to do. In Europe, there is solid and widespread support for protection of the environment (European Commission, 2014) and, therefore, it is likely that pro-environmental behavior may be perceived by most people as right and meaningful. As such, pro-environmental behavior can be framed as a normative goal that has an intrinsic positive moral value (Steg, Bolderdijk et al., 2014). Put differently, the well-being benefits of pro-environmental behavior depend on a favorable assessment of the rewards associated with it: rewards could derive from social identity or from the opportunity to view oneself in more positive terms (i.e., "I am the kind of person who takes right actions"). Being confident of one's ability to achieve the things that make a difference and forge a better life is one of the most important motivations hypothesized in the Reasonable Person Model of environmentally responsible behavior (Kaplan, 2000; Kaplan & Kaplan, 2003, 2008).

In addition, the specific features of social well-being would also explain this finding. Precisely, social well-being includes the evaluation of one's social value and contribution to society, the perception of the quality of the relationship between the individual and the society, and the view of human nature and society. Therefore, pro-environmental behavior is likely to influence the appraisal of one's circumstance and functioning in society, that is, social well-being. We do not deny that pro-environmental behavior can require, at least to some extent, sacrifice and

deprivation. However, once learned, pro-environmental behavior may be activated in an automatic, habitual fashion with low perceived costs associated with the behavior, while benefits remain the same. In our investigation, previous conservation behavior had a strong effect on actual conservation behavior, thereby suggesting the development of a habit. Voluntary simplicity is another variable that may be of interest here. Voluntary simplicity refers to a wide range of beliefs systems and practices that aim to limit material consumption due to self-centered (e.g., to free one's resources such as money and time) and/or altruistic (e.g., concern for the environment and social justice) considerations (Shaw & Newholm, 2002).

Our findings are in line with those of Son and Wilson (2012), who demonstrated a reciprocal relationship between well-being and pro-social behavior. Based on the idea that pro-environmental behavior is a form of pro-social behavior (Steg & de Groot, 2010; Turaga et al., 2010; Venhoeven et al., 2013), we hypothesized and found that social well-being predicts conservation behavior. This idea overturns the common perspective from which the relationship between conservation behavior and well-being is usually considered (i.e., conservation behavior is a predictor of social well-being). To our knowledge, this is the first attempt to measure the influence of well-being on conservation behavior using a cross-lagged panel design. The finding that well-being influenced conservation behavior is in line with the suggestion that a positive feedback loop exists between conservation behavior and well-being (Corral-Verdugo et al., 2011) and with the social outlook hypothesis (Carlson et al., 1988). Specifically, the positive mood associated with a favorable view of one's circumstance and functioning in society is likely to increase pro-social and pro-environmental behavior. People who feel good as a consequence of their efforts to pursue meaning in life and contribute to society can shift their focus from satisfaction and happiness associated with personal wealth and possessions to satisfaction associated with doing something good for their environment and their community. This shift in focus can provide meaning in life and reinforce a valuable social identity (Venhoeven et al., 2013). Put another way, eudaemonic well-being is likely to lead people to invest more time and effort in the pursuit of more intrinsic and non-materialistic goals such as the protection of the environment. Another, non-alternative, possibility is based on the norm of reciprocity (Gouldner, 1960). Specifically, individuals who see themselves thriving in their social life may have a tendency to reciprocate society's support and care for them by enacting pro-environmental behavior.

The finding that conservation behavior is affected by high social well-being has practical implications which warrant consideration. According to Steg, Bolderdijk, et al. (2014), pro-environmental actions can be promoted by explicitly emphasizing that conservation behaviors are good choices not only for the environment, they also make people feel good (hedonic goal), by increasing their resources (gain goal) and enhancing their status, offering them the opportunity to enter into a "moral right"

community (normative goal). Interventions that link hedonic and gain goals to normative goals should be more effective at promoting pro-environmental choices than those targeting single goals (Steg, Bolderdijk et al., 2014).

However, well-being, and in particular social well-being, is not only inside people's heads. It is influenced by people's values and goals but is nurtured by real-life opportunities to experience trustworthy relationships, and a sense of connectedness with people. This set of opportunities can be considered as part of social capital (Putnam, 1993; Putnam et al., 1993). Many empirical studies have shown that social capital has an impact on pro-environmental behaviors (Jones, 2010; Liu et al., 2014; Pretty & Ward, 2001) contributing to the environmental activation of the community. We speculate that social well-being could be one of the key processes that explains this impact. In addition, a role in the promotion of ecologically and socially sustainable societies is played by citizen involvement in the wider community and its social institutions, as it is implied in the concept of community participation (e.g., Bott et al., 2003; Dean & Bush, 2007; Prati et al., 2016). As such, interventions aimed at promoting pro-environmental choices should not only strengthen the added value and psychological gains of becoming part of a righteous community, but also offer concrete opportunities to experience community participation. Future work should investigate the influence of interventions aimed at promoting pro-environmental behavior on social well-being and whether such interventions are more effective when opportunities to experience a sense of community are provided.

A few limitations of the present study deserve mention. First, although the cross-lagged panel design provides a much stronger indication of the direction of the relationships than is possible with a cross-sectional study, it does not provide definitive answers to the question of causality. Experimental studies are needed to confirm the hypothesized causal relationships. Second, given that our sample comprised students, the findings may be limited by age or occupation and we cannot generalize our findings to the general population. We note that our results were consistent between male and female participants, indicating that gender does not affect the hypothesized relationships; future work should integrate other variables influencing environmental behavior to identify the unique role of social well-being (and its dimensions) in comparison to these other commonly cited predictors. Nonetheless, these findings need to be replicated in other samples to evaluate their theoretical and practical significance. Moreover, the use of self-reports has known limitations. Finally, we did not measure potentially confounding variables that might relate to both of the measured variables. For instance, self-construal, locus of control, values, attitudes, goals, and felt responsibility are thought to exert an influence on pro-environmental behavior (Gifford & Nilsson, 2014). As the literature suggests, behavior is a complex factor and the attempt to explain pro-environmental behavior can also be quite complex. We must recognize that our study provides one piece of

the complex puzzle of social well-being and energy conservation behavior. After all, the main aim of the present study was to shed light on bidirectional relationships between social well-being and energy conservation behavior.

Conclusion

Overall, our findings fill an important gap in the literature by showing that a bidirectional relationship between social well-being and conservation behavior exists. In addition, these relationships were demonstrated through a cross-lagged design. The findings of the current study may help tailor future interventions that are aimed at increasing conservation behavior and well-being.

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Reflections, Analysis, and Significance for Human Ecology of Pope Francis's Encyclical Letter *Laudato Si'*: On Care for Our Common Home

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Abstract

Pope Francis's significant and timely environmental encyclical is reviewed, analyzed, and reflected upon from a human ecology perspective. The analysis includes comparison with various ecological, philosophical, sociological, ethical, theological, and economic schools of thought. His powerful and influential prose and poetry are sampled and savored with respect to their potential impact on solutions for our current grave existential global environmental crisis. His call for an ecological spiritual awakening is interpreted from both religious and secular points of view. Historical relationships between Catholicism and environmental thought are explored. Application to the field of human ecology is considered.

Keywords: climate change, the commons, ecological economics, ecological limits, ecology, ecophilosophy, ecotheology, environmental ethics, global warming, human ecology, Pope Francis, sustainability

> Everything is related, and we human beings are united as brothers and sisters on a wonderful pilgrimage, woven together by the love God has for each of his creatures and which also unites us in fond affection with brother sun, sister moon, brother river and mother earth. (Pope Francis, *Laudato Si'*)

Introduction

For most of my professional life I have been trying to understand why we humans continue to destroy our own life support systems even though we know that we are doing so! The science is conclusive, but governmental and industrial policies, world views and individual lifestyles in the developed world are in opposition (van Tine, 2000). Pope Francis may have answered some of these questions and provided

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some insightful solutions in his powerful and comprehensive encyclical, *Laudato Si'* (Francis, 2015). It is a timely, highly significant, and influential work from one of the world's most important moral authorities, considering the magnitude of the environmental crises of its own making that humanity is now facing. It is a treatise on human ecology, a paean to environmental ethics, a plea for eco-spiritual awakening, and a call to action.

"Praise be to you, my Lord, through our Sister, Mother Earth, who sustains and governs us," Pope Francis begins the encyclical, quoting from his namesake's *Canticle of the Creatures* (Francis of Assisi, 1914), and reminding us that "our common home is like a sister with whom we share our life and a beautiful mother who opens her arms to embrace us" (¶ 1).[2] He goes on to forcefully write that "This sister now cries out to us because of the harm we have inflicted on her by our irresponsible use and abuse"—a powerful indictment of our failure to live in harmony with creation!

He connects "a violence in our hearts" to the "sickness evident in the soil, in the water, in the air and in all forms of life." Francis reminds us that our very bodies are made up of Earth's elements, that "we breathe her air" and that we "receive life … from her waters" (¶ 2). Or, as Seed et al. (2007) put it, "We are the rocks dancing." He's certainly not the first pope to remind us that we are damaging creation (van Tine, 2015), but with this encyclical he becomes the most forceful pontifical environmental advocate at this critical time in human history.

As cited by Francis, Paul VI wrote of an "ecological catastrophe under the effective explosion of industrial civilization."[3] "Due to an ill-considered exploitation of nature, humanity runs the risk of destroying it and becoming in turn a victim of this degradation," and he called for "radical change in the conduct of humanity" (¶ 4). He also wrote about the human interdependency with all of nature. John Paul II wrote that humans seem "to see no other meaning in their natural environment than what serves for immediate use and consumption" and in 2001 called for a "global ecological conversion".[4] In January of 2010, Roman Catholic Pope Benedict XVI stated "no less troubling are the threats arising from the neglect—if not downright misuse—of the earth and the natural goods that God has given us." He went on to write "economic activity needs to consider the fact that 'every economic decision has a moral consequence' and thus show increased respect for the environment" and concluded "If you want to cultivate peace, protect creation".[5] Pope Benedict XVI also wrote forcefully as an obvious systems thinker, about our interconnectedness—"the book of nature is one and indivisible," and that the natural environment has been "gravely damaged" by our irresponsible behavior (Benedict XVI, 2014).

2 Note: ¶ is used throughout to refer to the paragraph number of Pope Francis's encyclical, *Laudato Si'*.
3 Address to FAO on the 25th Anniversary of Its Institution (16 November 1970), 4: AAS 62 (1970), 833.
4 John Paul II, *Redemptor Hominis* (encyclical letter, 4 March 1979), 15: AAS 71 (1979), 287.
5 Benedict XVI, Message for the 2010 World Day of Peace, retrieved from w2.vatican.va/content/benedict-xvi/en/messages/peace/documents/hf_ben-xvi_mes_20091208_xliii-world-day-peace.html

Benedict held that "Man does not create himself. He is spirit and will, but also nature" (as quoted by Pope Francis, ¶ 6). See van Tine (2015) for a detailed analysis of Pope Benedict's book, *The Garden of God*.

Francis, writing plainly and forcefully about the seriousness of "the destruction of the human environment" (¶ 5) as a moral issue, quotes Bartholomew, Greek Orthodox patriarch:

> For human beings … to destroy the biological diversity of God's creation; for human beings to degrade the integrity of the earth by causing changes in its climate, by stripping the earth of its natural forests or destroying its wetlands; for human beings to contaminate the earth's waters, its land, its air, and its life—these are sins … to commit a crime against the natural world is a sin against ourselves and a sin against God[6] (¶ 8).

The Southern Baptist Convention, in a statement titled "Humans Must Care for Creation and Take Responsibility for Our Contributions to Environmental Degradation," states "There is undeniable evidence that the earth can be damaged by human activity … We believe that human activity is mixed in its impact on creation—sometimes productive and caring but often reckless, preventable and sinful." It goes on to state, "We must care about environmental and climate issues because of our love for God … This is not our world, it is God's. Therefore, any damage we do to this world is an offense against God Himself. We share God's concern for the abuse of His creation" (Southern Baptist Convention, n.d.).

Pope Francis refers frequently, not surprisingly, to his namesake, Francis of Assisi, stating that "Francis helps us to see that an integral ecology calls for openness to categories which transcend the language of mathematics and biology" (¶ 11). The phrase "integral ecology" is used by this and other popes to refer to the familiar academic human ecology concept that human welfare should be included in our considerations of environmental health—it's not just about science, it includes social and environmental justice.

Pope Francis also points out the great importance of Saint Francis's sense of awe and wonder for nature and our interdependency with it:

> If we approach nature and the environment without this openness to awe and wonder, if we no longer speak the language of fraternity and beauty in our relationship with the world, our attitude will be that of masters, consumers, ruthless exploiters, unable to set limits on their immediate needs. By contrast, if we feel intimately united with all that exists, then sobriety and care will well up spontaneously ... [creating] ... something much more radical: a refusal to turn reality into an object simply to be used and controlled (¶ 11).

6 Address in Santa Barbara, California (8 November 1997); cf. Chryssavgis (2012).

Saint Francis "asked that part of the friary garden always be left untouched, so that wild flowers and herbs could grow there" (¶ 12), perhaps encouraging future monks to experience awe and wonder. This is reminiscent of Rabbi Abraham Heschel's concept of "radical awe" as well:

> The greatest hindrance to … awareness is our adjustment to conventional notions, to mental clichés. Wonder or radical amazement, the state of maladjustment to words and notions, is therefore a prerequisite for an authentic awareness of that which is (Heschel, 1976).

Pope Francis appeals to us to consider the fact that "Young people demand change. They wonder how anyone can claim to be building a better future without thinking of the environmental crisis and the sufferings of the excluded" (¶ 13). He points out "the intimate relationship between the poor and the fragility of the planet, the conviction that everything in the world is connected, the critique of new paradigms and forms of power derived from technology, the call to seek other ways of understanding the economy and progress, the value proper to each creature, the human meaning of ecology" and "the throwaway culture" (¶ 16).

What is happening to our common home?

Pope Francis warns us:

> our common home is falling into serious disrepair … [and] we can see signs that things are now reaching a breaking point, due to the rapid pace of change and degradation; these are evident in large-scale natural disasters as well as social and even financial crises, for the world's problems cannot be analyzed or explained in isolation (¶ 61).

He is a great proponent of holistic thinking regarding the ecosphere. He declares that "The climate is a common good, belonging to all and meant for all" (¶ 23), but "this century may well witness extraordinary climate change and an unprecedented destruction of ecosystems, with serious consequences for all of us." It is a "global problem with grave implications: environmental, social, economic, political and for the distribution of goods. It represents one of the principal challenges facing humanity in our day. Its worst impact will probably be felt by developing countries" (¶ 25). Accepting the tenets of climate scientists without reservation and reiterating many of them, Pope Francis's encyclical reads like an environmental science or human ecology textbook in many places. What can it mean when a global religious leader speaks like a scientist while many members of the United States Congress deny science?

The pope proclaims that "The earth, our home, is beginning to look more and more like an immense pile of filth" (¶ 21), as did gaeologian, Catholic priest, and cultural historian Thomas Berry in his seminal book, *The Great Work*, when he stated "Our

quest for wonderworld is creating a waste-world" (Berry, 2000). Both agree that most of our environmental problems are at least partially results of our throwaway culture. "Who turned the wonderworld of the seas into underwater cemeteries bereft of colour and life?"[7] Francis quotes the Catholic Bishops' Conference of the Philippines (¶ 41), declaring:

> the degree of human intervention, often in the service of business interests and consumerism, is actually making our earth less rich and beautiful, ever more limited and grey, even as technological advances and consumer goods continue to abound limitlessly. We seem to think that we can substitute an irreplaceable and irretrievable beauty with something which we have created ourselves (¶ 34).

"Never have we so hurt and mistreated our common home as we have in the last two hundred years" (¶ 53).

He stresses over and over again that we have exceeded critical ecological limits, for example:

> it is not possible to sustain the present level of consumption in developed countries and wealthier sectors of society, where the habit of wasting and discarding has reached unprecedented levels. The exploitation of the planet has already exceeded acceptable limits and we still have not solved the problem of poverty (¶ 27).

The XIV Dalai Lama would agree:

> But now human use, population, and technology have reached that certain stage "where Mother Earth no longer accepts our presence with silence". In many ways she is now telling us, "My children are behaving badly," she is warning us that there are limits to our actions (Dalai Lama XIV, n.d.).

The plight of the poor is always front and center in Francis's concerns. To him, environmental justice and social justice issues are part and parcel of our selfish quest for unlimited profits and greed for ever higher levels of consumption—"The human environment and the natural environment deteriorate together; we cannot adequately combat environmental degradation unless we attend to causes related to human and social degradation" (¶ 48). Francis claims that the problems of the poor are treated as merely "collateral damage … frequently, we find beautiful and carefully manicured green spaces in so-called 'safer' areas of cities, but not in the more hidden areas where the disposable of society live" (¶ 45), in what Lerner (2010) calls "sacrifice zones." This is both an environmental injustice and social injustice, "we have to realize that a true ecological approach *always* becomes a social approach; it must integrate questions of justice in debates on the environment, so as to hear *both the cry of the earth and the cry of the poor*" (¶ 49). For example, Francis declares that "*access to safe drinkable water is a basic and universal human*

7 Catholic Bishops' Conference of the Philippines, pastoral letter "What Is Happening to Our Beautiful Land?" (January 29, 1988).

right, since it is essential to human survival and, as such, is a condition for the exercise of other human rights" (¶ 30). Access to water should not be commodified! This is the same approach that academic human ecology takes. The pope appears to agree with the conclusions of Garrett Hardin's seminal piece, "The Tragedy of the Commons" (Hardin, 1968).

"The problem is that we still lack the culture needed to confront this crisis" (¶ 53). We need a paradigm shift! A rapid one! Francis declares:

> the establishment of a legal framework which can set clear boundaries and ensure the protection of ecosystems has become indispensable; otherwise, the new power structures based on the techno-economic paradigm may overwhelm not only our politics but also freedom and justice (¶ 53).

He suggests that "rapid and constant change [is] not necessarily geared to the common good or to integral and sustainable human development" (¶ 18) and that we have "an irrational confidence in progress and human abilities" (¶ 19). "The growth of the past two centuries has not always led to an integral development and an improvement in the quality of life" (¶ 46), despite what those of us in the first world might believe.

Francis points out that technological and business solutions usually miss the "mysterious" interdependent web of existence of which we are a part, perhaps solving a single problem but causing many others. The pope declares that all of life, including ourselves, is interdependent and worthy of respect. "Because all creatures are connected, each must be cherished with love and respect, for all of us as living creatures are dependent on one another" (¶ 42).

Pope Francis gets at the crux of the basic environmental problem of modern technological civilization when he states:

> We have not yet managed to adopt a circular model of production capable of preserving resources for present and future generations, while limiting as much as possible the use of non-renewable resources, moderating their consumption, maximizing their efficient use, reusing and recycling them (¶ 22).

This is certainly a major goal of environmental science and human ecology, as well as being resonant with the tradition of certain Native American peoples to require the consideration of the impact of all current decisions on the Seventh Generation forward (Lyons, 1994).

The pope decries the tragic rise in refugees fleeing poverty caused by environmental degradation, and the fact that they are *not* considered refugees, but economic migrants. They are also part of the sacrifice zones that are caused by rampant industrial and commercial activities driven purely by the profit motive with little or no consideration for the lives of people or their ecosystems. The pope suggests

that "such effects will continue to worsen if we continue with current models of production and consumption" (¶ 26), stressing, in essence, that continuing with "business as usual" will be disastrous. The rapid changes caused by global warming are expected to result in millions of climate refugees, in the not-too-distant future, fleeing drought, flood, famine, and ecological collapse caused by the unfettered burning of fossil fuels for centuries.

Francis decries the current global economic system, writing "the earth's resources are … being plundered because of short-sighted approaches to the economy, commerce and production" (¶ 32). According to the pope, all creatures have intrinsic value and "It is not enough … to think of different species merely as potential 'resources' to be exploited, while overlooking the fact that they have value in themselves. The great majority become extinct for reasons related to human activity. We have no such right" (¶ 33). It is expected that about half of all known species will be extinct by the end of the twenty-first century due to the activities of technological human civilization.

> People may well have a growing ecological sensitivity but it has not succeeded in changing their harmful habits of consumption which, rather than decreasing, appear to be growing all the more … An outsider looking at our world would be amazed at such behaviour, which at times appears self-destructive (¶ 55).

This idea has been the central focus of my academic work for decades. The self-destructive nature of current practices is incomprehensible.

The pope claims that we willfully refuse to see clearly what is happening so that we can continue with our destructive lifestyles, and suggests:

> such evasiveness serves as a licence to carrying on with our present lifestyles and models of production and consumption. This is the way human beings contrive to feed their self-destructive vices: trying not to see them, trying not to acknowledge them, delaying the important decisions and pretending that nothing will happen (¶ 59).

This is a great social dilemma for the development of a sustainable world, as recognized by Garrett Hardin nearly half a century ago (Hardin, 1968).[8] Upton Sinclair once wrote, "It is difficult to get a man to understand something when his salary depends on his not understanding it" (Sinclair, 1994, p. 109). Pope Francis would extend that to our entire culture: "We can be silent witnesses to terrible injustices if we think that we can obtain significant benefits by making the rest of humanity, present and future, pay the extremely high costs of environmental deterioration" (¶ 36). He laments our shortsightedness and greed, explaining:

> Caring for ecosystems demands far-sightedness, since no one looking for quick and easy profit is truly interested in their preservation. But the cost of the damage caused by such selfish lack of concern is much greater than the economic benefits to be obtained (¶ 36).

8 See Osbaldiston and Sheldon (2002) for a thorough discussion of this idea.

Once again we are reminded of caring for the Seventh Generation (Lyons, 1994). Perhaps the recent international climate change accords in Paris, signed by most nations of the world, are the beginning of a global attempt to start facing reality and the start of serious actions to change our destructive ways. We shall see.

Not surprisingly, due to Catholic teachings on birth control, Pope Francis excludes population growth as the significant environmental problem that it is. But he does make a valid point that the issue can be used as a subterfuge to obfuscate the current pattern of unfair distribution of resources.

> To blame population growth instead of extreme and selective consumerism on the part of some, is one way of refusing to face the issues. It is an attempt to legitimize the present model of distribution, where a minority believes that it has the right to consume in a way which can never be universalized, since the planet could not even contain the waste products of such consumption (¶ 50).

Extreme consumption by the profligate few is part of a causal link that affects the poor in less-developed countries. It is impossible for everyone on Earth to consume and produce waste at the levels of the affluent—it would violate the laws of physics and ecology. But, despite the church's stance against birth control, population growth is an important factor that must be considered if sustainability is ever to be achieved.

Pope Francis speaks powerfully about the morality of food waste: "whenever food is thrown out it is as if it were stolen from the table of the poor" (¶ 50), quoting Catholic teachings. According to the United Nations Environment Programme, around 30–40 percent of all food in the United States is wasted. "Every year, consumers in rich countries waste almost as much food (222 million tonnes) as the entire net food production of sub-Saharan Africa (230 million tonnes)" (FAO, n.d.).

He points out that disproportionate use of resources by the few, mostly in the industrialized North, results in severe local damages in poor communities where the extraction of these resources mostly occurs. Paradoxically, waste and toxic materials are sent in the opposite direction, causing still more damage to those same poor communities—sacrifice zones. "Often the businesses which operate this way are multinationals. They do here what they would never do in developed countries" (¶ 51). He also decries the unfair and ironic devastating effects of global climate change "caused by huge consumption on the part of some rich countries" and felt most severely by the less-developed communities and countries that have not benefited from fossil fuel–powered industrialization. Great profits are earned by the multinationals at the expense of "the commons," and by the continuous creation of additional sacrifice zones. Corporations don't pay the costs of what neoclassical economists call externalities—poisoned air, water, soil, destabilized climate, loss of biodiversity, species extinction, human health, destruction of *the commons*. Neither are those costs included in the price of goods and services; therefore there is no incentive for consumers or businesses to operate in ways that are harmonious with

nature and human health. Lack of this *full-cost pricing* allows for great profits for the few while causing the many to suffer from the degradation of the ecosphere—the commons for all beings, including humans.

Pope Francis forcefully explains that "the foreign debt of poor countries has become a way of controlling them, yet this is not the case where ecological debt is concerned" (¶ 52). Crippling foreign debt held by developing countries and incurred mostly for huge development projects that may not have been sustainable or in the best interests of improving social justice puts those debtor nations at the mercy of the wealthy countries, but the more important "ecological debt" to the world caused by the degradation of Earth's water, air, soil, climate, and biodiversity by the excess consumption and waste production of the developed world is not paid. The profits of multinational corporations are all too often based on the fact that there is no full-cost pricing. That is, the multinationals do not, in most cases, pay for the degraded Earth capital (depleted and poisoned soils, destabilization of climate, poisoning or wasting of water, depletion of biodiversity, etc.) which is, unfortunately, the basis for much of their profit—not to mention environmental justice and worker safety and health issues. Why is monetary debt considered more important and real than the ecological debt that is destroying the natural commons that is *the real basis of life* for both humans and all other creatures? He points out that developing countries "continue to fuel the development of richer countries sacrificing their own present and future." They are almost still treated like colonies. Francis suggests "the developed countries ought to help pay this [ecological] debt by significantly limiting their consumption of non-renewable energy and by assisting poorer countries to support policies and programmes of sustainable development" (¶ 52). He points out that "the interests of economic groups which irrationally demolish sources of life should not prevail in dealing with natural resources" (¶ 54). How can it be that the life support systems of Earth are destroyed for the profit of the few, causing suffering for many and for all species of creatures and for future generations?

Powerful special interests trump the common good, over and over, as the repeated failed attempts by the international community to come together to solve the growing global climate change disaster have shown, although perhaps the recent Paris Agreement will prove to be a turning point. There is a desperate need for a paradigm shift that places the common good above the profits of the few; a change that would protect the sacred commons, instead of the "sacred" financial interests of the few. Pope Frances claims that "environmental deterioration and human and ethical degradation are closely linked." For example, when:

> economic powers continue to justify the current global system where priority tends to be given to speculation and the pursuit of financial gain, which fail to take the context into account, let alone the effects on human dignity and the natural environment … whatever is fragile, like the environment, is defenceless before the interests of a *deified market* [italics added], which become the only rule (¶ 56).

David Korten (2015) terms this the "sacred money and markets story." When the market is sacred all else is made profane, and some places and communities become sacrifice zones. But, as poet Wendell Berry points out, in actuality, "there are no unsacred places; there are only sacred places and desecrated places" (Berry, 2006, p. 18). It is we who have allowed the holy to become degraded and it is we who have made the profane sacred. Perhaps the cartoon character Pogo was right all those years ago when he said, "We have met the enemy and he is us" (Kelly, 1953).

Francis strongly condemns the "myth of progress," writing that "we find those who doggedly uphold the myth of progress and tell us that ecological problems will solve themselves simply with the application of new technology and without any need for ethical considerations or deep change" (¶ 60), suggesting that increasing resource depletion could well lead to new wars, "albeit under the guise of noble claims" (¶ 57).

Pope Francis feels that we should "become painfully aware, to dare to turn what is happening to the world into our own personal suffering and thus to discover what each of us can do about it" (¶ 19), as did philosopher Arne Næss with his concept of the "ecological self"—an expansion of the psychological sense of self that includes one's ecosystem, the ecosphere, and Earth (Næss, 1973, 1993).

The gospel of creation

Pope Francis affirms that different ways of knowing will be needed if we are to solve our grave human-ecological problems:

> science and religion, with their distinctive approaches to understanding reality, can enter into an intense dialogue fruitful for both … If we are truly concerned to develop an ecology capable of remedying the damage we have done, no branch of the sciences and no form of wisdom can be left out, and that includes religion (¶ 63).

This would also include the unique cultural, artistic, and spiritual riches of all peoples. Francis reiterates Pope John Paul II's claim that people with religious faith "realize that their responsibility within creation, and their duty towards nature and the Creator, are an essential part of their faith"[9] and goes on to proclaim that "it is good for humanity and the world at large when we believers better recognize the ecological commitments which stem from our convictions" (¶ 64).

Interestingly, Francis explains that the original creation story in Genesis shows humanity's refusal to accept limits—which is one of the central causes of our global environmental crisis:

9 John Paul II, Message for the 1990 World Day of Peace, 15: AAS 82 (1990), 156.

> human life is grounded in three fundamental and closely intertwined relationships: with God, with our neighbour and with the earth itself … these three vital relationships have been broken, both outwardly and within us. This rupture is sin. The harmony between the Creator, humanity and creation as a whole was disrupted by our presuming to take the place of God and refusing to acknowledge our creaturely limitations. This in turn distorted our mandate to 'have dominion' over the earth (cf. *Gen* 1:28), to 'till it and keep it' (*Gen* 2:15). As a result, the originally harmonious relationship between human beings and nature became conflictual (cf. *Gen* 3:17–19). (¶ 66)

The pope explains that this "original sin" broke the human relationship with God's laws, his limits (ecological limits in essence), thus our apparent inability to face the limits of physics and ecology in our personal lives and in our industrial, economic, and governmental policies. Ironically, perhaps also our refusal to confront necessary population limits that have been exceeded.

Significantly, Pope Francis responds to the criticism by Lynn White (1967) and many others that the concept of "dominion" from Genesis is a root cause of the "unbridled exploitation of nature." He insists on a "forceful rejection" of the interpretation that being given "dominion over the earth justifies absolute domination over other creatures." He argues strongly that the admonition in Genesis 2:15 to "till and keep" the garden makes it plain that humanity was given the responsibility to care for, protect, and preserve creation.

> The earth was here before us and it has been given to us. This allows us to respond to the charge that Judaeo-Christian thinking, on the basis of the Genesis account which grants man "dominion" over the earth (cf. *Gen*. 1:28), has encouraged the unbridled exploitation of nature by painting him as domineering and destructive by nature. This is not a correct interpretation of the Bible as understood by the Church. Although it is true that we Christians have at times incorrectly interpreted the Scriptures, nowadays we must forcefully reject the notion that our being created in God's image and given dominion over the earth justifies absolute domination over other creatures. The biblical texts … tell us to "till and keep" the garden of the world (cf. *Gen*. 2:15). "Tilling" refers to cultivating, ploughing or working, while "keeping" means caring, protecting, overseeing, and preserving. This implies a relationship of mutual responsibility between human beings and nature. Each community can take from the bounty of the earth whatever it needs for subsistence, but it also has the duty to protect the earth and to ensure its fruitfulness for coming generations. (¶ 67)
>
> This responsibility for God's earth means that human beings, endowed with intelligence, must respect the laws of nature and the delicate equilibria existing between the creatures of this world … "he [God] established them for ever and ever; he fixed their bounds and he set a law which cannot pass away (*Ps* 148:5b–6)" (¶ 68).

These are powerful commands that are in complete accordance with the discoveries of science and the recommendations of the Intergovernmental Panel on Climate Change (IPCC, 2014). Most, if not all, of the urgent environmental crises we are

currently facing are caused by humanity's attempts to violate the laws of physics and the principles of ecology. The significance of Pope Francis's admonitions that God has charged humans with respecting the laws of nature and ecological balances cannot be overstated. If every Christian on Earth followed these admonitions we would be well on our way toward an important paradigm shift.

"The laws found in the Bible dwell on relationships, not only among individuals but also with other living beings" (¶ 68). Here, Francis recognizes that all living beings, including humans, are in relationship—*sacred ecosystemic relationship*. Francis states emphatically, "clearly, the Bible has no place for a tyrannical anthropocentrism unconcerned for other creatures" (¶ 68). This is in sharp contrast to criticisms by many scholars that Christian teachings emphasize an anthropocentrism inconsistent with a true environmental ethic (White, 1967). Indeed, he goes on to declare that "we are called to recognize that other living beings have a value of their own in God's eyes," and "to respect creation and its inherent laws." The pope insists that we must respect the laws of physics and the inherent value of each living being, and points out Catholic teachings that "each creature possesses its own particular goodness and perfection" and so "man must therefore respect the particular goodness of every creature, to avoid any disordered use of things"[10] (¶ 69). We certainly have not avoided "disordered use of things" at least since the Industrial Revolution, if not since the Agricultural Revolution some 10,000 years ago!

Francis also reminds us that the ancient biblical stories "full of symbolism, bear witness … that everything is interconnected, and that genuine care for our own lives and our relationships with nature is inseparable from fraternity, justice and faithfulness to others" (¶ 70). He laments our separation from nature: "We were not meant to be inundated by cement, asphalt, glass and metal, and deprived of physical contact with nature" (¶ 44). He uses the story of Noah to imbue us with hope for renewal, "All it takes is one good person to restore hope!" He goes on to emphasize "the biblical tradition clearly shows that this renewal entails recovering and respecting the rhythms inscribed in nature" (¶ 71), which resonates with the acceptance of the "way of the Tao," the fundamental nature of the flow of the universe (LaFargue, 1992).

Sabbatical year, jubilee year, and gleanings

Francis gives examples of biblical injunctions for renewal by citing the ancient Old Testament Judaic laws commanding rest on the Sabbath of the week, a sabbatical year of rest for the land every 7 years, and the jubilee year (every 49 years) of general forgiveness as attempts "to ensure balance and fairness in their

10 Catechism of the Catholic Church, 339.

relationships with others and with the land on which they lived and worked … it was an acknowledgment that the gift of the earth with its fruits belongs to everyone" (¶ 71). This is a consistent theme throughout the encyclical—the land and its resources belong to everyone, and those who control them must share them. He quotes Leviticus 19:9–10:

> When you reap the harvest of your land, you shall not reap your field to its very border, neither shall you gather the gleanings after the harvest. And you shall not strip your vineyard bare, neither shall you gather the fallen grapes of your vineyard; you shall leave them for the poor and for the sojourner (¶ 71).

Francis slays the "modern myth of unlimited material progress," as he terms it, by arguing that "a fragile world, entrusted by God to human care, challenges us to devise intelligent ways of directing, developing and limiting our power" (¶ 78). This idea is similar to Korten's "sacred money and markets story"—"with enough money our human technologies will liberate us from a dependence on nature" (Korten, 2015, p. 53). So, the pope recognizes sacred limits; just as scientists recognize the reality of limits dictated by the laws of physics and the realities of ecosystem dynamics with complex feedback loops. "In this universe, shaped by open and intercommunicating systems, we can discern countless forms of relationship and participation." He reminds us that the church teaches not only of "the duty to care for nature," but also to "protect mankind from self-destruction" (¶ 79)—a self-destruction that is so obvious to environmental and climate scientists and human ecologists today.

Francis also holds that other living beings are not just objects to be used by humans however they see fit:

> subjected to arbitrary human domination … When nature is viewed solely as a source of profit and gain, this has serious consequences for society. This vision of 'might is right' has engendered immense inequality, injustice and acts of violence against the majority of humanity, since resources end up in the hands of the first comer or the most powerful: the winner takes all (¶ 82).

"The ultimate purpose of other creatures is not to be found in us … each creature has its own purpose. None is superfluous … Soil, water, mountains: everything is, as it were, a caress of God" (¶ 84). David Abram (1996) goes much further, referring to the other creatures of Earth as "the more than human others," contrary to the pope's view that humans have a special status. But Francis's position has moved further toward understanding all creatures as having value in their own right and that all of life is part of a "sacred" interdependent web, or Thomas Berry's (2000) beautiful vision that the universe is a sacred communion, not a disparate group of objects, or even philosopher Martin Buber's (2000) concept of "I-Thou" applied to the other creatures with whom we share this planet. Greek Orthodox Patriarch Bartholomew is quoted by Francis as also saying "accept the world as a sacrament of

communion"[11] (¶ 9). In a section of the encyclical called "A Universal Communion," Francis claims that "all of us are linked by unseen bonds and together form a kind of universal family, a sublime communion which fills us with a sacred, affectionate and humble respect" (¶ 89). Human humility could certainly be an antidote to our arrogant sense of ownership of all creatures, the land, the air, the water!

Pope Francis reminds us of Pope John Paul II's admonishment, "we cannot interfere in one area of the ecosystem without paying due attention to the consequences of such interference in other areas"[12] (¶ 131)—a statement of basic ecological wisdom, and one that "wilderness prophet" John Muir frequently uttered—"When we try to pick out anything by itself, we find it hitched to everything else in the Universe" (Muir, 1911, p. 211). Francis proclaims that "God has joined us so closely to the world around us that we can feel the desertification of the soil almost as a physical ailment, and the extinction of a species as a painful disfigurement" (¶ 89), thus giving us even more responsibility for healing our dysfunctional relationship with the rest of creation. This is almost the same idea as philosopher Arne Næss's concept of the ecological self, to include the ecosystems of which we are a part in our sense of self (Næss, 1988).

Francis quotes the Canadian Conference of Catholic Bishops, "From panoramic vistas to the tiniest living form, nature is a constant source of wonder and awe. It is also a continuing revelation of the divine."[13] He also quotes the Catholic Bishops' Conference of Japan, "To sense each creature singing the hymn of its existence is to live joyfully"[14] (¶ 85). He goes on to quote Paul Ricoeur (2009, p. 216)—"I express myself in expressing the world; in my effort to decipher the sacredness of the world, I explore my own" (¶ 85), evoking William Blake (Gilchrist, 2010):

> To see a World in a Grain of Sand,
> And a Heaven in a Wild Flower,
> Hold Infinity in the palm of your hand,
> And Eternity in an hour.

The pope sanctifies the laws of physics and ecology by quoting the Catholic catechism:

> God wills the interdependence of creatures. The sun and the moon, the cedar and the little flower, the eagle and the sparrow: the spectacle of their countless diversities and inequalities tells us that no creature is self-sufficient. Creatures exist only in dependence on each other, to complete each other, in the service of each other[15] (¶ 86).

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11 Halki Summit I, Istanbul, closing remarks "Global Responsibility and Ecological Sustainability" (June 20, 2012).

12 John Paul II, Message for the 1990 World Day of Peace, 6: AAS 82 (1990), 150.

13 Canadian Conference of Catholic Bishops, Social Affairs Commission, pastoral letter "You Love All That Exists … All Things Are Yours, God, Lover of Life" (October 4, 2003), 1.

14 Catholic Bishops' Conference of Japan, Reverence for Life. A Message for the Twenty-First Century (January 1, 2001), 89.

15 Catechism of the Catholic Church, 340.

This is a concise affirmation of ecological reality, in both prose and poetry! He points out that "the Spirit of life dwells in every living creature and calls us to enter into relationship with him. Discovering this presence leads us to cultivate the 'ecological virtues'" (¶ 88). If all people on Earth felt that all creatures were sacred, we would treat them very differently indeed.

He points out the inequity and social injustice inherent in the huge disparity of resource use by humans, emphasizing that if everyone wasted like the most profligate, we "would destroy the planet," a strong confirmation of the conclusions of ecologists, dramatically illustrated with ecological footprint analyses. As of 2016 "humanity uses the equivalent of 1.6 planets to provide the resources we use and absorb our waste" (Global Footprint Network, 2016).

Francis declares:

> A sense of deep communion with the rest of nature cannot be real if our hearts lack tenderness, compassion and concern for our fellow human beings … Everything is connected. Concern for the environment thus needs to be joined to a sincere love for our fellow human beings and an unwavering commitment to resolving the problems of society … Moreover, when our hearts are authentically open to universal communion, this sense of fraternity excludes nothing and no one … Our indifference or cruelty towards fellow creatures of this world sooner or later affects the treatment we mete out to other human beings … Every act of cruelty towards any creature is contrary to human dignity. (¶ 92)

He quotes the Dominican Bishops' warning about reductionism, "Peace, justice and the preservation of creation are three absolutely interconnected themes, which cannot be separated and treated individually without once again falling into reductionism"[16] (¶ 92). His support for a holistic, systems-oriented view of the world, rather than the old Cartesian reductionism is apparent. "Everything is related, and we human beings are united as brothers and sisters on a wonderful pilgrimage, woven together by the love God has for each of his creatures and which also unites us in fond affection with brother sun, sister moon, brother river and mother earth" (¶ 92). But he repeatedly and firmly admonishes us to include humans, and especially the poor in our ecological ruminations: "every ecological approach needs to incorporate a social perspective which takes into account the fundamental rights of the poor and the underprivileged" (¶ 93). Francis declares that the "golden rule of social conduct" and "first principle of the whole ethical and social order" (referring to John Paul II) is the universal right of everyone to the use of the goods necessary for life. "The Christian tradition has never recognized the right to private property as absolute or inviolable, and has stressed the social purpose of all forms of private

16 Conference of Dominican Bishops, pastoral letter "Sobre la Relación del Hombre con la Naturaleza" (January 21, 1987).

property" (¶ 93). He quotes John Paul II, "God gave the earth to the whole human race for the sustenance of all its members, *without excluding or favouring anyone*"[17] and "there is always a social mortgage on all private property"[18] (¶ 93).

Francis holds that nature is a collective good belonging to everyone and is *likewise the responsibility of all*! If everyone using "the commons" of Earth acted responsibly, with care for each other and Earth, the "Tragedy of the Commons" (Hardin, 1968) could be avoided. He explains that if we own property and do not administer it for the good of all, then "we burden our consciences with the weight of having denied the existence of others" (¶ 95). He reports that the "New Zealand bishops asked what the commandment 'Thou shalt not kill' means when 'twenty percent of the world's population consumes resources at a rate that robs the poor nations and future generations of what they need to survive'"[19] (¶ 95). *What a powerful thought*! If the privileged use up so many resources in their excess consumption of goods and energy and despoil distant lands due to extraction of minerals and creation of toxic wastes, causing destabilization of the climate, can we not say that they have violated that commandment?

The human roots of the ecological crisis

Technological knowledge and the economic resources to use them, what Francis calls "the dominant technocratic paradigm," have given those few who possess them "an impressive dominance over the whole of humanity and the entire world" (¶ 104). He points out the risks created by this power being held by such a small fraction of humanity and that the immense power modern technology has given us has not been matched by an increase in human responsibility, values, and conscience. Pope Francis claims that we do not have an ethics, culture, or spirituality capable of setting limits—limits that we are not even aware of, or are unwilling to admit! The ecological and social dangers of the "paradigm of limitless growth" and the story of "sacred money and markets" are thoroughly treated by Dyball and Newell (2015) and Korten (2015), respectively. Francis quotes Romano Guardini repeatedly, including, "power is never considered in terms of responsibility of choice" (Guardini, 1998, p. 82).

Pope Francis condemns the reductionist paradigm that worships technology resulting in the "deterioration of the environment" (¶ 107) and suggests that by using this "undifferentiated and one-dimensional paradigm" we ignore reality while extracting everything we can "based on the lie that there is an infinite supply of the earth's goods, and this leads to the planet being squeezed dry beyond every limit" (¶ 106). He emphasizes the fact that there are definitely *not* infinite quantities of

17 John Paul II, *Centesimus Annus* (encyclical letter, May 1, 1991), 31: AAS 83 (1991), 831.
18 Address to Indigenous and Rural People, Cuilapán, Mexico (January 29, 1979), 6: AAS 71 (1979), 209.
19 New Zealand Catholic Bishops Conference, "Statement on Environmental Issues" (September 1, 2006).

resources nor energy available and that the negative effects of extraction and use *cannot* easily be absorbed by natural systems. Additionally, "technological products are not neutral, for they create a framework which ends up conditioning lifestyles and shaping social possibilities along the lines dictated by the interests of certain powerful groups" (¶ 107). That is, the choices for society are diminished because of the dictates of technology. A "technology severed from ethics will not easily be able to limit its own power" (¶ 136). He decries that we are trapped in a system in which it is acceptable, even expected, that technology will shape lives and determine sociological norms "as dictated by the interests" of a small powerful group. We have become slaves to the interests of technology. "The idea of promoting a different cultural paradigm and employing technology as a mere instrument is nowadays inconceivable … It has become countercultural to choose a lifestyle whose goals are even partly independent of technology, of its costs and its power to globalize and make us all the same" (¶ 108). He holds that profit, and finance for profit, drives politics and every other aspect of our technological world, with little or no regard for the impacts on human beings or the rest of nature. "The economy accepts every advance in technology with a view to profit, without concern for its potentially negative impact on human beings" (¶ 109). The fallacy of blind belief in future technological fixes is firmly part of the paradigm of limitless growth!

Our global economic system and social institutions are thus enslaved to the needs of technology and do not take care of the needs of the poor, or the environment, showing "no interest in more balanced levels of production, a better distribution of wealth, concern for the environment and the rights of future generations" (¶ 109). Maximizing profits is the focus! "We fail to see the deepest roots of our present failures, which have to do with the direction, goals, meaning and social implications of technological and economic growth" (¶ 109); technological specialization leads to a failure to see the big picture, "a loss of appreciation for the whole, for the relationships between things … Life gradually becomes a surrender to situations conditioned by technology, itself viewed as the principal key to the meaning of existence," despite obvious "symptoms which point to what is wrong, such as environmental degradation, anxiety, a loss of the purpose of life and of community living" (¶ 110).

Francis calls for an alternative world view involving new ways of perceiving and thinking, new policies, more appropriate education, a new "lifestyle and a spirituality which together generate resistance to the assault of the technocratic paradigm" (¶ 111). He promotes a holistic, systems approach to solving our deep human-ecological problems. "To seek only a technical remedy to each environmental problem which comes up is to separate what is in reality interconnected and to mask the true and deepest problems of the global system" (¶ 111). In essence, Francis is calling for an earthy spirituality plus the breadth of human ecology and environmental studies: "A science which would offer solutions to the great issues

would necessarily have to take into account the data generated by other fields of knowledge, including philosophy and social ethics" (¶ 110). "There is a growing awareness that scientific and technological progress cannot be equated with the progress of humanity and history" (¶ 113).

Declaring that "an authentic humanity, calling for a new synthesis, seems to dwell in the midst of our technological culture, almost unnoticed, like a mist seeping gently beneath a closed door" (¶ 112), Francis notes some signs of that new paradigm forming, declaring them as the beginnings of "liberation from the dominant technocratic paradigm" (¶ 112):

1. cooperatives of small producers adopting less polluting means of production, and opting for non-consumerist models of life, recreation and community;
2. technology directed primarily to resolving people's concrete problems, truly helping them live with more dignity and less suffering;
3. people desiring to create and contemplate beauty and managing to overcome reductionism through a kind of salvation which occurs in beauty and in those who behold it.

He calls for a switch from a way of life filled with the superficiality of constantly changing technological toys to one filled with wondering about "the purpose and meaning of everything" (¶ 113), and suggests there is:

> [an] urgent need for us to move forward in a bold cultural revolution … Nobody is suggesting a return to the Stone Age, but we do need to slow down and look at reality in a different way, to appropriate the positive and sustainable progress which has been made, but also to recover the values and the great goals swept away by our unrestrained delusions of grandeur (¶ 114).

Crisis of anthropocentrism

Claiming that we currently suffer from an "excessive anthropocentrism," Pope Francis insists that "the time has come to pay renewed attention to reality and the limits it imposes." He admits that Christianity has misunderstood the relationship between humans and the world, claiming a "Promethean vision of mastery over the world, which gave the impression that the protection of nature was something that only the faint-hearted cared about. Instead, our 'dominion' over the universe should be understood more properly in the sense of responsible stewardship" (¶ 116). "Once the human being declares independence from reality and behaves with absolute dominion, the very foundations of our life begin to crumble" (¶ 117). This is a remarkable reframing of the Christian concept of dominion, one which incorporates the realities of physics, chemistry, and ecological limits into a responsible stewardship. However, he does warn against biocentrism, describing it as just as imbalanced as anthropocentrism. Most scientists would disagree and

lean towards biocentrism or ecocentrism as the most objective perspective. Human ecologists would surely include humans firmly within that biocentric, ecocentric, but non-anthropocentric perspective. Critics of Christianity (e.g., White, 1967) have often pointed out its anthropocentric bias, so it is interesting that Pope Francis holds the much more nuanced position of rejecting anthropocentrism and focusing on a broader interpretation of "dominion." He does, however, insist that Christian thought holds human beings above all other creatures, each human being innately worthy of esteem and thus requiring that all persons must have respect for all others. I would extend that respect to all beings in creation, and Pope Francis seems to imply such in several places in *Laudato Si'*. For example, "we are called to recognize that other living beings have a value of their own" and "we are called to respect creation" and "Man must therefore respect the particular goodness of every creature" (¶ 69).

He holds that the ecological crisis is a "sign of the ethical, cultural and spiritual crisis of modernity" and goes on to explain that "we cannot presume to heal our relationship with nature and the environment without healing all fundamental human relationships" (¶ 119). So he understands our environmental crisis as part of a larger human-ecological crisis, as did Pope Benedict XVI before him (van Tine, 2015). "There can be no renewal of our relationship with nature without a renewal of humanity itself. There can be no ecology without an adequate anthropology" (¶ 118). He claims that a culture of relativism wherein everything is irrelevant unless it serves one's own interests is the attitude that promotes "the mindset of those who say: Let us allow the invisible forces of the market to regulate the economy, and consider their impact on society and nature as collateral damage" (¶ 123). He has little faith in politics or the power of law to prevent environmental degradation. "We should not think that political efforts or the force of law will be sufficient to prevent actions which affect the environment because, when the culture itself is corrupt and objective truth and universally valid principles are no longer upheld, then laws can only be seen as arbitrary impositions or obstacles to be avoided" (¶ 123).

Value of labor

Pope Francis emphasizes that "Any approach to an integral ecology,[20] which by definition does not exclude human beings, needs to take account of the value of labour" (¶ 124). "Work is a necessity, part of the meaning of life on this earth, a path to growth, human development and personal fulfilment" (¶ 128). Francis promotes and points out the value of small-scale local food production, for example, "there is a great variety of small-scale food production systems which feed the greater part of the world's peoples, using a modest amount of land and producing less waste, be it in small agricultural

20 The phrase "integral ecology" is used by this and other popes to refer to the familiar academic human ecology concept that human welfare should be included in our considerations of environmental health—it's not just about science, it includes social and environmental justice.

parcels, in orchards and gardens, hunting and wild harvesting or local fishing" (¶ 129), whereas large-scale global industrial agriculture forces small landowners to "sell their land or to abandon their traditional crops." Pope Francis shares that "the Catechism firmly states that human power has limits and that 'it is contrary to human dignity to cause animals to suffer or die needlessly'" (¶ 130). The use of and experimentation on animals "requires a religious respect for the integrity of creation."[21]

Integral ecology

Francis holds that the study of ecology "entails reflection and debate about the conditions required for the life and survival of society, and the honesty needed to question certain models of development, production and consumption" (¶ 138), and so endorses what seems to me to be the very heart of the academic field of human ecology. He states forcefully that "it cannot be emphasized enough how everything is interconnected." He is firmly against reductionism in science, concluding that "fragmentation of knowledge and the isolation of bits of information can actually become a form of ignorance, unless they are integrated into a broader vision of reality" (¶ 138).

> Nature cannot be regarded as something separate from ourselves or as a mere setting in which we live. We are part of nature, included in it and thus in constant interaction with it. Recognizing the reasons why a given area is polluted requires a study of the workings of society, its economy, its behaviour patterns, and the ways it grasps reality. (¶ 139)

The pope insists:

> it is essential to seek comprehensive solutions which consider the interactions within natural systems themselves and with social systems. We are faced not with two separate crises, one environmental and the other social, but rather with one complex crisis which is both social and environmental. Strategies for a solution demand an integrated approach to combating poverty, restoring dignity to the excluded, and at the same time protecting nature (¶ 139).

This is at its core a statement of the purposes of the academic study of human ecology: basically the same as what Pope Francis and other popes and Catholic scholars have called integral ecology. "Human ecology is inseparable from the notion of the common good, a central and unifying principle of social ethics" (¶ 156).

Francis states that ecosystems "have an intrinsic value independent of their usefulness" (¶ 140). *Ecosystems are sacred*, according to Pope Francis: "Each organism, as a creature of God, is good and admirable in itself; the same is true of

21 Catechism of the Catholic Church, 2418.

the harmonious ensemble of organisms existing in a defined space and functioning as a system" (¶ 140). Humanity is an interdependent part of the sacred wholeness, holiness. And the pope seems to recognize that our very bodies are part of nature, tying us intimately with the rest of creation. "It is enough to recognize that our body itself establishes us in a direct relationship with the environment and with other living beings" (¶ 155). He points out that Jesus was not a dualist, that he was "far removed from philosophies which despised the body, matter and the things of the world" saying that these are "unhealthy dualisms" (¶ 98).

The pope insists that we must pay "greater attention to local cultures when studying environmental problems," necessitating "a dialogue between scientific-technical language and the language of the people" (¶ 143). Solutions need "to be based in the local culture itself" (¶ 144), respecting the rights of peoples and cultures, paying "special care for indigenous communities and their cultural traditions" (¶ 146). This is a refreshing position in light of the colonial history of the Catholic Church. "For them, land is not a commodity but rather a gift from God and from their ancestors who rest there, a sacred space with which they need to interact if they are to maintain their identity and values" (¶ 146). He also suggests that "social ecology is necessarily institutional, and gradually extends to the whole of society, from the primary social group, the family, to the wider local, national and international communities" (¶ 142).

Justice between the generations

The pope argues that ethics demand that there be justice between the generations (¶ 159). "Leaving an inhabitable planet to future generations is, first and foremost, up to us. The issue is one which dramatically affects us, for it has to do with the ultimate meaning of our earthly sojourn" (¶ 160), as recognized by many indigenous peoples throughout the world:

- The notion of the common good also extends to future generations.
- We can no longer speak of sustainable development apart from intergenerational solidarity. Once we start to think about the kind of world we are leaving to future generations, we look at things differently; we realize that the world is a gift which we have freely received and must share with others.
- Intergenerational solidarity is not optional, but rather a basic question of justice, since the world we have received also belongs to those who will follow us.
- The environment is part of a logic of receptivity. It is on loan to each generation, which must then hand it on to the next.[22]

22 Portuguese Bishops' Conference, pastoral letter "Responsabilidade Solidária Pelo Bem Comum" (September 15, 2003), 20.

> Doomsday predictions can no longer be met with irony or disdain. We may well be leaving to coming generations debris, desolation and filth. The pace of consumption, waste and environmental change has so stretched the planet's capacity that our contemporary lifestyle, unsustainable as it is, can only precipitate catastrophes, such as those which even now periodically occur in different areas of the world. The effects of the present imbalance can only be reduced by our decisive action, here and now. We need to reflect on our accountability before those who will have to endure the dire consequences. (Pope Francis, ¶ 161)

Francis pleads, "let us not only keep the poor of the future in mind, but also today's poor, whose life on this earth is brief and who cannot keep on waiting" (¶ 162). He quotes Pope Benedict XVI, "in addition to a fairer sense of intergenerational solidarity there is also an urgent moral need for a renewed sense of intragenerational solidarity"[23] (¶ 162).

Lines of approach and action

Pope Francis reminds us that "interdependence obliges us to think of one world with a common plan. Yet the same ingenuity which has brought about enormous technological progress has so far proved incapable of finding effective ways of dealing with grave environmental and social problems worldwide" (¶ 164), despite the fact that "our planet is a homeland and that humanity is one people living in a common home" (¶ 164). "We know that technology based on the use of highly polluting fossil fuels—especially coal, but also oil and, to a lesser degree, gas—needs to be progressively replaced without delay" (¶ 165).

"Although the post-industrial period may well be remembered as one of the most irresponsible in history, nonetheless there is reason to hope that humanity at the dawn of the twenty-first century will be remembered for having generously shouldered its grave responsibilities" (¶ 165), as Thomas Berry predicted with his positive concept of the coming Ecozoic era, an era of ecological understanding and human cooperation with the laws of nature and physics—a time of spiritual renewal and a deepening of both responsibility and life satisfaction (Swimme & Berry, 1992).

He decries that "recent World Summits on the environment have not lived up to expectations because, due to lack of political will, they were unable to reach truly meaningful and effective global agreements on the environment" (¶ 166). However, the pope's encyclical may well have influenced the recent international Paris climate agreement. Francis reminds us that the 1992 Earth Summit in Rio proclaimed, "human beings are at the centre of concerns for sustainable development"[24] and that it reflected the important Stockholm Declaration which "enshrined international

23 Benedict XVI, Message for the 2010 World Day of Peace, 8: AAS 102 (2010), 45.
24 Rio Declaration on Environment and Development (June 14, 1992), Principle 1.

cooperation to care for the ecosystem of the entire earth, the obligation of those who cause pollution to assume its costs, and the duty to assess the environmental impact of given projects and works" (¶ 167).

"Reducing greenhouse gases requires honesty, courage and responsibility, above all on the part of those countries which are more powerful and pollute the most" (¶ 169). Perhaps we see the beginnings of just this with the recent climate agreements between the United States, China, and India related to the 2015 Paris Agreement. Francis warns against proposals to reduce CO_2 emissions that would unfairly impact poor countries most in need of development; "further injustice is perpetrated under the guise of protecting the environment" where "the poor end up paying the price" (¶ 170). He reiterates what the Catholic Bishops of Bolivia stated in 2012, "the countries which have benefited from a high degree of industrialization, at the cost of enormous emissions of greenhouse gases, have a greater responsibility for providing a solution to the problems they have caused."[25] He is against carbon credits, fearing that it would lead to a new abusive speculative market. He argues that the top priority is to eliminate extreme poverty and promote social development in poor countries. Poor countries must develop sustainable energy production systems, "but to do so they require the help of countries which have experienced great growth at the cost of the ongoing pollution of the planet" (¶ 172). He holds that this should be mostly at the expense of the developed countries, for the sake of the whole planet. "The costs of this would be low, compared to the risks of climate change. In any event, these are primarily ethical decisions, rooted in solidarity between all peoples" (¶ 172).

"Enforceable international agreements are urgently needed … [which] lay down mutually agreed means of averting regional disasters"(¶ 173). "What is needed, in effect, is an agreement on systems of governance for the whole range of so-called 'global commons'" (¶ 174), especially because of the weakening of the nation states compared to the power of transnational financial and economic sectors. The pope holds that "it is essential to devise stronger and more efficiently organized international institutions" (¶ 175). "The same mindset which stands in the way of making radical decisions to reverse the trend of global warming also stands in the way of achieving the goal of eliminating poverty" (¶ 175). He seems to be in agreement with Naomi Klein, who contends that "any attempt to rise to the climate challenge will be fruitless unless it is understood as part of a much broader battle of worldviews" (Klein, 2014, p. 21). "Our economic system and our planetary system are now at war." She goes on to write, "there is still time to avoid catastrophic warming, but not within the rules of capitalism as they are currently constructed. Which is surely the best argument there has ever been for changing those rules" (ibid., p. 88).

25 Bolivian Bishops' Conference, pastoral letter on the environment and human development in Bolivia "El Universo, don de Dios Para la Vida" (March 2012), 86.

The people of the world need laws to protect the common good. "How can a society plan and protect its future amid constantly developing technological innovations? One authoritative source of oversight and coordination is the law, which lays down rules for admissible conduct in the light of the common good" (¶ 177). He holds that a "healthy, mature society" must impose limits. Nature, physics, chemistry, and biology impose real limits. We exceed them at our peril, at the peril of the common good. A wise society would impose legal limits to protect the common good from its own excesses. When nature's limits are exceeded the results are catastrophic, as we are beginning to understand regarding climate change! Cannot humanity govern itself so as to avoid such calamitous outcomes?

> A politics concerned with immediate results, supported by consumerist sectors of the population, is driven to produce short-term growth … governments are reluctant to upset the public with measures which could affect the level of consumption or create risks for foreign investment. The myopia of power politics delays the inclusion of a far-sighted environmental agenda … True statecraft is manifest when, in difficult times, we uphold high principles and think of the long-term common good (¶ 178).

Francis holds that creation of processes that foster the "common good" are better than attempting to hold on to power.

Providing an example of cooperatives developing sustainable energy for local self-sufficiency, Francis claims that local individuals and groups can cause change even within large systems that are stuck in the old "business as usual" paradigm—"while the existing world order proves powerless to assume its responsibilities, local individuals and groups can make a real difference" (¶ 179). Often, this creative leadership is found in indigenous communities where a deep love for the land, the value of community, and concern for future generations is strong, as illustrated with many contemporary examples by Klein (2014).

Francis affirms standard environmental science recommendations such as increased efficiency, less consumption, less pollution, recycling, and protecting endangered species. The encyclical, at times, reads like an environmental science or ecology textbook. He encourages new forms of cooperation and community organization and diligent public pressure to cause change:

> continuity is essential, because policies related to climate change and environmental protection cannot be altered with every change of government. Results take time … in the absence of pressure from the public and from civic institutions, political authorities will always be reluctant to intervene (¶ 181).

He decries the typical short-term thinking of contemporary politicians. He warns that the potential environmental impacts of projects must not be hidden corruptly "in exchange for favors." He insists that environmental impact assessments should

be completed before business plans are finalized, and should be part of the process from the beginning, "carried out in a way which is interdisciplinary, transparent and free of all economic or political pressure" (¶ 183).

He advises that all economic projections for projects should realistically include all environmental effects and their costs, and

> [a] consensus should always be reached between the different stakeholders, who can offer a variety of approaches, solutions and alternatives. The local population should have a special place at the table; they are concerned about their own future and that of their children, and can consider goals transcending immediate economic interest … Honesty and truth are needed in scientific and political discussions; these should not be limited to the issue of whether or not a particular project is permitted by law (¶ 183).

Just because something is legal doesn't necessarily mean it is right and just. "The culture of consumerism, which prioritizes short-term gain and private interest, can make it easy to rubber-stamp authorizations or to conceal information" (¶ 184). Consideration of the "common good", not just profit, must be a priority in any proposed venture. The pope endorses a "genuine integral development"[26] that works toward the common good with special emphasis on the human rights of the local inhabitants. He supports the precautionary principle, as elucidated in the Rio Declaration of 1992,[27] in order to protect the most vulnerable: "objective and conclusive demonstrations will have to be brought forward to demonstrate that the proposed activity will not cause serious harm to the environment or to those who inhabit it" (¶ 186). This effectively reverses the burden of proof, requiring proof that no serious harm to the environment or to the people would result from proposed development projects. There is a recent encouraging movement to create "B Corporations"—for-profit companies that are certified to uphold rigorous social and environmental justice standards. As of 2016, according to "B Lab," the non-profit certifying organization, there are more than 1,600 certified B Corporations in 42 countries with the goal of redefining business success (Community of Certified B Corporations, 2016).

26 Defined by the Organization of American States as "the general name given to a host of policies that work in tandem to foster sustainable development in both developing and underdeveloped countries" (www.oas.org/en/topics/integral_development.asp).

27 "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a pretext for postponing cost-effective measures," Rio Declaration on the Environment and Development (June 14, 1992), Principle 15.

Politics and economy in dialogue for human fulfillment

"Today, in view of the common good, there is urgent need for politics and economics to enter into a frank dialogue in the service of life … The financial crisis of 2007–08 provided an opportunity to develop a new economy, more attentive to ethical principles … But the response to the crisis did not include rethinking the outdated criteria which continue to rule the world" (¶ 189) with the possible exception of Iceland where "the government let the banks go bust rather than bail them out at taxpayers' expense; it imposed capital controls on outflows; and it used fiscal transfers to protect the bottom half of the population from disproportionate cuts" (Wade & Sigurgeirsdottir, 2012, p. 127).

The pope reiterates that "environmental protection cannot be assured solely on the basis of financial calculations of costs and benefits. The environment is one of those goods that cannot be adequately safeguarded or promoted by market forces" (Pontifical Council for Justice and Peace, 2004, p. 470) and he forcefully rejects what he terms the "magical conception of the market" (¶ 190) that promises that all problems are solvable by simply increasing profits! David Korten calls this our "sacred money and markets story." According to him "Time is money. Money is wealth. Material consumption is the path to happiness. Making money creates wealth, drives consumption to increase happiness, and is the defining purpose of individuals, business and the economy" (Korten, 2015, p. 23). Francis asks us:

> Is it realistic to hope that those who are obsessed with maximizing profits will stop to reflect on the environmental damage which they will leave behind for future generations? Where profits alone count, there can be no thinking about the rhythms of nature, its phases of decay and regeneration, or the complexity of ecosystems which may be gravely upset by human intervention. Moreover, biodiversity is considered at most a deposit of economic resources available for exploitation, with no serious thought for the real value of things, their significance for persons and cultures, or the concerns and needs of the poor (¶ 190).

Francis points out that higher profits will be made in the long term if the whole picture, including the environment and human well-being, is considered. He promotes what he terms "productive diversification" to use "human ingenuity to create and innovate, while at the same time protecting the environment and creating more sources of employment" instead of "excessive technological investment in consumption and insufficient investment in resolving urgent problems facing the human family". He decries our current focus on finding "ever new ways of despoiling nature, purely for the sake of new consumer items and quick profit" (¶ 192).

Francis pleads for limits to be set before it is too late. He states "we need also to think of containing growth by setting some reasonable limits and even retracing our steps before it is too late" (¶ 193). It is deeply unethical that ever-increasing levels of consumption and consequent environmental destruction occur "while others are not yet able to live in a way worthy of their human dignity." And these are *not* unrelated conditions! To the contrary, environmental injustice creates sacrifice zones all over the world in less-developed and developing societies as a result of the insatiable search for higher profits and insatiable consumption in the developed world. The pope declares "the time has come to accept decreased growth in some parts of the world, in order to provide resources for other places to experience healthy growth" (¶ 193). "Live simply so that others may simply live."[28] In their human ecology textbook, Dyball and Newell (2015) refer to the "Goldilocks Principle," a mathematically derived range of human consumption by community that would allow a minimum level of human dignity for all, if the most affluent consume less. They refer to this reduced consumption as "sufficiency," and discuss the possibility of an enriched life with lowered levels of consumption. Pope Francis reminds us that Christianity eschews "obsession with consumption" and, like the teachings of most religions, holds that "less is more" (¶ 222). He proposes a spirituality of personal fulfillment "marked by moderation and the capacity to be happy with little," embracing "simplicity which allows us to stop and appreciate the small things, to be grateful for the opportunities which life affords us, to be spiritually detached from what we possess, and not to succumb to sadness for what we lack" (¶ 222).

Francis argues that it is too late for halfway measures that attempt to balance the preservation of nature with financial gain or "the preservation of environment with progress. Halfway measures simply delay the inevitable disaster" (¶ 194). The contemporary conception of the idea of "progress" needs to be redefined as leaving a better world to future generations and providing a higher *quality* of life—not by higher levels of consumption. He holds that "people's quality of life actually diminishes—by the deterioration of the environment, the low quality of food or the depletion of resources—in the midst of economic growth" (¶ 194). The concept of "sustainable growth" as opposed to "sustainable development" is often used as a subterfuge to obscure destruction of the environment and abuse of peoples in the name of profit—all cloaked in a greenwash of marketing. He holds that environmental protection must be an "integral part of the [sustainable] development process" (¶ 141).

> The principle of the maximization of profits, frequently isolated from other considerations, reflects a misunderstanding of the very concept of the economy ... [for] ... as long as the clearing of a forest increases production, no one calculates the

28 Frequently attributed to either Elizabeth Ann Seton (1774–1821) or Mahatma Gandhi (1869–1948), and although there is little evidence that either ever said it, the truth of the statement is not diminished by not knowing its origin.

> losses entailed in the desertification of the land, the harm done to biodiversity or the increased pollution. In a word, businesses profit by calculating and paying only a fraction of the costs involved (¶ 195).

Ecological and environmental economists have argued for decades for full-cost pricing that would include the costs of the damage to the environment, climate, and health in the cost of all goods and services, thus causing the market to reward good stewardship and punish environmental degradation and creation of sacrifice zones (Costanza et al., 2015; Daly & Cobb, 1994). As Pope Benedict XVI wrote, only when "the economic and social costs of using up shared environmental resources are recognized with transparency and fully borne by those who incur them, not by other peoples or future generations"[29] will there be social and environmental justice and equity. There should be a "greater sense of responsibility for the common good from those who wield greater power … [and] some economic sectors exercise more power than states themselves" (¶ 196).

Pope Francis suggests that we need "a politics which is far-sighted and capable of a new, integral and interdisciplinary approach to handling the different aspects of the crisis" (¶ 197). In effect, he endorses paradigm shifting as called for by human ecologists: "A strategy for real change calls for rethinking processes in their entirety, for it is not enough to include a few superficial ecological considerations while failing to question the logic which underlies present-day culture" (¶ 197).

Francis apologizes for misbegotten mistakes of the past by the Catholic Church with respect to human ecology:

> If a mistaken understanding of our own principles has at times led us to justify mistreating nature, to exercise tyranny over creation, to engage in war, injustice and acts of violence, we believers should acknowledge that by so doing we were not faithful to the treasures of wisdom which we have been called to protect and preserve (¶ 200).

He strongly urges all "religions to dialogue among themselves for the sake of protecting nature, defending the poor, and building networks of respect and fraternity" (¶ 201), since the majority of people on Earth profess to have religious beliefs. "The gravity of the ecological crisis demands that we all look to the common good, embarking on a path of dialogue which requires patience, self-discipline and generosity, always keeping in mind that 'realities are greater than ideas'" (¶ 201).

29 Benedict XVI, *Caritas in Veritate* (encyclical letter, June 29, 2009), 50: AAS 101 (2009), 686.

Ecological education and spirituality

The pope believes that "we lack an awareness of our common origin, of our mutual belonging, and of a future to be shared with everyone," and so "A great cultural, spiritual and educational challenge stands before us" (¶ 202). Citing Guardini (1998, p. 60), Francis agrees that compulsive consumerism is caused by the techno-economic paradigm; the gadgets of mass production become *the very forms of life itself*. "This paradigm leads people to believe that they are free as long as they have the supposed freedom to consume. But those really free are the minority who wield economic and financial power" (¶ 203). "When people become self-centered and self-enclosed, their greed increases. The emptier a person's heart is, the more he or she needs things to buy, own and consume. It becomes almost impossible to accept the limits imposed by reality" (¶ 204). Francis quotes Pope Benedict XVI, "the issue of environmental degradation challenges us to examine our lifestyle"[30] and goes on to write that "obsession with a consumerist lifestyle, above all when few people are capable of maintaining it, can only lead to violence and mutual destruction" (¶ 204).

He extolls consumer movements and boycotts that are designed to effect change by forcing businesses to modify their models of production, claiming there is a "great need for a sense of social responsibility on the part of consumers" (¶ 206). He goes on to quote his predecessor, Pope Benedict XVI, "purchasing is always a moral—and not simply economic—act."[31] Referring to the Earth Charter, he states: "As never before in history, common destiny beckons us to seek a new beginning … Let ours be a time remembered for the awakening of a new reverence for life, the firm resolve to achieve sustainability, the quickening of the struggle for justice and peace, and the joyful celebration of life,"[32] the same awakening called for by Thomas Berry's Ecozoic era (Berry, 2000). The pope holds that it is wrong that "we fail to set limits on ourselves in order to avoid the suffering of others or the deterioration of our surroundings," but we have "the moral imperative of assessing the impact of our every action and personal decision on the world around us" (¶ 208).

He finds that young people in the developed consumer-oriented countries "have a new ecological sensitivity and a generous spirit, and some of them are making admirable efforts to protect the environment" (¶ 209), yet he warns that they have grown up with the expectations of extreme consumption that will be difficult to change. The pope expresses satisfaction that contemporary environmental education has broadened to include a "critique of the 'myths' of a modernity grounded in a utilitarian mindset (individualism, unlimited progress, competition, consumerism,

30 Benedict XVI, Message for the 2010 World Day of Peace, 11: AAS 102 (2010), 48.
31 Benedict XVI, *Caritas in Veritate* (encyclical letter, June 29, 2009), 66: AAS 101 (2009), 699.
32 Earth Charter, The Hague (June 29, 2000) (earthcharter.org/discover/the-earth-charter/).

the unregulated market)" (Dyball & Newell, 2015; Korten, 2015), and goes on to suggest that "environmental education should facilitate making the leap towards the transcendent which gives ecological ethics its deepest meaning" (¶ 210).

He holds that the "existence of laws and regulations is insufficient in the long run to curb bad conduct, even when effective means of enforcement are present," and that if those laws are to be effective the majority of the people of a society must be virtuous enough and "adequately motivated to accept them, and personally transformed to respond" to "make a selfless ecological commitment" (¶ 211). "Reusing something instead of immediately discarding it, when done for the right reasons, can be an act of love," and, Francis reminds us, these good efforts will spread and cause change and positive good in the world, even if we are unaware of it! He holds that the family is the primary source of integral ecological education, being where we learn simple respect for each other and for our local ecosystem, and caring for all creatures. It is where we are taught gratitude and sharing and it creates a "culture of shared life and respect for our surroundings" (¶ 213). He stresses that "if we want to bring about deep change, we need to realize that certain mindsets really do influence our behaviour," for example, an appreciation for beauty is needed to defeat the paradigm of consumerism; without that appreciation "consumerism will continue to advance, with the help of the media and the highly effective workings of the market" (¶ 215).

Ecological conversion

Pope Francis encourages all Christians to develop an "ecological spirituality grounded in the convictions of our faith" (¶ 216). He admits that Christianity has in the past disassociated "the life of the spirit … from the body or from nature or from worldly realities" and urges a "communion with all that surrounds us" (¶ 216). Reflecting on Pope Benedict XVI's exhortation that "the external deserts in the world are growing, because the internal deserts have become so vast,"[33] Francis replies that "the ecological crisis is also a summons to profound interior conversion" (¶ 217). He reminds us that the teachings of Saint Francis of Assisi can help us to understand that "a healthy relationship with creation is one dimension of overall personal conversion … Living our vocation to be protectors of God's handiwork is essential to a life of virtue; it is not an optional or a secondary aspect of our Christian experience" (¶ 217). But, the pope warns that "social problems must be addressed by community networks and not simply by the sum of individual good deeds. The ecological conversion needed to bring about lasting change is also a community conversion" (¶ 219) that requires gratitude for creation and "entails a loving awareness that we are not disconnected from the rest of creatures, but joined in a splendid universal communion" (¶ 220),

33 Benedict XVI, "Homily for the Solemn Inauguration of the Petrine Ministry" (April 24, 2005): AAS 97 (2005), 710.

or as self-described gaeologian and Catholic priest and professor Thomas Berry put it, "the universe is a communion of subjects rather than a collection of objects" (Swimme & Berry, 1992, p. 243).

Pope Francis asks for all Christians to undergo a sacred ecological conversion that "can inspire us to greater creativity and enthusiasm in resolving the world's problems" (¶ 220). This conversion, according to the pope, would include

> the awareness that each creature reflects something of God and has a message to convey to us … that Christ has taken unto himself this material world and now, risen, is intimately present to each being … [and] God created the world, writing into it an order and a dynamism that human beings have no right to ignore (¶ 221).

Francis asks all Christians to "recognize and to live fully this dimension of their conversion," giving the invocation:

> May the power and the light of the grace we have received also be evident in our relationship to other creatures and to the world around us. In this way, we will help nurture that sublime fraternity with all creation which Saint Francis of Assisi so radiantly embodied (¶ 221).

Could not all peoples of the world take on a similar conversion within the framework of their world views or religious cosmologies? A conversion to the realization that all of life is sacred and interconnected, that we are all part of that hallowed interdependent web of existence, that Earth, and her creatures, including people, are holy and worthy of respect and care? That we must honor the Tao by learning to live in harmony with it? Could this conversion even encompass the growing numbers of the non-religious, or atheists? A conversion to the realization that the very existence of all living creatures, Earth, its ecosystems, its peoples, the biochemistry of life, the amazing ecological interdependencies, are all breathtaking, and should be honored and preserved? A deep awareness of the responsibility that being a part of this profoundly interconnected web requires cooperation to maintain it?

Joy and peace, civic and political love

Francis reminds us that "once we lose our humility, and become enthralled with the possibility of limitless mastery over everything, we inevitably end up harming society and the environment" (¶ 224) and:

> inner peace is closely related to care for ecology and for the common good because, lived out authentically, it is reflected in a balanced lifestyle together with a capacity for wonder which takes us to a deeper understanding of life … [and so] integral ecology includes taking time to recover a serene harmony with creation (¶ 225).

He applauds the act of giving thanks before a meal, for, among other things, "it strengthens our feeling of gratitude for the gifts of creation; it acknowledges those who by their labours provide us with these goods" (¶ 227).

The pope extends the Christian tradition of fraternal love to *all of creation*, "gratuitousness[34] inspires us to love and accept the wind, the sun and the clouds, even though we cannot control them. In this sense, we can speak of a 'universal fraternity'" (¶ 228). "An integral ecology is also made up of simple daily gestures which break with the logic of violence, exploitation and selfishness. In the end, a world of exacerbated consumption is at the same time a world which mistreats life in all its forms" (¶ 230).

Francis holds that social love is the key to causing positive change and sustainable development.

> Love for society and commitment to the common good are outstanding expressions of a charity which affects not only relationships between individuals but also "macro-relationships, social, economic and political ones,"[35] social love moves us to devise larger strategies to halt environmental degradation and to encourage a 'culture of care' which permeates all of society (¶ 231).
>
> Around these community actions, relationships develop or are recovered and a new social fabric emerges. Thus, a community can break out of the indifference induced by consumerism … These community actions, when they express self-giving love, can also become intense spiritual experiences (¶ 232).

Comparison with the philosophy of Deep Ecology

The philosophy of Deep Ecology is in many ways similar to Pope Francis's main points. Here is the Deep Ecology Platform, as articulated by philosophers Arne Næss and George Sessions in 1984 (Næss, 1993):

1. The well-being and flourishing of human and non-human life on Earth have value in themselves (synonyms: intrinsic value, inherent worth). These values are independent of the usefulness of the non-human world for human purposes.
2. Richness and diversity of life forms contribute to the realization of these values and are also values in themselves.
3. Humans have no right to reduce this richness and diversity except to satisfy vital needs.

34 Something freely given or received without payment or obligation.

35 Benedict XVI, *Caritas in Veritate* (encyclical letter, June 29, 2009) 2: AAS 101 (2009), 642.

4. The flourishing of human life and cultures is compatible with a substantially smaller human population. The flourishing of non-human life requires a smaller human population.
5. Present human interference with the non-human world is excessive, and the situation is rapidly worsening.
6. Policies must therefore be changed. These policies affect basic economic, technological, and ideological structures. The resulting state of affairs will be deeply different from the present.
7. The ideological change will be mainly that of appreciating life quality (dwelling in situations of inherent value) rather than adhering to an increasingly higher standard of living. There will be a profound awareness of the difference between bigness and greatness.
8. Those who subscribe to the foregoing points have an obligation directly or indirectly to try to implement the necessary changes.

The main discrepancy is with point number 4: Human population. Catholic teachings do not support efforts to limit the human population by birth control, each potential life being a gift from God. However, the other tenets of Deep Ecology resonate strongly with the message of Pope Francis in his powerful encyclical. Francis also adds admonitions to ecological spiritual renewal based on religious belief and Catholic moral teachings. But perhaps there can also be ecological spiritual renewal outside traditional religious practice.

Conclusions

Laudato Si' is a powerful and well-reasoned paean to environmental sanity from one of the most important moral voices of the world. It is a comprehensive, multifaceted argument for applied environmental ethics for individuals, corporations, countries, and the world community based not only on Catholic religious traditions and teachings but also grounded in scientific fact. Pope Francis calls for an ecological spiritual renewal that can be applied to Catholics, Protestants, Jews, Muslims, Buddhists, or to the non-religious. He forcefully argues for an integral ecology that recognizes humans as part of the interdependent web of existence which includes all of creation, the plants, animals, and ecosystems, all of which he considers sacred. He supports the necessity of using all different ways of knowing, including religion and science, sociology, economics, and the arts, to solve our existential environmental crises. He is passionate and convincing in his arguments for caring for our common home. Human ecologists have found an ally in Pope Francis.

Pope Francis ends his encyclical "Care for Creation" with two powerful prayers: *A Prayer For Our Earth* and *A Prayer in Union With Creation*. Here, in conclusion, are some excerpts:

Bring healing to our lives,
that we may protect the world and not prey on it,
that we may sow beauty,
not pollution and destruction.
Touch the hearts
of those who look only for gain
at the expense of the poor and the earth.
Teach us to discover the worth of each thing,
to be filled with awe and contemplation,
to recognize that we are profoundly united
with every creature.

Awaken our praise and thankfulness
for every being …

Give us the grace to feel profoundly joined
to everything that is.

Enlighten those who possess power and money
that they may avoid the sin of indifference,
that they may love the common good,
advance the weak,
and care for this world in which we live.

The poor and the earth are crying out.

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The Structure and Coherence of the New Environmental Paradigm: Reconceptualizing the Dimensionality Debate

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Abstract

This research examines the structure and coherence of an emerging environmental world view as measured by the new environmental paradigm (NEP) scale, developed by Dunlap and Van Liere (1978). We utilize data from two independent surveys of three communities in Colorado and Wyoming, United States, in 1997 and 2012, and examine the extent to which this world view has been accepted by the general public. Using factor analysis, we focus our attention on the structure and coherence of the NEP, as well as the dimensionality of this scale, revisiting the original question raised by Dunlap and Van Liere of whether a coherent ecological world view has emerged among the general public at this point in time. Comparisons between the two surveys reveal that both the structure and coherence of the NEP are highly consistent and stable over time, lending support to the belief that the general public within our study areas has indeed developed such a world view.

Keywords: belief constraints, belief systems, environmental beliefs, environmental world view, new ecological paradigm, new environmental paradigm

Introduction

In the midst of heightened public concern for environmental issues from the late 1960s through the 1970s, Dunlap and colleagues among several social researchers believed there might be a paradigmatic shift in society, a new ecologically oriented world view named the new environmental paradigm (NEP), emerging to challenge

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the anti-ecological dominant social paradigm (DSP) (see Dunlap, 2008 for a review). The DSP reflects the prevailing values and beliefs that favor a free-market economy, advancements in science and technology, as well as never-ending growth and progress, which were argued by many as one major cause of more and more salient environmental problems. The NEP, in contrast, represents such beliefs that there is an inevitable limit to economic growth, and that humans are not above nature, but instead depend on an ecologically balanced nature to survive (e.g., Dunlap & Van Liere, 1978; Pirages & Ehrlich, 1974). To capture this change in the world view regarding human–environment relations, Dunlap and Van Liere (1978) created an instrument, the NEP scale, which was updated to the new ecological paradigm (still NEP) scale in 2000. Development of the updated scale was for the purpose of uncovering a wider range of factors that potentially comprise an ecological world view, offering a better balance of pro- and anti-environmental items, and updating the terminology of the specific items (Dunlap et al., 2000). The NEP scale has since become the most widely used measure of environmental concern worldwide (Hawcroft & Milfont, 2010).

Naturally, such a widely used instrument has received a great deal of criticism regarding its measurement quality (Amburgey & Thoman, 2012; Dunlap et al., 2000; Hawcroft & Milfont, 2010). One of the most persist criticisms is that the NEP scale is not unidimensional (Dunlap, 2008). Almost immediately after the creation of the original NEP scale, Albrecht et al. (1982) found that although the scale appears to have adequate internal consistency and validity, it seems to have three dimensions that are only mildly interrelated. This tripart factor structure was then somewhat confirmed by Geller and Lasley (1985). Since that time, a number of studies have found that the NEP scale, in both the original and the revised versions, has two or more dimensions (e.g., Bechtel et al., 2006; Corral-Verdugo & Armendariz, 2000; Edgell & Nowell, 1989; Englis & Phillips, 2013; Fleury-Bahi et al., 2015; Furman, 1998; Gooch, 1995; Noe & Snow, 1990; Schuett & Ostergren, 2003; Woodworth et al., 2011).

It is noticeable, however, that there seems to be little consensus on the factor structure of the NEP scale, in terms of both the number of factors and which individual items load on which factors (Hawcroft & Milfont, 2010). A significant amount of disagreement in the empirical findings has led Dunlap et al. (2000) to argue that most findings are likely sample-specific, and therefore there is not yet decisive enough evidence to draw conclusions about the multidimensionality of the NEP scale. We believe the current empirical literature on the dimensionality of the NEP scale is rather difficult to make sense of, given the lack of a consensus on the factor structure of the NEP.

We believe a more productive alternative is to return to the original question when the scale was created almost four decades ago. While it appears that academics and intellectuals endorse the world view as measured by the NEP scale, to what

extent has such a world view been accepted by the general public (Dunlap & Van Liere, 1978)? By raising this question, we argue it is time to reconceptualize the dimensionality debate as more than a methodological issue, even though the methodological concern remains important in this debate. Instead, we should pay attention to a more conceptual question: what is the status of the supposed paradigmatic shift from the DSP to the NEP for the general public? In this paper we first lay out the reasons why we believe this alternative approach will be more productive. Then we reexamine the factor structure of the original NEP scale using data from identical surveys conducted at two different points in time to demonstrate there is a significant amount of evidence for an ecological world view with regard to the general public.

The dimensionality debate

Much of the attention on the dimensionality of the NEP scale is methodological in nature. As in the case of any multi-item scale, it is critical to make sure that all items measure the same underlying construct, which necessitates examination of a scale's internal consistency and dimensionality. Up to this point, we can see studies demonstrating that the 12–15 items in the original and revised NEP scales load onto two (e.g., Gooch, 1995; Ji, 2004; Noe & Snow, 1990; Nooney et al., 2003; Van Riper & Kyle, 2014), three (e.g., Albrecht et al., 1982; Edgell & Nowell, 1989; Englis & Phillips, 2013; Geller & Lasley, 1985), four (e.g., Erdogan, 2013; Furman, 1998; Khan et al., 2012), and even five or more underlying factors (e.g., Brennan et al., 2014; Woodworth et al., 2011; Wu, 2012). Furthermore, while some studies find factors corresponding to the hypothesized facets as identified in Dunlap and Van Liere (1978) and Dunlap et al. (2000) (e.g., Albrecht et al., 1982; Amburgey & Thoman, 2012; Woodworth et al., 2011), most studies do not.

Aside from the obvious variations in the samples (time, place, population, etc.) used in these studies, several other methodological reasons may also contribute to the cross-study variation summarized above. First, Hawcroft and Milfont (2010) demonstrate that both the length of the NEP scale (6, 12, or 15 items) and the choices of items (in studies not using the full scales) can affect the findings on the factor structure of the NEP. Second, many studies using one form of exploratory factor analysis (e.g., Brennan et al., 2014; Englis & Phillips, 2013; Ji, 2004; Noe & Snow, 1990; Woodworth et al., 2011; Wu, 2012) tend to find factors that mostly reflect sample-specific methodological artifacts, such as survey question wording direction (see a review of this issue in Dunlap et al., 2000). Third, scholars also use different practices when interpreting results that can cause inconsistencies in their interpretation of findings. Some results on model-fit or interfactor correlations that were judged as supporting the multidimensional claim in the past (e.g., Geller & Lasley, 1985; Nooney et al., 2003) could actually be interpreted differently depending on the criteria used. In fact, Dunlap (2008) argues that some measures of unidimensionality may be unrealistic.

In sum, the current literature on the dimensionality of the NEP scale, although considerable, is largely inconclusive, as it was prior to 2000 (Dunlap et al., 2000). Much of the attention on dimensionality focuses on methodological issues, while implicitly assuming there is a coherent ecological world view that can be observed at this point, and therefore the debate is whether the NEP scale is adequate to capture it. We argue that this implicit assumption itself needs further attention.

Reconceptualizing the dimensionality of the NEP

A high degree of coherence of the NEP scale is of crucial importance if we are to treat the NEP as an ecological world view (e.g., Dunlap & Van Liere, 1978; Dunlap et al., 2000; Guber, 1996; Nooney et al., 2003; Pierce & Lovrich, 1980). Switching the focus of attention to the structure and coherence of the NEP is essentially going back to the aforementioned question for which the NEP scale was originally designed: is there a coherent ecological world view that has emerged among the general public at this point? Indeed, this switch would then turn the debate on the dimensionality of the NEP from a simplistic dichotomous question—is the NEP uni- or multi-dimensional—into a much more dynamic discussion on the degree of coherence of the NEP across time, samples, and even cultures, as well as the variables that may influence the coherence of the NEP.

Of course, to enable such a discussion of the coherence of the NEP in a comparative approach using the NEP scale, one necessary condition is needed: that the NEP scale is a valid and reliable measure. For this assertion, the current literature provides ample support. First, as Dunlap and colleagues (Dunlap 2008; Dunlap & Van Liere, 1978; Dunlap et al., 2000) illustrate, the construction of the NEP scale is theoretically guided (although not in the sense of attitude theory as Dunlap points out regretfully in his 2008 retrospective essay). The NEP scale primarily targets the main elements of the DSP, which includes (as Pirages & Ehrlich, 1974, among others, point out) a belief in unlimited resources, a commitment to progress and continuous economic growth, faith in science and technology, and a strong endorsement of a laissez-faire economy and private property (also see Kilbourne & Beckmann, 2001; Milbrath, 1984; Takács-Sánta, 2007). This helps to explain the choice of facets included in the 1978 version of the NEP scale and the later updated 2000 version.

Second, the validity and reliability of the NEP scale are well established in the empirical literature (e.g., Dunlap et al., 2000; Hawcroft & Milfont, 2010). Even on the dimensionality front, we see that many studies find the NEP scale likely unidimensional within certain groups and populations (e.g., Bechtel et al., 1999; Edgell & Nowell, 1989; Lee & Paik, 2011; Noe & Snow, 1990; Rideout, 2014; Rideout et al., 2005). Others report strong interfactor correlations, suggesting a high degree of internal consistency (e.g., Fleury-Bahi et al., 2015; Nooney et al., 2003).

We therefore argue that it is reasonable to treat the NEP scale as a valid and reliable measure, and that we can reinterpret the many findings of multidimensionality as not showing the inadequacy of the NEP scale, but revealing the variation in the degree of coherence of the NEP within different groups and populations. Indeed, as a new social paradigm, it would be unrealistic to expect that the NEP be universally and consistently accepted in human societies shortly after it emerges. On the contrary, we might anticipate fluctuations in the degree of acceptance and hence the coherence of the NEP over time and across samples and cultures. In fact, as Dunlap (2008, p. 15) points out, the diffusion of an ecological world view has been slow, the proponents of the DSP have mounted powerful and effective opposition to the spread of the NEP, and "we are in the midst of a paradigm war, with two sides attempting to give highly divergent interpretations of ecological realities."

In the literature, several scholars similarly argue that an ecological world view may just be emerging, and still lacks widespread acceptance by the general public, often using the multidimensionality as supporting evidence (e.g., Brennan et al., 2014; Corral-Verdugo & Armendariz, 2000; Erdogan, 2013; Khan et al., 2012; Wu, 2012). Some (e.g., Takács-Sánta, 2007, p. 31) argue for the importance of recognizing key barriers to sustained environmental concern, such as a faith in science and technology or a tendency of media sources to "defend the status quo"; while others (e.g., Lawrence & Abrutyn, 2015) point to the slowly emerging knowledge of the interconnectedness of ecosystems, and the need for an expansion of what a society acknowledges as "local" environmental issues.

Thus, it is important to continue tracking changes in the ecological world view within different groups and populations. One promising approach is to take insights from the belief-systems perspective that has originated from political science. The belief-systems perspective developed by political scientist Philip Converse defines a belief system as "a configuration of ideas and attitudes in which the elements are bound together by some form of constraint or functional interdependence," where constraint means "the success we would have in predicting, given initial knowledge that an individual holds a specified attitude, that he holds certain further ideas and attitudes" (Converse 1964, p. 207). Constraint as so defined refers to the interconnectedness among different beliefs within the same presumed belief system. As such, the NEP can be seen as a belief system, and its coherence can be reconceptualized as "belief constraint" at the group level because it also concerns interrelations among different beliefs within a given group.

The structure and coherence of the NEP as a belief system

In the literature of environmental concern, Pierce and Lovrich (1980) were among the first to use the belief-system perspective and found in their empirical study of environmental belief systems that "beliefs about specific environmental issues seem to fit together on a single dimension, thus suggesting some underlying

concept or fundamental orientation to which these beliefs are mutually connected" (Pierce & Lovrich, 1980, p. 261). Later, Pierce et al. (1987, p. 64) define belief constraint as "the extent to which an individual's beliefs are bound together or integrated into a larger, single complex," consistent with the definition offered by Converse (1964). According to Pierce and colleagues, environmental concern as a belief system clearly reflects belief constraint. However, deHaven-Smith (1991) argues, based on empirical studies of one national and one Florida survey, that the general public's environmental belief system tends to be largely fragmented, localized, and issue-specific, or lacks belief constraint. In these studies, the debate on the dimensionality of environmental concern evolved into an examination of the existence of belief constraint within the environmental belief system.

A number of studies explicitly apply the belief-system perspective to examine the NEP. Pierce et al. (1989) examine the organization of an environmental belief system using a 6-item NEP scale derived from the original 1978 12-item NEP scale, with attention not on the dimensionality of the scale, but on the conceptual structure across different samples. Nooney et al. (2003, p. 765) interpret the persistent debate on the dimensionality as a reflection on the lack of agreement regarding whether the NEP is a unified system of beliefs, and therefore argue that attention is needed on the "magnitude and direction of covariance between latent factors" to gain insight about "the cultural organization of environmental world views." Woodworth et al. (2011), on the other hand, argue their analysis affirms an emerging consensus that the NEP measures a coherent set of environmental beliefs; or an environmental paradigm or world view.

Several studies (Bechtel et al., 2006; Bechtel et al., 1999) use the NEP scale as a measure of an environmental belief system and examine how culture may influence the structure of environmental beliefs in cross-national comparative research. Results from these studies show that, in general, the NEP in the United States tends to show a higher degree of coherence than elsewhere. Several others compare and contrast the factor structure of the NEP cross-nationally and find significant variations, but do not apply the belief-systems perspective explicitly (e.g., Brennan et al., 2014; Denis & Pereira, 2014).

In sum, studies utilizing the belief-systems perspective show a general shift of attention from methodological concerns on the adequacy of the NEP scale to interesting questions on the existence of and changes in an environmental world view. Dunlap (2008) in his review of the 30-year history of the NEP scale specifically calls for additional studies of this kind, applying the belief-systems perspective so that we can document variation in both the structure and coherence of an environmental world view. In our current study, we answer to this call.

Analysis strategy

In this study, we obtained data from two independent surveys, one in 1997 and the other in 2012, held in three communities in Colorado and Wyoming, United States (more on this later). Both surveys used identical questionnaires, providing a good opportunity to examine and compare the structure and coherence of the NEP between two time points within the same geographic areas. To accomplish this, we followed the literature to make use of a theory-driven confirmatory factor analysis (CFA). CFA is known to be superior to exploratory factor analysis, for it has the ability to incorporate and test a preset factor structure commonly proposed in the literature, and also to run statistical tests for significances while controlling potential sample-specific correlations among measurement errors (e.g., Geller & Lasley, 1985; Guber, 1996; Nooney et al., 2003; Xiao & Dunlap, 2007).

Because the first survey in this study took place in 1997, prior to the publication of the revised NEP scale, we examined the original NEP scale for the 2012 survey as well, for comparison purposes. According to Dunlap and Van Liere (1978), the original NEP scale was designed to capture three primary aspects of the new social paradigm: limits to growth (LG), balance of nature (BN), and anti-anthropocentrism (AA). We therefore modeled each as a latent factor in our analysis. Each latent factor has four survey items as measurement indicators (a total of 12 items). To examine whether these three latent factors form a coherent ecological world view as Dunlap and Van Liere (1978) argue, we modeled one higher-order latent factor named "NEP" as measured by these three first-order latent factors, effectively forming a higher-order CFA as described in Amburgey and Thoman (2012). We fit this model to the data of both surveys simultaneously, using a multigroup modeling technique to increase estimation efficiency (see Byrne, 2012, for more technical details). Table 1 displays these 12 items and their corresponding latent factors and Figure 1 shows the path diagram of our CFA model.

Table 1. Twelve items of the new environmental paradigm scale and their corresponding factors

Variable	Wording**	Factor
NEP1	We are approaching the limit of the number of people that the Earth can support.	Limits to growth
NEP2	The balance of nature is very delicate and easily upset.	Balance of nature
NEP3*	Humans have the right to modify the natural environment to suit their own needs.	Anti-anthropocentrism
NEP4*	Humankind was created to rule over the rest of nature.	Anti-anthropocentrism
NEP5	When humans interfere with nature, it often produces disastrous consequences.	Balance of nature
NEP6*	Plants and animals exist primarily to be used by humans.	Anti-anthropocentrism
NEP7	To maintain a healthy environment, we will have to develop a "steady state" economy where industrial growth is controlled.	Limits to growth

Variable	Wording**	Factor
NEP8	Humans must live in harmony with nature in order to survive.	Balance of nature
NEP9	The Earth is like a spaceship with only limited room and resources.	Limits to growth
NEP10*	Humans don't need to adapt to the natural environment, because they can remake it to suit their needs.	Anti-anthropocentrism
NEP11	There are limits to growth beyond which our industrialized society cannot expand.	Limits to growth
NEP12	Humankind is severely abusing the environment.	Balance of nature

*These four items are worded in an anti-NEP direction. Reverse coding is performed on them in our confirmatory factor analysis. **Respondents were asked to indicate whether they agree or disagree with the listed statements, using a Likert scale (*strongly agree, agree, neutral, disagree, strongly disagree*).

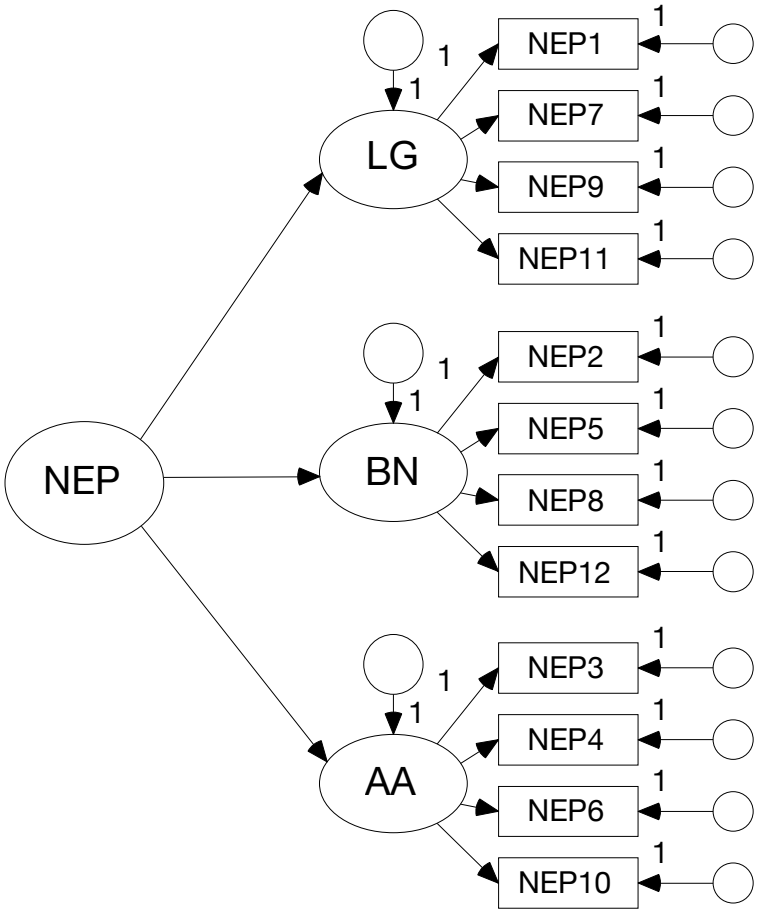

Figure 1. Path diagram of a higher-order confirmatory factor analysis examining the structure and coherence of the new environmental paradigm scale

Note. See Table 1 for details of all latent and observed variables.

Methodology

Samples, data, and study areas

The 1997 survey used in this study is based on initial work by Nielsen and Ellington (1983), and includes the original NEP scale items, as well as additional questions on recycling and other environmentally conscious behaviors, attitudes on environmental policies, and demographics. The samples used in this survey were developed in 1997 and included three communities in Colorado and Wyoming, United States. An initial random sample of 200 households was collected for one community (Park Hill, part of the greater Denver, Colorado, area). Two additional random samples of 200 households were developed for Loveland, Colorado and Cheyenne, Wyoming. These three communities were chosen specifically because of the different levels of recycling services available to residents in 1997.

Loveland is a city of just over 70,000 in 2012, increasing from 46,000 in 1997,[2] located approximately 50 miles north of Denver and approximately 60 miles southwest of Cheyenne. Politically, the City of Loveland is a "mixed" community of more politically conservative and more liberal residents. According to the US Census in 2010, 38% of voters were registered as Republican, 37% of registered voters were non-partisan, and 23% were registered as Democrats. This community is primarily Caucasian/white (91% in 2010, down just slightly from 93% in 2000).

The community of Park Hill is part of the larger Denver metropolitan area, and had a population in 2010 of just over 29,700 (up from 27,000 in 1997). While political party information is not available for the Park Hill neighborhood specifically, the larger Denver area tends to be more heavily Democratic (48% of registered voters in 2010), while non-partisan voters made up 35%, and Republicans made up 15% of registered voters in 2010. In 1990, this community had a larger percentage of African-American residents (60%), as compared to whites/Caucasians (34%) (Park Hill Neighborhood Plan, 2000, p. 100).

The City of Cheyenne, Wyoming, had a population of 61,600 in 2012, up from 54,000 in 1997. This community is primarily white/Caucasian (87% in 2010 and 88% in 2000), and included a majority of Republican voters (60 per cent), as compared to those registered Democratic (28%) and non-partisan (11 per cent).

The mean rate of return for the 1997 study was 60% (Loveland 62%, Cheyenne 59%, and Denver 60%). For the 2012 survey, we used identical addresses for each of the three communities. Where identical addresses were not available, addresses were substituted (by a random selection process) from identical census blocks, with updated names provided by the Public Works departments for the cities of Loveland

2 Demographic data cited in this section is from the U.S. Census: censusviewer.com

and Cheyenne, and by the Greater Park Hill Neighborhood Association for the Park Hill community. The mean rate of return for the 2012 study was 63.7%—slightly higher than for the 1997 survey (Loveland 62%, Cheyenne 64%, and Denver 65%).

Over the 15-year time span, it is likely that a majority of surveys were not completed by the same individuals who participated in the 1997 study. Core demographics for each of the three communities varied somewhat between the two survey years. Using multiple analysis of variance tests, we found statistically significant differences between the 1997 and 2012 samples ($p < .05$) for both age and education. The 2012 sample included a greater percentage of individuals in the 65+ age category, as well as a greater number of individuals holding college degrees. Similarly, we found that gender and income demographics were significantly different between the two years. The 2012 sample included a higher percentages of females and those with more than $60,000 annual household income as compared to respondents in 1997 (see Table 2 for more details). Although comparisons of the demographic differences between these three communities is beyond the scope of the current study, an advantage we find in using these samples is that the study populations are not overly homogenous, allowing for a greater degree of generalizability to larger populations. However, we must note that this is a rather small sample from just a few communities in two states of the United States, thus our ability to make generalizations to broader areas is still limited.

Table 2. Descriptive statistics of the samples in 1997 (N = 364) and 2012 (N = 382)

Variables	Year	Coding				
Age*		**18–25**	**26–40**	**41–65**	**65+**	
	1997	2.92%	28.90%	48.38%	19.81%	
	2012	1.36%	16.08%	42.51%	40.05%	
Income*		**Under $30k**	**$30–60k**	**Over $60k**		
	1997	29.06%	35.31%	35.63%		
	2012	16.96%	32.14%	50.89%		
Education*		**< High school**	**High school**	**Some college**	**College**	**Graduate degree**
	1997	4.67%	13.74%	30%	25%	21.15%
	2012	1.05%	13.61%	28.01%	25.13%	27.23%
Gender*		**Male**	**Female**			
	1997	43.13%	50.27%			
	2012	38.74%	55.24%			

*Statistically significant difference found between 1997 and 2012 ($p < .05$).

Dunlap (2008) notes that the United States culture is in the midst of a paradigm shift, gradually moving away from the tenets of the dominant social paradigm toward a belief system that puts a greater level of priority on environmental quality and protection. However, he also notes that this new paradigm has come under significant attack and

criticism for the last few decades by those whose interests would be negatively affected by substantial shifts away from fossil fuels and many other aspects of consumer culture. For this reason, it is important to measure the degree of belief constraint over time (in the case of the current study, a 15-year period) to assess the extent to which environmental beliefs and concern have held steady or been influenced by those who continue to call into question the reality of climate change, or the need to find both short- and long-term alternatives to fossil fuels, for example.

Table 3 reports frequency distributions for the 12 NEP items for the two years. We tested differences in these 12 items between the two years and found none that were statistically significant.

Table 3. Frequency distribution (%) of the new environmental paradigm items in 1997 (*N* = 364) and 2012 (*N* = 382)

Variable*	Year	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
NEP1	1997	16.67	33.33	22.50	16.11	6.11
	2012	18.32	32.72	22.77	15.45	6.02
NEP2	1997	31.67	39.17	13.33	10	2.50
	2012	30.37	37.70	17.28	7.33	3.40
NEP3	1997	1.67	11.67	19.72	41.67	21.39
	2012	3.40	11.78	20.68	44.76	15.18
NEP4	1997	8.06	11.39	17.50	29.17	29.17
	2012	7.33	10.21	14.14	31.15	32.46
NEP5	1997	24.17	45.56	13.06	8.33	4.44
	2012	22.77	39.79	19.90	8.90	4.45
NEP6	1997	7.50	11.11	17.78	36.67	21.94
	2012	4.71	10.21	17.54	37.43	25.65
NEP7	1997	13.89	34.17	31.11	10.28	5.28
	2012	12.83	31.41	32.46	11.26	5.76
NEP8	1997	42.22	43.06	6.94	1.39	1.67
	2012	39.79	41.36	8.38	3.40	2.88
NEP9	1997	30.83	38.33	13.89	8.89	2.50
	2012	24.87	37.70	17.02	10.99	3.93
NEP10	1997	1.94	6.94	10.56	39.44	34.72
	2012	1.05	3.40	13.09	43.72	33.77
NEP11	1997	20.83	40.28	22.50	6.94	2.22
	2012	14.92	36.39	27.49	9.69	4.19
NEP12	1997	31.94	40.00	13.06	7.50	3.06
	2012	30.37	34.82	18.32	6.54	5.24

Note. No statistically significant difference found between 1997 and 2012 in any comparison.

*For descriptions of each variable, see Table 1.

We examined patterns of missing data before we estimated our confirmatory factor analysis model. We found that 28 cases had missing values on at least 10 NEP items and hence were deleted from the data set. For the remaining missing data, we chose to impute them using an imputation tool included in the statistical software Mplus 7.11. To account for random errors that may occur during this imputation process, particularly considering the relatively small sample size, we followed Rubin (1987) to obtain five imputed data sets, which we then analyzed to provide five sets of model results. Our final results were acquired by properly averaging results from these five sets of results (see Rubin, 1987, for more technical details).

With missing data dealt with, we proceeded to model estimation using Mplus 7.11. Table 4 reports relevant model estimation results. Mplus provides multiple indexes to gauge how well our model fits the sample data (reported in Table 4). These model-fit indexes generally show this model has acceptable to good fit, with > 0.95 comparative fit index and Tucker-Lewis index, as well as a reasonably small root mean square error of approximation (RMSEA = 0.07).

Table 4. Results of a higher-order confirmatory factor analysis examining the structure and coherence of the new environmental paradigm scale

		Standardized loadings (standard error)	
First-order factors	**Item**	**1997 (*N* = 351)**	**2012 (*N* = 367)**
LG (limits to growth)	NEP1	0.60 (0.04)	0.60 (0.04)
	NEP7	0.64 (0.04)	0.70 (0.03)
	NEP9	0.73 (0.04)	0.71 (0.04)
	NEP11	0.70 (0.04)	0.70 (0.03)
BN (balance of nature)	NEP2	0.77 (0.03)	0.84 (0.02)
	NEP5	0.71 (0.03)	0.68 (0.03)
	NEP8	0.77 (0.03)	0.73 (0.03)
	NEP12	0.81 (0.03)	0.83 (0.02)
AA (anti-anthropocentrism)	NEP3	0.73 (0.04)	0.70 (0.03)
	NEP4	0.74 (0.04)	0.79 (0.03)
	NEP6	0.62 (0.05)	0.70 (0.04)
	NEP10	0.67 (0.04)	0.75 (0.04)
Second-order factor		**Standardized loadings (standard error)**	
NEP	LG*	0.85 (0.03)	0.96 (0.03)
	BN	0.99 (0.03)	0.95 (0.02)
	AA	0.74 (0.05)	0.74 (0.04)
Interfactor correlations		**Correlations (standard error)**	
LG and BN		0.84 (0.03)	0.91 (0.02)
LG and AA		0.63 (0.05)	0.71 (0.04)
BN and AA		0.73 (0.04)	0.70 (0.04)

Model-fit statistics	
Chi-square/degree of freedom	313.06/113
RMSEA (root mean square error of approximation)	0.07
CFI (comparative fit index)	0.97
TLI (Tucker-Lewis fit index)	0.97

Note. All factor loadings and correlations are statistically significant ($p < .05$). Interfactor correlations are estimated using an alternative model that has no second-order latent factor but only three correlated first-order latent factors.

*Statistically significant difference found between the two loadings ($p < .01$).

Results and discussions

We begin with a discussion of results related to the structure of the NEP scale, which examines the conceptual integrity of the NEP. First, each NEP item has a strong factor loading (0.60–0.84) on its hypothesized latent factor in both years. Second, each first-order latent factor has a very strong (0.85–0.99) loading on the second-order latent factor, the NEP. Thus, our model confirms the overall factor structure as proposed in Dunlap and Van Liere (1978), that the NEP scale has three facets as conceptually designed—limits to growth, balance of nature, and anti-anthropocentrism—which all then load onto the same overarching world view named the NEP.

It is important to note that many second-order loadings are significantly less than 1.00. Indeed, a Wald test of model-fit differences between this current model and an alternative model with all 12 items loading onto one single latent factor shows statistical significance (Chi-square = 52.67, degree of freedom = 6, $p < .05$), indicating that our current trifactor model fits the data significantly better than the one-factor model. Thus, this current model fails to confirm a unidimensional factor structure. However, the very strong second-order factor loadings show that the three first-order latent factors have very high covariances between them. We used an alternative model that has no second-order latent factor but only three correlated first-order latent factors to obtain estimations of interfactor correlations (also reported in Table 4). Results show that the three latent factors (LG, BN, and AA) are highly correlated with one another. The correlation between LG and BN is especially high in both years, while AA is a relatively distinct facet, as is often found in the literature (Dunlap et al., 2000). Therefore, we conclude that the NEP scale has a multidimensional factor structure with three strongly correlated underlying factors.

We now turn our attention to the coherence of the NEP. As discussed above, coherence can be conceptualized as belief constraint at the group level that refers to the interconnectedness among different beliefs within the belief system. Thus,

coherence is a matter of degree. In the framework of factor analysis, factor loadings display how closely survey items connect to the hypothesized underlying concepts. Therefore, factor loadings can illustrate the degree of interconnectedness. However, one problem is that there is no widely agreed objective standard, or a cutoff value, that we can use to judge the interconnectedness, making the evaluation of factor loading magnitude ultimately arbitrary.

In the literature of factor analysis, a number of cutoff values of factor loading are used, ranging from 0.20 to 0.70; 0.40 is the most commonly used, 0.30 the second, and 0.50 the third (Peterson, 2000). Our results show that even the lowest of all first-order factor loadings, 0.60 to be exact, is above the more restrictive common cutoff of 0.50. For the 1997 survey, all 12 first-order factor loadings have a range of 0.60–0.81 and a mean of 0.71; for 2012 the range is 0.60–0.84 and the mean 0.73. Therefore, it is reasonable to conclude that all three facets (LG, BN, and AA) have a good degree of coherence within each individual facet. Furthermore, all three facets strongly load onto the second-order latent factor, the NEP, with all loadings above even the highest cutoff of 0.70. For 1997, the second-order factor loadings have a range of 0.74–0.99 and a mean of 0.86; for 2012 the range is 0.74–0.96 and the mean 0.88. Thus, we conclude the NEP within the two samples of our study has a high degree of coherence or belief constraint.

Next, we compare results of the two years. Our first step is to compare the overall factor structure between the years, which examines how stable the conceptual structure of NEP has been over the years. As already mentioned, our analysis suggests the same factor structure exists in both years, essentially confirming that the NEP has three correlated facets as hypothesized (Table 4). In the second step, we compare, one by one, each of the 12 first-order factor loadings. These factor loadings are remarkably consistent between the two years. In fact, none of the 12 tests for factor loading differences is statistically significant.

Lastly, we compare the three pairs of second-order factorings. Once again, these loadings are quite consistent between the two surveys, with only one statistically significant result showing that limits to growth loads significantly higher on the NEP in 2012 than 1997 ($p < .001$). However, since both loadings are already very high at 0.96 and 0.85, respectively, this difference is of little substantive meaning. With these comparisons, we conclude that the NEP has the same factor structure and degree of coherence in both years of 1997 and 2012.

Because the above comparison also largely establishes measurement invariance between the two independent samples (Byrne, 2012), we took the opportunity to conduct tests for differences in latent means, first of the three facets, then of the overall NEP, between the years. No results were statistically significant, indicating no significant change found in the levels of endorsement of the NEP between 1997 and 2012. With this finding of the same levels of endorsement, and also the findings

of the same factor structure and degree of coherence in the years of 1997 and 2012, we conclude that the NEP has remained conceptually stable between the two survey years, even though the two independent samples are significantly different from one another in terms of age, household income, education, and percentages of males and females.

With the above results, we now have a similar situation to that of several previous studies (e.g., Amburgey & Thoman, 2012; Nooney et al., 2003), where the NEP is found to be multidimensional, but the underlying factors are closely correlated with one another. How then, should we draw conclusions about the coherence of the NEP, enough to support the existence of an environmental world view? We believe that despite the finding of multidimensionality, there is ample support for a coherent environmental world view that also exhibits remarkable stability within the general public, at least in the study areas of our two surveys.

As previously mentioned, we believe that some criteria for unidimensionality and hence the existence of a coherent world view is unrealistic. The NEP scale, both the original and revised versions, is designed to capture a set of different but connected beliefs or views regarding the relationship between human society and the environment. In the framework of confirmatory factor analysis, this means a model with multiple latent factors. A unidimensional model means one single latent factor, either at the first order with all measurement items loading onto it, or at the second order with each first-order latent factor loading onto it perfectly. Thus, to achieve unidimensionality, one would need to find no statistically significant difference in the model-fit comparison between these two models, effectively testing against the null hypothesis that all first-order latent factors have either interfactor correlations or standardized factor loadings at 1.00. Such a null hypothesis is unreasonably strong and restrictive, not only because a magnitude of 1.00 for correlation or factor loading is typically unattainable in real-world research, but also that it is somewhat unfair, since in exploratory factor analysis we almost never expect the loadings of survey items to approach 1.00 (e.g., Peterson, 2000). We thus argue that multidimensionality does not necessarily deny the existence of a coherent belief system without a careful examination of the coherence indicators, such as second-order factor loadings and interfactor correlations.

Conclusion

In this study, we used data from two independent surveys of three communities in Colorado and Wyoming in 1997 and 2012 to examine the structure and coherence of an environmental world view as measured by the NEP scale. We propose that the debate on the dimensionality of the NEP scale be reconceptualized as variation in the factor structure and degree of coherence of the NEP, or, in the terminology of

belief-systems perspective, the degree of belief constraint. Our results show that, similar to several previous studies (e.g., Amburgey & Thoman, 2012; Nooney et al., 2003), the NEP in our study area is likely multidimensional with three facets—limits to growth, balance of nature, and anti-anthropocentrism—but these three facets are highly correlated with one another, indicating a high degree of coherence or belief constraint. Comparisons between the two years reveal that both the structure and coherence of the NEP are highly consistent over time, displaying remarkable stability. With such findings, we believe that the general public within our study areas indeed has a coherent environmental world view.

Next, we offer several insights for future research, reflecting upon the limitations of the current study. First, our study employs the original version of the new environmental paradigm scale, not the updated new ecological paradigm scale. We believe future studies should reexamine the stability and coherence of the NEP using this newer version of the NEP scale with a longitudinal design. Second, because this study has its origin in research for a doctoral dissertation, it uses small samples that are limited to a few local communities in only two states within the United States. It will be important to expand the research onto the national and international levels. Finally, the finding of the remarkable stability of the NEP also deprives us of the chance to look into additional factors that may influence the structure and belief constraint. As we mentioned earlier, there are reasons to be cautious about the extent to which the general public may have adopted this new social paradigm/world view. For this reason, it is crucial to anticipate variation in the coherence of the NEP and study its causes. Several cross-national studies (e.g., Bechtel et al., 2006; Bechtel et al., 1999) use a comparative research design to demonstrate that cultural differences may influence the structure and belief constraint of the NEP. Similarly, Aoyagi-Usui et al. (2003) and Heyd (2010) highlight the importance of examining cultural norms and traditions in terms of their impact on environmental values and beliefs. We thus call for more such research in the future.

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Book Reviews

Environmental Sociology: The Ecology of Late Modernity

By Thomas J. Burns and Beth Schaefer Caniglia

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Reviewed by Jennifer E. Givens[1]

Burns and Caniglia's book is an excellent new addition to the growing catalog of resources for teaching environmental sociology and related disciplines to both undergraduate and graduate students. Developing from the authors' own experience teaching such classes, this book highlights how environmental sociology is uniquely positioned to improve our ability to understand and address our "wicked" (p. 15) environmental problems. By providing an accessible introduction to the origins of sociology and the sociological perspective, this book will be useful for students familiar with sociology and especially useful for those coming to the class with an interest in the environment but less familiarity with the sociological approach.

The book makes a connection between the historical origins of sociology, a discipline originally concerned with understanding the social upheaval caused by the transition to modernity, and the resulting environmental problems we now face in this time of late modernity. The authors identify these environmental problems as especially "wicked" because humans now have the technological capability and act on a scale that enables the creation of problems we are not able to readily solve. This aligns with Crutzen's (2002:23) identification of the Anthropocene era in which humankind's relationship with the environment has grown to become "human-dominated." Despite this focus on problems and acknowledgment of their scale and complexity, Burns and Caniglia still take a decidedly optimistic approach that will be appealing to students. The authors acknowledge that the problems are pressing, but argue "we can address them" (p. 20). They go on to give examples of progress that has been made in difficult times (p. 60), cover both individual and institutional approaches, and discuss such solutions in some depth.

Analyzing both institutions and culture, Burns and Caniglia trace how the two have evolved, and they employ concepts such as cultural lag (p. 56) to support the view that we have a mismatch between sustainability and our current institutions and culture, which developed under assumptions of a different time. The book develops the idea that because of the evolving historical processes of modernity, and specifically with

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the move away from agrarian society toward industrialization and an increasingly urban global population, many in society have lost a connection with the natural world; this has contributed to the creation of environmental problems (pp. 15, 59). In part, the authors describe how it has become a norm to degrade the environment via consumption and other processes because the effects are not felt immediately or locally and because there is an emphasis on expansion of both markets and scales of production. The authors also take a global approach, focusing on large-scale change, while at the same time not neglecting the local; current examples are provided at multiple levels. For example, the water crisis in Flint, Michigan, is discussed, as is sociological research on the political economy of the globally uneven distribution of environmental problems. The book has excellent breadth of coverage of both theoretical perspectives and main concepts, from the human exemptionalism paradigm and new environmental paradigm transition (p. 137) as articulated by Dunlap and Catton (1979), to the Jevons paradox (p. 58), to the Netherlands fallacy (p. 162). One criticism could be that because of the great breadth of the work, some topics are mentioned only briefly and lack depth; however, as it is the book remains highly readable, engaging, and thought-provoking, and instructors may supplement such areas with additional materials.

The institutional focus helps to provide the book with its coherent structure. The first chapter presents the ecological dilemma of late modernity. This chapter highlights the urgency and scale of problems, the authors' optimistic approach, the book's global focus, and the authors' critical approach toward economics as the dominant paradigm of late modernity. Chapter 2 introduces the sociological perspective, environmental sociology, and their respective histories. While acknowledging that the classical theorists didn't completely neglect the natural environment (Foster, 1999), Burns and Caniglia note that during the time of the origins of sociology the natural environment was not the primary focus of the emerging discipline. Also covered here are the roots of some theoretical perspectives, including those from the critical tradition and from human ecology. Chapter 3 addresses culture; here the authors highlight the emphasis on the individual in late modernity and develop their focus on the mismatches between culture, evolution, technology, the scale of the economy, and sustainability and the natural ecology. A useful point here relates to the inadequacy of institutional fixes that do not accurately take into account and address culture and cultural mismatches.

The focus on specific institutions begins with Chapter 4, which tackles the question of whether science and technology are more accurately seen as problem or solution and the theoretical perspectives that address this debate. Science and technology can be seen as existing and evolving in tandem with the institutions of the economy and governance systems covered in the next two chapters. Chapter 5 highlights the origins of economics and covers concepts important to the environment such as economies of scale and externalities, employing a useful example from modern

industrial-scale agriculture. Throughout the book, but especially in this chapter, the authors engage with the "Tragedy of the commons" (Hardin, 1968), local to global inequality in the distribution of environmental problems, and the "treadmill of production" (Schnaiberg, 1980). Governance is covered in Chapter 6 and this chapter includes discussion of multiple theoretical perspectives. Following in the legacy of scholarship by Rachel Carson, Chapter 7 looks at links between an environment "out of balance" and human health and well-being (p. 130). Examples related to specific environmental toxins draw attention to issues of environmental justice, raise the issue of trade-offs, and highlight how benefits and harms of many products are experienced unevenly across more- and less-advantaged groups in society. Chapter 8 focuses on collective behavior and social movements targeted at environmental problems and explores the multiple groups and their various points of cohesion and conflict, assessments of their efficacy, and movements both local and global. Although the global focus is interwoven throughout the book, Chapter 9 extends this by focusing specifically on the global nature of environmental problems, trade, and the environmental situation in developing countries.

Three of the four final chapters emphasize working toward solutions. In addition to Chapter 8 on collective action, Chapters 10 and 11 address ways to create social change. Chapter 10 emphasizes the role of catalysts for change and details five specific approaches, two at the individual level and three at the institutional level that, working in conjunction, will lead to a growing environmental consciousness and structural change. The final chapter sums up the arguments of the book with an emphasis on the types of solutions that grow from the authors' particular identification of the problems that have led us to our current environmental dilemmas.

The authors do not advocate a return to a time before late modernity; instead, they advocate for strategies that rebuild a connection with the natural environment at both the individual and the institutional level. Throughout the book many sections raise similar thought-provoking assertions that will make for lively discussion topics with students. Some additional features that will make the book appealing to students are the annotated table of contents, the end of chapter summaries, and the figures, which appear throughout the book and provide expanded information on key topics or examples.

To conclude, this book is an excellent resource and a thoughtful contribution. It will enable students to gain a theoretically informed and global perspective on the influences of modernity on our natural environment. The book is invaluable in the way it concisely provides background and draws connections between the origins of sociology and environmental sociology and large-scale societal changes, and it doesn't neglect highlighting unequal contributions to and outcomes of environmental problems. Furthermore, the way we frame problems determines the solutions we can imagine. Burns and Caniglia provide a historically rooted and uniquely presented identification of the problems: a loss of connectedness with

nature and a mismatch between the institutions and culture of modernity and sustainability; they then follow this logic to specific examples, at various levels, of steps toward reconnecting with and preserving the planet.

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Capitalism in the Web of Life: Ecology and the Accumulation of Capital

By Jason W. Moore

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In *Capitalism in the Web of Life*, Jason W. Moore advances a new synthetic framework that draws on environmentalist, feminist, and Marxist thought to formulate a theoretical edifice of capitalism-in-nature (as opposed to capitalism and nature). Hailing from the growing World-Ecology Research Network, Moore's book is unique in its transdisciplinary approach, spanning an impressive array of key scholarship from sociology, economics, geography, history, international development, and political science, among others. The crux of the argument hinges on an essential concept, the *oikeios*, that "enables—but on its own does not accomplish—a theory of capital accumulation in the web of life" (p. 10). For Moore, the *oikeios* names the life-making relation that includes all forms of human organization, which is both a product and producer of the *oikeios*. It is with this dialectical tool that Moore disrupts perceived separations of humanity from nature and anthropogenic contributions to ecological crises; in doing so, he shifts focus to how humanity is unified with nature within the web of life and chronicles the historical coproduction of wealth and power accumulation in which humans put nature (including other humans) to work. For Moore, human history must be reconsidered to reflect the coproduction of humans in nature within the web of life.

Moore furthers the argument that humanity is unified with and within nature by synthesizing Marxist thought with environmental historiography to establish a relational method and mode of inquiry for interrogating the grand questions posed by the text and by current crises. A central point is that although many environmentalists agree that humans are a part of nature, the methods and analytic tools applied to study related phenomena contradict this axiom. For Moore, a critical first step is abolishing Cartesian dualism embodied in the generalized acceptance of Nature/Society (humanity *and* nature) and embracing instead a relational ontology and dialectical tool, the *oikeios* (humanity-*in*-nature). For example, Moore indicts the concept of "metabolism" as struggling with an insurmountable contradiction: embracing a relational ontology, on the one hand, but analytically adopting

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Nature/Society dualism, on the other hand. Thus, rather than forging the Nature/Society divide, the domains are epistemologically separated in ways that eschew comprehension of the deep interpenetration of humans with and within nature.

Readers are urged to consider capitalism as a world ecology, one that joins the accumulation of capital, power, and the coproduction of nature in dialectical unity. Another conceptual crux of the framework put forth is the double internality—the movement of capitalism through nature, and of nature through capitalism—that emphasizes the historical coproduction of nature in society. As Moore states "humans make environments and environments make humans—and human organization" (p. 3). His paradigm has hints of Weberian refraction, too, when he notes, for instance, "geology is a *basic* fact; it becomes a *historical* fact through the historically co-produced character of resource production, which unfolds through the *oikeios*" (p. 179, emphases in original). This feature of his treatise encourages readers to begin asking how and why (some) geological facts become historical processes—a sure and swift departure from the vast bulk of "green thinking" today.

I am especially appreciative of Moore's treatment of accumulation and the formation of value relations within the framework of capitalism-in-nature. Fundamental to this task is Moore's identification of the "Four Cheaps" (or Cheap Nature)—food, energy, raw materials, and labor-power—that are posited as frontiers for expansion within the capitalist world regime conquest of space and time. Moore is clear on this point: "capitalism does not *have* an ecological regime; it *is* an ecological regime" (p. 158, emphases in original). Moore extends the ecological regime to encompass governance, technology, stratification, and the institutional/organizational mechanisms that consolidate, sustain, and propel adequate flows of Cheap Nature to centers of world accumulation since the "long" sixteenth century. Ecological regimes, then, are stabilized conditions of extended accumulation. Moore substantiates the claim that world hegemonies are socioecological projects by illustratively detailing the hegemonic emergence of Britain as inextricably linked to the harnessing of coal and steam power and companion shifts in plantations, and tracing American hegemony to oil and the industrialization of agriculture it enabled. The distinctly dialectic and historical approach from which the world-ecological framework is derived challenges the tendency toward periodization in which dualistic notions of social causes and environmental consequences reign supreme, supplanting this impulse with a thoroughly interlocked view of historical capitalism as coproduced by interpenetrating layers of society-in-nature.

Moore demonstrates how specific historical moments coalesce with the appropriation and exploitation of Cheap Natures (in various forms and configurations across the space-time nexus) to solidify value relations, production processes, and the accumulation of wealth and power—all part and parcel of the capitalism-in-nature paradigm. He gives numerous examples of humans and nature coproducing capitalized ecologies that galvanize power and wealth in the hands

of so few, leaving the vast majority of humanity-in-nature as frontiers for further accumulation via appropriation and exploitation. In this way, capitalism in the web of life transforms, appropriates, and exploits nature (including humans) such that biophysical dynamics interpenetrate social ecologies in ways that render them virtually analytically inseparable and central to contradictions witnessed globally, as well as crises, both historical and current. To illustrate, social transformations (e.g., the global agro-food regime) and biophysical feedbacks (e.g., weed control) are unified contradictions from the standpoint of the *oikeios*. It must be stressed that the author does not inculcate a vision of historical volleying of forces between society and nature; rather, history is best viewed as "a cascade of environment-making processes and relations, through which particular bundles of human and extra-human nature flow, upon which these bundles act and re-form as they act" (p. 174). The vision put forth, this flow of flows that interpenetrates all of humanity-in-nature, is a paradigmatic tour de force with serious analytic implications. Though impossible to grapple with entirely in such a limited space, the point remains that the scope and magnitude of the analytic conclusions reached by Moore are substantial and significant, potentially a call for marshaling new approaches to replace the current "industry standards," epitomized perhaps by the proliferation of quantifrenetic tendencies (e.g., econometrics) in macrocomparative social science scholarship. To be sure, the framework advanced by Moore calls into question the assumptions necessary to conduct analyses premised on a dualistic model of "Nature" in one box and "Society" in the other(s) that inherently reify the separation of nature from society.

A particular strength is the incorporation of feminist theory to establish a critical analysis of value relations eminent to the capitalism-in-nature paradigm, an area in which there is ample room for intersection and extension across existing macrocomparative research. Moore posits the omission of women's reproductive work is but one axis of exclusion from value relations established by capitalized nature; instructive is his pithy statement that "only some energy becomes work, and only some work becomes value" (p. 174). As ecological regimes face constraints to the Four Cheaps that threaten accumulation (e.g., rising costs of inputs, falling rates of profit), the appropriation of unpaid work is a critical frontier to counterbalance crippling increases in the costs of production. As these relations unfold through the *oikeios*, readers are given a clear conception of the historical coevolution of bundled human and extra-human relations, a true mosaic of interplay across a multitude of layers that belie current conceptualizations of Nature separate from Society.

Moore's treatment of gender starkly contrasts dominant figures and modes of analysis that characterize the subfield of environmental sociology, and thus represents a valuable advancement in the theoretical unpacking of capital so that gender, race, and class are brought into account. While Moore explicates how capitalism is premised on a strictly dualized gendered division of labor, more so

than any civilization before it, there is no discussion of patriarchy, which presents a fruitful direction for forging debates on structural–cultural systems. For instance, is patriarchy the structural and ideological gel that enforces value relations, especially regarding unpaid work? I also see potential for pushing the argument further to explore questions of how gender, race, and class work in broader social formations to contest power and accumulation regimes. To illustrate, the conceptualization of gender as social organization is closely bundled to heteronormativity and compulsory monogamy (see e.g., Schippers, 2016). Possibilities for alternatives (e.g., communal/communitarian living) to disrupt accumulation processes and value relations within capitalism are important to consider. Given his exceptional treatment of feminist theory, in general, I look forward to future thought on this important, overlooked, and understudied area of emphasis within environmental sociology.

Moore's perspective brings other untapped areas of interest into the conversation, such as the role of entropy in value relations and ecological surplus declines over long waves of accumulation. His work in this area highlights yet again the expansive interdisciplinary thinking that, in this case, is used to consolidate laws of entropy within specific patterns of power and production. Entropy exacts a toll of wear and tear that is closely associated with declines in ecological surplus; to quote Moore, "this is an entropy problem: matter/energy move from more useful to less useful forms within the prevailing configuration of the *oikeios*" (p. 97). Taken with the feminist thought outlined above, I see possibilities for developing a feminist theory of entropy and unequal exchange. For instance, declines in ecological surplus imposed by entropic dynamics could be extended to marginalized populations whose suffering is compounded by accumulation struggles via depletion and devaluation within capitalism. Such an approach would highlight the magnified vulnerability of women at the lowest nodes of commodity chains (Dunaway, 2001). Accordingly, the productive and reproductive labor of women functions to alleviate accumulation crises by serving as frontiers of exploitation that are epicenters for the accumulation of entropy.

In sum, *Capitalism in the Web of Life* traces the historical patterning of appropriation and exploitation in which capital aggressively pursues and taps sources of Cheap Nature and, in doing so, coproduces geographical, institutional, organizational, and technological forms to further accumulation. The theoretical and methodological urging to abolish Nature/Society divides that dominate Green and Red scholarship alike is consequential for scholars working across diverse areas of study. I am enthusiastic about the potential for integrating Moore's core insights with scholarship from critical animal studies, political ecology, geography, environmental sociology, ecofeminism, and coupled human and natural systems approaches (e.g., Liu et al., 2013), to name just a few branches of study ripe for developing the substantive and analytic implications stemming from this framework. Moore's book is a formidable addition to world-ecology perspectives and precisely the sort of text needed to further the reach of this ever-growing area of research.

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