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SPECIAL SECTION: WHERE ARE THE WILD THINGS?

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BOOK REVIEW

Special Section: Where Are the Wild Things?

Introductory Comments

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It is perhaps inevitable that we become concerned about things in proportion to their rate of disappearance: interest in wildlife has never been greater than today, when wildlife is scarcest. This holds particularly true for large carnivores, the beasts of our evolutionary past that now need saving from us, their former prey. But far from our dominant position easing our anxieties vis-à-vis the monsters of the wild, we continue to be both fascinated and terrified, wanting to bring wild things back without really knowing how to live with them.

The very idea of a fundamental separation between nature and culture, the wild and the civilized, is vehemently contested in an increasingly human world. This, however, does not mean that our cultural imaginaries are keeping up with the critique: the category of the beast, of the wild thing that threatens the fabric of civilized life, is as present as ever, in many different forms. For example, new conservation measures can themselves be perceived as beastly when they rely on the re-creation of extinct animals (Lorimer & Driessen, 2013, 2016). The category of invasiveness in ecology uncomfortably transpires into social discourse, relegating to monstrous forms both human and non-human others (Anderson, 2017; Comaroff, 2017). A human ecology of wildness, in other words, has to parse the complicated and often contradictory relations between our ecological role and the social imaginaries that only partially overlap with it.

There is a contradiction inherent in recognizing both human impact on the planet and the need for further human intervention to maintain a livable (for us) ecosystem. The worth, therefore, in examining what wildness *is* lies in the light that can be thrown on our own human actions and desires, especially in this technologically advanced, highly globalized modern world; a world wherein calls to "reconnect to nature" are loud and salient (Ives et al., 2018). Appreciating "wildness" encapsulates a variety of intersecting issues: from philosophical notions of agency and sovereignty (Matthews, 2012; Monbiot, 2013; Plumwood, 2006), to logical, technical, and instrumental categorizations of wild or domestic, natural or artificial, managed

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or unmanaged (Braverman, 2015). In the following collection of papers, we draw together three facets of this problem, each interrogating one aspect of the idea of wildness and its relation to a livable future.

The first question that arises is whether it makes sense to speak of wildness at all in a world that will, in all likelihood, become increasingly managed and engineered. John Visvader's articulation of nature and wildness as *process* rather than essence is a very helpful answer to this question. The ancient Greek and Chinese conceptions of "wild" presented in his paper offer an alternative to the dualistic divide often drawn between humans and nature. He shows that our idea of wild is on a scale; that is to say, it does not always mean "not-created-by-humans." Instead, the ways in which we use the concept of wild betrays its affinity to the idea of autonomous process: something is wild in relation to its distance from human control, which is always judged contextually. Visvader's plea for a future that makes space for autonomous processes echoes calls from across ecology (Snyder, 1994), pop science (Monbiot, 2013), anthropology (Kohn, 2013), and environmental ethics (Schmidtz & Willott, 2002).

If retaining wildness means retaining self-willed, natural cycles of life and death—that is, of predation—then how do human societies and individuals deal with the potential consequences of encouraging the size and distribution of predator populations? One way to think about this question is by first trying to understand the magnitude of the problem of predation on humans. As Jennifer Kelly et al. summarize in "Large Carnivore Attacks on Humans," the risk of death via carnivore attack is minimal compared to, for example, the risk from lightning. Though this is the case, it is not on its own enough to soothe our fear of predators; something that Jonathan Thurston's article shows likely to be rooted in deep evolutionary processes.

In "The Face of the Beast," we are guided through the ways predators are represented and portrayed in fiction and horror genres. Beastly predators in literature tend to be reduced to abstractions of teeth, eyes, and claws, yet this is enough to send shivers down our spine. Why? As Thurston argues, our evolutionary fear of being eaten is still present, despite our immediate environment not resembling that of our distant ancestors. Through the ways we choose to represent these "beasts" back to ourselves, we reinforce their difference from and danger to us, all the while ignoring their complexity as living, wild beings. The more we relate to predators as literary monsters, the less are we able to understand them on their own terms.

Taken together, these three contributions suggest that the idea of a future where space is made for autonomous processes must also reckon with the psychological responses humans have to a wild understood, often unconsciously, as dangerous. It is not enough to engage in ecological rewilding; we must also engage in new forms of conviviality with wild animals (Büscher & Fletcher, 2019). The role of

human ecology in this process is to keep the focus on *the relation* between ecological processes and social ones, so as to avoid the pitfalls of narrowmindedness: an entirely human world, or else an inhuman one.

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Future Wild: Ecology, Sustainability, and Science Fiction

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Abstract

It will be difficult to imagine a sustainable earth in the long-term future without realizing that we will have to increasingly interfere with natural earth systems in order to maintain ourselves and those things and creatures we value. Will we be able to speak of anything wild or even natural on such a managed planet? I argue in the affirmative, drawing on some concepts of nature of both the ancient Greeks and the Chinese. The essentialist concept of nature that depends on the absolute distinction between humans and nature is criticized, and a process view is suggested which sees nature as more than a collection of objects untouched by humans.

Keywords: concepts of nature, concepts of sustainability, concepts of wild, essentialism, science fiction

Commentary

When we talk about sustainability there is a problematic conservative factor that we are not often aware of. In this sense, to sustain means to hold on to, to keep something going—to keep something going in the same or similar way. We often get to conversations about this topic when we begin to fear that things are getting worse and about to get much worse, and we wonder how we can at least keep things as they are now or, at most, make things better. And when we think this way—either pessimistically, when we think it will be all that we can do to keep things from getting worse; or optimistically, when we think that we can make things better or even a lot better—we think long term, very long term. Sustainability riding off into the sunset.

The problematic factor concerning sustainability comes about in the following way, in two steps. First, we realize that what we want to sustain primarily is ourselves and all those sorts of things that we value. We don't want to freeze things, but we would like things to develop within a comfortable parenthesis, so to speak. Things can

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develop freely and progress in various ways, but change can't be so large or drastic that the whole human enterprise is undercut. This is step one, the maintenance of the protective parenthesis. Step two comes about when we think about the long-term future. This is where the science fiction comes in.

The further into the future we look the more effort will appear necessary in attaining "sustainability," for we will have to deal with threats that do not arise primarily from the actions of human beings—though our own actions have and will often continue to add to our perils. In terms of geological time we are indeed a very young species of only a million or so years. During its four and a half billion years the earth has continually changed and various creatures that have inhabited its surface have come and gone. The longer the human species exists the more threats and disruptions it can expect from large-scale changes. The continents continue to move, other ice ages can be expected, and we now suspect the earth regularly receives large-scale collisions with astronomical objects.

If our technologies continue to develop as they have, we will increasingly be able to decide not only our own fate, but the fate of the planet and the other creatures that share it with us. In fact, we can look at these attempts we are making to develop a practical or applied human ecology as the first stages in the formation of the god-like art and science of planet management. In this sense, long-term sustainability means maintaining this particular kind of earth system into the indefinite future. This will involve either increased adaptability, or power to control large-scale earth systems, or both. Very long-term sustainability may require us to think of leaving the earth itself, or at least of transplanting life of various kinds in other places. Some have spoken of this possibility as the "greening of the universe."

I admit this is not a topic on our frontline agenda. Not many of us are worrying about what our possible long-term descendants will do when the sun uses up its supply of hydrogen four and a half billion years from now, to collapse and then expand to the orbit of the earth as it enters its helium cycle. Our problem is how to figure out how to begin living now in such a way that we can have future descendants to worry about such things. But this science fiction scenario about the future, though remote, raises some conceptual issues about the present, and it's those that I'm really after here.

For many of us, one of the things we'd like to take along with us into a sustainable future are the natural and wild systems that we still find in relative abundance. Many have argued for the intrinsic value of the wild and the natural. We would not like to lose a single species (look at the arguments for preserving the few remaining tubes of smallpox virus); some would even like to bring back vanished species via some sort of Jurassic Park technique. But continued, long-term sustainability means that these systems will have to live inside our parenthesis. Wild but not too wild, natural but not too natural. But can the earth, as a kind of futuristic Noah's ark,

contain wild and natural systems? What would a wild system of the future, of even the very far distant future, look like—if we would even allow for the possibility? Of course, this depends upon what you want to call wild and natural.

There are some who have defined wild and natural in terms of the absence of human influence or effect. Some like Bill McKibben (1989) have argued that Nature itself is gone because there are effects of human processes everywhere on the globe. But this narrowness does not get us very far, for in this sense the natural and the wild have gone a long time ago. This sort of thing would also make it problematic to say such perfectly good things as describing a garden as going wild (because a garden, after all, is a human artifice), or even to speak of people behaving badly or living differently as "wild people."

Philosophy thrives in situations in which the normal categories of description break down when faced with novel or neglected situations. Is it male or female, plant or animal, living or dead, or—in our case—is it natural or unnatural, wild or manufactured or designed? Philosophers usually deal with these kinds of situations by giving recommendations for one usage or another, or by inventing a totally new term to cover the problematic situation. And here the arguments for the recommendation will resemble those in the law courts by citing certain precedents and examples that will have the force of analogy, or by emphasizing some salient features in the case at hand that may unlock the conceptual knots and guide us through the dilemma. I propose to do something like this in puzzling out the case as to whether or in what way a Noah's ark earth (or at least some parts of it) can have wild or natural areas. If we can make any progress with this, we may come to understand the wild and the natural in a slightly different way—one that might be more helpful for some purposes. For precedents, I'd like to call briefly on the ancient Greeks and Chinese.

The Greek word for nature is *phusis*, and if we can trust the etymology of someone like Heidegger it means "the emergent self-upraising, the self-unfolding that abides in itself" (Heidegger, 2000, p. 64) To translate this Heideggerese slightly, nature is not conceived as a group of objects with certain common properties—say, being untouched by humans—but as a process that things can undergo to a greater or lesser extent. Something comes forth like a flower that blooms, it unfolds, it "abides," it holds itself as what it is, it has integrity in the sense that it holds itself integral, then folds, withers or gets eaten. It's this aspect of the world that is dynamic, in flux, continuously emergent and constantly tumbling into new and different forms that is thought of as nature. As a process, nature is not alien to humans as we also manifest the same processes in different ways, at different times, and more or less. The Greek word *poiesis*, from which we derive the word poetry, is nature naturing (*natura naturans*) or unfolding clearly in humans. Humans manifest this when they are openly creative—that is, when they open themselves to a kind of inspiration—it is something one can receive rather than do.

Interestingly enough, the ancient Chinese of roughly the same period had very similar notions of nature as a process. The Chinese word for nature is *dz ran*, which literally translated means "self-so," or that which is of itself so. It is sometimes translated as "spontaneous," something that comes forward by itself in its own way at its own time. Like the Greek concept, nature is something that is continuously self-emergent; it constantly discloses itself, holds itself in many forms that tumble into each other. Nature also permeated the human world in an important way. To incorporate into oneself this kind of spontaneous and creative action was one of the major efforts of Chinese spirituality and aesthetics. Many materials used in the arts invited or made use of the accidental or the recalcitrant. One learned to be spontaneously creative by working with these elements in one's environment. Rice paper was often prized for aesthetic purposes because it was highly absorptive and required artists to work quickly and freely, taking advantage of whatever unplanned accidents they were presented with. One became most creative when one became most natural.

Well, what do these examples tell us about nature, the natural or the wild that may be helpful to us? I think the first thing to notice is that in both cases nature and humans are not essentially opposed to each other, they are not defined as the negative of each other as north pole and south pole—they are not polar opposites. We, being over-civilized and super-urbanized, look desperately for something that is not us or our doing. We tend to think of nature as everything we are not, as our polar opposite. The Chinese were capable of making natural gardens. This sounds like an oxymoron to us.

Some Daoist monasteries had gardens that were continuously cultivated for hundreds of years but could not be recognized as such by an unenlightened or casual observer. In what sense could they be natural, in what sense wild? The Chinese were contextualists, they realized that there was no such thing as an isolated individual—or in the lingo of Hobbes—an independent atomic individual. Everything is in relationship. Whether a tree is in a garden or in a forest, it unfolds in relation to the things around it. Since humans are not essentially opposed to nature, they could also enter into the web of relationships in which things unfold themselves. The key of course is to let things alone as much as possible without abandoning them completely, to encourage things to unfold themselves as much as possible. Things could be natural, and in a sense wild, even in a parenthesis, as long as the parenthesis was very wide and very gentle, as long as nature as process was a major factor.

This seems to me to capture one important part of the concept of wild—things are wild when they are left to do or develop on their own. But of course, nothing develops or acts completely on its own. Nothing is wild in any absolute or metaphysical sense; things are wild with respect to some aspect or some context that we find it important to contrast them with. Are there such things as wild horses? Well, sure—but of course all the wild horses that we used to round up for dog food

were escaped horses that were carefully bred for centuries. "Wild" is one of those tricky contrast words that disguise themselves as substantives, and seem to name an absolute quality that a thing has similar to its hooves or tail or even genes. A horse in my stable can be wild in contrast to another horse in my stable that is more calm and cooperative. My unruly horse would not be considered wild when compared to the roaming dog-food horses, and of course these in turn would not be considered wild in comparison to a newly discovered herd of eohippus.

Let's now explore the question of what Future Wild would look like and whether it is even conceivable under the conditions I've sketched out. As long as we don't take wild to be some sort of intrinsic property, I don't see why we couldn't use the word as a way of contrasting features of things that we feel are important to us. Suppose in the far future we find that all creatures, including ourselves, have to be re-engineered genetically because of some terribly noxious conditions that arise on the earth, say from a collision with one of those mini black holes that are supposed to be roaming the universe. Can we call any of these creatures wild? The answer depends upon what contrasting features we are interested in. Some things will be wild when left to themselves as opposed to those things which are continually changed, controlled and influenced by us. As long as nature as process, in the Greek and Chinese sense, is allowed a large enough scope, things will develop "naturally" and by contrast be wild. Of course, these free-living genetically engineered creatures may not be considered wild in comparison to creatures that are not so engineered, but why make the origin such an important, almost metaphysical factor? Being unengineered alone doesn't make them wild. Suppose we kept the few remaining originals in a huge air tank zoo, would they be wilder than their modified descendants left on their own to roam without interference? These might be revered because they are rare but not because they are wild.

So of course I think that we can talk of wild places and wild things in a future Noah's ark world, but the key here has to be the same thing that applies in a Chinese garden; leave the things alone as much as possible, keep the parenthesis as broad and gentle as possible. But don't the unengineered creatures have more intrinsic worth than those that are not? In answering this I come to the most contentious part of this little paper. These "unaltered creatures" will have more worth to the degree that we hold an essentialist view of the natural and the wild. They will have more worth to the degree that we hold an absolute distinction between humans and nature; humans themselves, according to the essentialist view, must in some sense be held to be artificial, and everything they do must be seen to be unnatural. Why is a beaver dam natural but a human dam not—even though the beaver dam might be much bigger in a particular case and more environmentally significant? Such an absolute dichotomy is itself artificial and has always been difficult to defend conceptually, and at present is becoming difficult to maintain practically. (Some have suggested,

with some insight, that this abyss between humans and nature has been fostered by the humanist tradition's incorporation of Platonic Christianity, in its attempt to ward off the exaggerations of naturalistic reductionism.)

We can easily imagine a time in the not-too-distant future in which the use of prosthetics will become the rule, and a dispute arises between the 20 percenters (those who have 20% or less of artificial organs) and the 50 percenters as to who is artificial and who is natural. The essentialist will claim that neither group is natural; only one without any artificial organs is natural. But would such a "natural" person be able to wear glasses, clothes, have fillings in their teeth, or use tools? The Greek philosopher Diogenes was famous for his cynicism—walking around in daylight with a lighted lantern looking for an honest man—but his cynicism also led him to reject the artificiality of human life and he tried to live naturally. He wore no clothes, lived in a cast-off wine jar (they were pretty big in those days) and tried to refrain from using human speech. Most feel that his concept of natural was a little artificial and had gone too far, but here was an essentialist trying, paradoxically, to be natural. The paradox arises from the absolute dichotomy between humans and nature, so that even someone who tried as hard as Diogenes to be natural was doomed to be artificial.

This distinction—between the natural and the artificial, the wild and the tame (or whatever its counterpart is)—though it may have immense practical value in underlining contrasts we feel it important to make, when taken philosophically in an essentialist sense offers us little in the way of guidance as to what is valuable and what we should cherish. Is a test-tube baby worth less than one who was conceived in the usual manner? And what is the usual manner? Can we plan our children without decreasing their value? Few think that cloning is something that we ought to do, but clones would not be much different than identical twins. Some fertility drugs seem to stimulate multiple births of identicals—are any of these "copies" worth less than "originals"? I think the problem of clones has to do with the purpose which may bring them about. We don't want humans treated instrumentally as organ donors; we also feel that such produced humans will be things controlled in some way and therefore less human. In a world in which technology will give us an increasing ability to control our circumstances, and at a time in which technology may be necessary to maintain sustainability, we will find that origin will become less important in our valuation of things. We don't value programmed humans or things whose details and actions are fully predicted and controlled or altered merely for our pleasures or purposes. In the Chinese sense, we value things that are self-sos, things that can determine in one way or another their own circumstances or fate. We all live within parentheses of one kind or another, but we also respect and strive for an openness and freedom within our circumstances.

As for Future Wild, why not? All we have to do is to make sure to learn to leave things alone, the more the better, within a gentle parenthesis. Nothing is wild in any absolute sense, but things can remain wild in a sense that is important both to them and to us.

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Large Carnivore Attacks on Humans: The State of Knowledge

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Abstract

In this paper, we summarize the state of the literature regarding attacks on humans from large carnivores, and classify them, where possible, according to three common precursors of such attacks including human provocation and animal disease. We found the risk of a large carnivore attacking a human is relatively low in comparison to other natural threats, such as being struck by lightning. Our recommendations include ways for humans to coexist with large carnivores, such as aversive conditioning of habituated carnivores. Finally, we argue for a more standardized method of obtaining attack information across scholars and practitioners such as the use of consistent timelines, regions and sources, the inclusion of gray literature, and the recording of causal factors such as provocation and disease. Empirical knowledge of carnivore attacks can augment and inform individual and culturally influenced understandings with the potential for more humane, effective, and locally appropriate wildlife management and conservation techniques.

Keywords: attacks, human–wildlife interactions, large carnivores, predators

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Introduction

Representations in popular discourse of attacks on humans by large carnivores often assume the wild animal is in some way to "blame" for the attack. However, the circumstances of wild animal attacks on humans are multilayered. Apart from unprovoked attacks (e.g., predation), common precursors to large carnivore attacks are human behaviors and practices.

In this paper, we summarize the state of the literature regarding attacks on humans by large carnivores. In doing so, we have two main objectives: (1) to quantify such attacks in a single record with a view to providing accurate accounting, and classify the causal factors as much as possible as part of that account; and (2) to assist future research into the development of more systematic methods and criteria for reporting of and compiling data on such attacks, by providing scholars and practitioners with a reference paper on the range of existing methods. We extend these objectives by using the numbers compiled to illuminate the relatively low risk of carnivore attack compared to other threats to human safety from the natural world, and to argue for more thorough and systematic record-keeping of attacks. Furthermore, aligning with a shift in public sentiment away from lethal control of large carnivores, we recommend some ways to coexist with wild animals and reduce the incidence of attacks.

Many factors can contribute to wild carnivore attacks on humans. Large carnivores may, unprovoked, predate on humans as they would with other prey animals, but provocations (intentional and unintentional) from human behaviors and practices can also contribute to encounters that result in attacks. Apart from human behaviors intended to harm, antagonize, or threaten an animal or its young, unintentional human provocations such as food-conditioning and other forms of habituation of an animal may be a precursor to an attack. For example, failure to understand proper food storage when camping in bear habitat can result in an encounter with a bear (which, while unintended, would be considered a provocation if followed by an attack). Habituation describes the process by which an individual wild animal becomes accustomed to the presence of humans. Food-conditioning, while a form of habituation, is distinct (Smith et al., 2005, p. 2) in that it describes a wild animal who feeds on human food (e.g., direct feeding by humans, taking food from campsites, or eating human garbage). In addition to considerations of provocation, Quigley and Herrero (2005) describe yet another layer of attacks: that of rabid or diseased animals, as disease may disrupt an animal's normal behaviors, which could result in an attack. Despite the complexities of wild animal attacks on humans, these common factors—provocation (including unintended forms such as habituation) and disease—are not widely discussed in the literature in such a way as to distinguish them from unprovoked attacks.

In our research we encountered considerable inconsistency in the available literature in the reporting and recording of information on wild animal attacks on humans. First, the terminology and framing used to report on attacks varied based on the objective or type of the source (newspaper, academic journal, database, etc.). Second, animal attack information on human injuries and fatalities was not consistent across species, time, and geopolitical boundaries. Third, some sources described and classified the same attack in different ways. Finally, the method of data collection and time periods covered varied across sources.

Methods

We conducted a literature search of large carnivore attacks on humans through Google Scholar. The sources included published media reports, interviews and surveys with victims or witnesses of attacks, and information obtained from nationally or academically maintained databases. We used primarily quantitative data rather than qualitative data, although some of the sources we used analyzed news reports. We did not use case studies as the sample size was too small to produce meaningful results. From articles published between 1982 and 2012 we selected those that had been cited more frequently, ranging from 20 to 220 citations. For more recent articles, 2013 to 2019, we did not consider the number of citations given that citation rates for these are still growing. Where sufficient information was available, we identified characteristics of the attacks as they were described in the source, including where the source itself had provided a classification. We then classified the instances into four categories: Provoked, Unprovoked, Diseased, and Unclassified. We followed the work of Quigley and Herrero (2005) to determine parameters for extending and refining our definitions of Provoked and Unprovoked attacks. Table 1 draws from these established definitions for Provoked and Unprovoked in the literature, and to give a sense of the various ways such concepts are used.

The classification Diseased was chosen where the information in the source was sufficient to identify a diseased animal. Few of the sources noted the overall condition of the animal beyond identifiable diseases such as rabies. Moreover, the data available were insufficient to capture other causes of poor health in an animal, such as injury or malnourishment, which are also likely causal factors in attacks. For example, Herrero et al.'s (2011) study of black bear attacks reported that 68% of fatalities (23 of 34) were associated with bears exhibiting signs of poor health such as "underweight, injured, poor condition" (p. 599). Where the details of attacks were explicit, we were able to classify some of these as Diseased.

Table 1. Definitions and descriptions of Provoked and Unprovoked attacks

Species*	**Provoked** Person(s) enters an animal's personal space or purposely tries to touch, injure or kill the animal, and the animal attacks (Quigley & Herrero, 2005).	**Unprovoked** Animal approaches and attacks, with the principal attraction being the person(s) (Quigley & Herrero, 2005).
Coyote (*Canis latrans*)	*Defensive*: Person(s) corners coyote, or coyote is defending pups or a den. *Companion animal*** related: Person is bitten while a domestic companion animal is present (White & Gehrt, 2009).	*Predatory*: Coyote directly and aggressively pursues and bites a victim, including attacks from pairs and packs. *Investigative*: Coyote tests the victim as possible prey, victim is sleeping or resting when bitten (White & Gehrt, 2009).
Shark	A person initiates contact with a shark, is spearfishing or feeding sharks, or is unhooking a shark from a fishing net (Naylor & Bowling, 2018).	Attack on a human occurs in the shark's natural habitat with no provocation of the shark (Naylor & Bowling, 2018).
Bear	Person is perceived by the bear as a threat, or comes between a sow and her cubs.	Person does not threaten the bear and/or is not in the presence of food. Instances where a sleeping human is dragged by a bear and eaten.
Wolf (*Canis lupus*)	*Defensive*: Defending dens, rendezvous sites, or disabled conspecifics. *Provoked aggression in self-defense*: Aggression in response to pursuit by a human. *Agonistic*: Animal exhibits aggression or avoidance. These include: person's activity is threatening, annoying or unexpected, instances of food-conditioning, or person is accompanied by dogs (McNay, 2002).	*Predatory*: Wolf establishes orientation toward the prey, stalking, chasing, biting. *Prey-testing agonistic charges*: Aggressive charges or leaps toward people but the motivations are unclear. These could include: a misidentification of people as prey, naive wolves testing unfamiliar prey, wolves feeling compelled to aggressively drive people away, or non-habituated wolves (McNay, 2002).

* Scientific name included only where citation has done so.

** "Pet" is the common term used in the human–wildlife literature, however, we use companion animal, which has recently emerged in the animal studies literature to minimize the role of domination.

Where the source contained insufficient information to classify an attack as Provoked, Unprovoked, or Diseased, the fourth category of Unclassified was used.

We recognize as limitations in our research the inconsistencies noted above in reporting and record-keeping of these data. However, the two main objectives of our study—compiling attack numbers as thoroughly as possible, and summarizing the state of record-keeping methods and criteria—justified gathering our data from the widest possible range of sources, time spans, and land areas. Given the existing inconsistencies in the source literature, narrowing our focus to only the most comparable sources would have omitted most of the available data on attacks, and failed to adequately address the current state of data available on this topic.

Results

Table 2 provides the data from our search: location, date range, and frequency of attacks on humans (including human fatalities, where known) from large carnivorous species. As discussed above, we identified attacks as Provoked, Unprovoked, Diseased, or Unclassified (where sources provided insufficient detail for classification). We list global data on human attacks from 17 species of large carnivores. Polar bears had the longest recorded data at 144 years, during which time 73 attacks took place globally (Wilder et al., 2017). Sharks had the highest frequency of attacks at 984 over an 11-year period. Leopards had the second-highest frequency of recorded attacks at 840 across a 100-year time span in India, Nepal, Uganda, and South Africa (Löe & Röskaft, 2004). Cheetahs and snow leopards had no recorded attacks globally in studies up to 2009 (Inskip & Zimmerman, 2009).

Details for those species for which the literature met one or more of the following criteria: (1) recorded a long time range of collected data, (2) covered a large geographic area, (3) provided unique insight, or (4) described categories consistent with our Provoked or Unprovoked classifications, are discussed below.

Black bears (*Ursus americanus*)

From 1900 to 2009 there were a total of 60 attacks on humans by black bears resulting in 63 deaths[2] in the United States and Canada (Herrero et al., 2011). Non-fatal outcomes were not reported in this study. Of these attacks, 49 were Unprovoked, defined as natural predatory behavior of a bear (Herrero et al., 2011). We were unable to record the provoked attacks clearly with the information provided. For example, Herrero et al. (2011) found 15 fatalities involved human food or garbage, one involved a hunter wounding a bear, and two involved a bear breaking into a cabin. Furthermore, 11 were considered to have a health problem (Diseased), but it was not clear if these 11 bears had been provoked or were unprovoked by humans. These data were procured through the national park services of each state, territory, or province in the United States and Canada, as well as electronic newspaper reports (Herrero et al., 2011).

In British Columbia, Canada, there were 22 attacks by black bears on humans from 1960 to 1997 (Herrero & Higgins, 1999). Data for these attacks were obtained through a scientific literature review, as well as by contacting all wildlife management agencies operating within British Columbia during this time period. Of these attacks, 18 were Unprovoked or predatory in nature (Herrero & Higgins, 1999). In three instances, the bear was reported by wildlife officials to have a "low body weight" (Diseased) (Herrero & Higgins, 1999, p. 214).

2 In some cases, more than one person was attacked in the incident.

Brown bears (*Ursus arctos*)

Using wildlife management agency records, newspapers, and a bear attack database, Smith (2005) found 420 brown bear incidents with humans in Alaska between 1990 and 2004. Of these, 216 attacks were described in the source as "aggressive-defensive" and the remaining incidents were "attributed to curiosity, attraction to foodstuffs, carcass defense, or provocation" (Smith et al., 2005, p. 2), but could not be clearly classified as Provoked, or even as an attack. All "aggressive-defensive" attacks were Unclassified as there was no clarification whether the attack was aggressive (i.e., unprovoked) or defensive (i.e., provoked).

Through a scientific literature review, as well as in gathering data from wildlife management agencies operating within British Columbia, Canada, Herrero and Higgins (1999) found 49 brown bears had attacked humans from 1960 to 1997. Of the 49, we classified five attacks as Unprovoked, three were recorded by wildlife officials of animals in "poor physical condition" (Diseased) (Herrero & Higgins, 1999, p. 214), and the 41 remaining incidents as Unclassified.

Polar bears (*Ursus maritimus*)

From 2005 to 2016, there was a total of 68 Unprovoked polar bear attacks reported in the media globally (Bombieri, 2018). In North America, Europe (Svalbard, Norway), and Russia there were 13 attacks on humans from 1955 to 2014 (Penteriani et al., 2016). These findings were obtained from Wikipedia and online newspapers, where attacks were reported with insufficient detail to determine classification (Unclassified). In a global study from 1870 to 2014, Wilder et al. (2017) reported 73 attacks by polar bears on humans. Of these, 20 people were killed and 63 people were injured.[3] By region, 38 occurred in Canada, four in Greenland, 10 in Norway, 15 in Russia, and six in the United States (Wilder et al., 2017, p. 540). The study defined attacks as "predatory" in instances where the bear made "intentional contact in human injury … preyed upon, or attempted to prey upon, people … [or were involved in] behavioral components such as stalking and rushing the victim" (Wilder et al., 2017, p. 539). Based on this definition, we identified 37 Unprovoked attacks on humans. Of the 30 Provoked attacks, 14 were attributed to anthropogenic attractants such as "garbage, harvested animals, meat caches, and dog yards" (Wilder et al., 2017, p. 544).

3 In some cases, more than one person was attacked in the incident.

Sloth bears (*Melursus ursinus*)

In Sri Lanka, interviews with victims and eyewitnesses revealed 271 attacks on humans from 1938 to 2004 (Ratnayeke et al., 2014). Provoked attacks included 82 reports of bear cubs being present, three instances where the bear was provoked by a dog, three cases where a human tried to drive a bear off its food source, and two encounters which resulted in a human shooting at the bear "to avert a possible attack" (Ratnayeke et al., 2014, p. 472). Eleven involved cases where a person was run down by a bear (Ratnayeke et al., 2014), but it was unclear if the attack was provoked so we placed these 11 with the remaining attacks that could not be confidently classified (Unclassified).

Coyotes (*Canis latrans*)

White and Gehrt (2009) analyzed databases, newspapers, and Google News archives to report 142 coyote attacks on 159 victims in urban areas in the United States and Canada from 1960 to 2006. Of these, 63 were described as predatory and 32 were investigative, classified here as 95 Unprovoked attacks. A total of 13 Provoked attacks included eight related to companion animals, and five in which coyotes were defending themselves, cubs, or a den. A further 15 were classified as rabid coyotes (Diseased) and 36 were unknown cases (Unclassified).

Wolves (*Canis lupus*)

McNay (2002) reviewed cases from biologists, locals, law officials, public health records, and published literature in order to identify 50 aggressive encounters with wolves in Alaska, Minnesota's Canadian border, and Canada from 1969 to 2000. It was reported that healthy wolves were responsible for 38 of these attacks, while 12 were rabid (Diseased). In six cases where healthy wolves attacked, dogs were present (Provoked). Of the 18 Unprovoked attacks, none were life-threatening, although 13 ended in a bite, four of which were severe (McNay, 2002, Table 2, p. 835).

Leopards (*Panthera pardus*)

According to the Ugandan Government, there were 114 attacks by leopards on humans in Uganda from 1923 to 1994 (Treves & Naughton-Treves, 1999), where 32.5% of these resulted in human fatalities. Of the people killed by leopards, 75% were women or children. Of the 114 attacks, four were a result of leopards protecting their kill from humans (Provoked) (Treves & Naughton-Treves, 1999).

Lions (*Panthera leo*)

In Rufiji and Lindi, Tanzania, from 1990 to 2007, there were 274 attacks on humans (Kushnir, 2009). Of these, all (99 in Rufiji and 175 in Lindi) were Unprovoked (Kushnir, 2009), attributed to predation. High concentrations of bush pigs (*Potamochoerus porcus*) and low numbers of other forms of prey in both districts was correlated with a higher frequency of lion attacks (Kushnir, 2009). Lion attack information was procured from the District Game Office and follow-up interviews with "survivors, victims' family members, or village leaders" (Kushnir, 2009, p. 6).

In Uganda, drawing on data maintained by the Ugandan Government, there were 275 attacks by lions on humans in Uganda from 1923 to 1994 (Treves & Naughton-Treves, 1999). Of these, 74.9% of attacks were fatal. Five of the 275 attacks were Provoked, where lions were attempting to defend their kills from human scavengers (Treves & Naughton-Treves, 1999).

Sharks

According to the International Shark Attack File, there has been a total of 984 attacks by sharks on humans from 2007 to 2018 (ISAF, 2018). Of these attacks, great white (or white pointer) sharks (*Carcharodon carcharias*), tiger sharks (*Galeocerdo cuvier*), and bull sharks (*Carcharhinus leucas*) were responsible for 314, 111, and 100 attacks on humans, respectively.

In 2018, of a global total of 130 attacks reported, there were 66 Unprovoked and 34 Provoked attacks. The remaining 30 attacks we grouped as Unclassified. These comprised a mix of attacks on boats, post-mortem bites, unverified and doubtful reports (including where the attacking animal may not have been a shark), among others (Naylor & Bowling, 2018).

Table 2. Large carnivore attacks on humans

	Date range	Location (Source)	Unprovoked	Provoked	Diseased	Unclassified	Total attacks (per date range)
Bears (Ursidae)							
Black bear (*Ursus americanus*)	1900–2009	United States & Canada (Herrero et al., 2011)	49	NR	11	NR	63* (109 years)
	1900–2000	United States & Canada (Löe & Röskaft, 2004)	NR	NR	NR	37	37 (100 years)
	1955–2014	North America (Penteriani et al., 2016)	NR	NR	NR	85	85 (59 years)
	1960–1997	British Columbia, Canada (Herrero & Higgins, 1999)	18	NR	3	1	22 (37 years)
	2005–2016	Global (Bombieri et al., 2018)	NR	NR	NR	164	164 (11 years)
Brown bear (*Ursus arctos*)	1900–2000	Global# (Löe & Röskaft, 2004)	NR	NR	NR	313	313* (100 years)
	1955–2014	North America (Penteriani et al., 2016)	NR	NR	NR	92	92 (59 years)
	1960–1997	British Columbia, Canada (Herrero & Higgins, 1999)	5	NR	3	41	49 (37 years)
	1955–2014	Sweden, Finland & Spain (Penteriani et al., 2016)	NR	NR	NR	65	65 (59 years)
	1880–2015	Alaska (Smith & Herrero, 2018)	NR	NR	NR	289	289 (135 years)
	1900–2004	Alaska (Smith et al., 2005)	NR	NR	NR	420	420 (104 years)
	1977–2016	Scandinavia (Støen et al., 2018)	NR	26	NR	16	42 (39 years)
Sloth bear (*Melursus ursinus*)	1938–2004	Sri Lanka (Ratnayeke et al., 2014)	NR	90	NR	181	271 (66 years)
	2003–2013	Chitwan NP, Nepal (Ruda et al., 2018)	NR	NR	NR	59	59 (10 years)
Polar bear (*Ursus maritimus*)	1900–2000	United States, Norway (Svalbard), & Canada (Löe & Röskaft, 2004)	NR	NR	NR	12	12* (100 years)
	2005–2016	Global (Bombieri et al., 2018)	NR	NR	NR	68	68 (11 years)
	1870–2014	Global (Wilder et al., 2017)	37	30	0	6	73 (144 years)
	1955–2014	North America, Europe (Svalbard, Norway), & Russia (Penteriani et al., 2016)	NR	NR	NR	13	13 (59 years)

	Date range	Location (Source)	Unprovoked	Provoked	Diseased	Unclassified	Total attacks (per date range)
Dogs (Canidae)							
Coyote (*Canis latrans*)	1960–2006	Urban North America (White & Gehrt, 2009)	95	13	15	36	159** (46 years)
	1960–1988	Western United States & Canada (Carbyn, 1989)	4	NR	NR	10	14 (28 years)
	1978–2003	California (Timm et al., 2004)	NR	NR	NR	89	89 (25 years)
Wolf (*Canis lupus*)	1900–2000	Global## (Löe & Röskaft, 2004)	NR	NR	NR	607	607 (100 years)
	2001–2012	Hamedan Province, Iran (Behdarvand & Kaboli, 2015)	36	12	0	5	53 (11 years)
	1969–2000	United States (Alaska) & Canada (McNay, 2002)	18^	20	12	0	50 (31 years)
Spotted hyena (*Crocuta crocuta*)	1923–1994	Uganda (Treves & Naughton-Treves, 1999)	NR	NR	NR	4	4 (71 years)
Striped hyena (*Hyena hyena*)	1900–2000	India (Löe & Röskaft, 2004)	NR	NR	NR	2	2 (100 years)
Cats (Felidae)							
Cheetah (*Acinonyx jubatus*)	1979–2007	Global (Inskip & Zimmermann, 2009)	0	0	0	0	0 (28 years)
Cougar (*Puma concolor*)	1900–2000	Chile, Canada, & United States (Löe & Röskaft, 2004)	NR	NR	NR	18	18 (100 years)
	1980–2016	Urban United States & Canada (Bombieri et al., 2018)	12	0	0	0	12 (36 years)
	1890–1990	United States & Canada (Beier, 1991)	NR	NR	NR	53	53 (100 years)
	1890–2008	United States & Canada (Mattson et al., 2011)	NR	NR	NR	200	200 (118 years)
Jaguar (*Panthera onca*)	1995	Argentina (North Chaco) (Inskip & Zimmermann, 2009)	NR	NR	NR	1	1 (1 year)
	1940–2015	Venezuela (Jędrzejewski et al., 2017)	NR	7	NR	15	22 (75 years)

	Date range	Location (Source)	Unprovoked	Provoked	Diseased	Unclassified	Total attacks (per date range)
Leopard (*Panthera pardus*)	1900–2000	India, Nepal, Uganda, South Africa (Löe & Röskaft, 2004)	NR	NR	NR	840	840* (100 years)
	2005–2016	Global (Bombieri et al., 2018)	NR	NR	NR	177	177 (11 years)
	2003–2013	Chitwan NP, Nepal (Ruda et al., 2018)	NR	NR	NR	18	18 (10 years)
	2005–2011	Central India (Dhanwatey et al., 2013)	NR	NR	NR	29	29 (6 years)
	1993–2003	Maharashtra, India (Packer et al., 2018)	NR	NR	NR	67	67 (10 years)
	2004–2014	Himachal Pradesh, India (Packer et al., 2018)	NR	NR	NR	329	329 (10 years)
	1923–1994	Uganda (Treves & Naughton-Treves, 1999)	NR	4	NR	110	114 (71 years)
Lion (*Panthera leo*)	1900–2000	India, South Africa, Tanzania, Uganda, Zambia (Löe & Röskaft, 2004)	NR	NR	NR	552	552* (100 years)
	1990–2007	Rufiji & Lindi, Tanzania (Kushnir, 2009)	274	0	0	0	274 (17 years)
	1989–2008	Tanzania (Packer et al., 2018)	NR	NR	NR	319	319 (19 years)
	2005–2016	Global (Bombieri et al., 2018)	NR	NR	NR	73	73 (11 years)
	1923–1994	Uganda (Treves & Naughton-Treves, 1999)	NR	5	NR	270	275 (71 years)
	2006–2008	Mozambique (Dunham et al., 2010)	NR	NR	NR	44	44** (2 years)
	2006–2010	Mozambique (Le Bel et al., 2011)	NR	NR	NR	17	17 (4 years)
	2002–2008	Zambia (Chomba et al., 2012)	NR	NR	NR	21	21 (6 years)
Snow leopard (*Panthera uncia*)	1979–2007	Global (Inskip & Zimmermann, 2009)	0	0	0	0	0 (28 years)

	Date range	Location (Source)	Unprovoked	Provoked	Diseased	Unclassified	Total attacks (per date range)
Tiger (*Panthera tigris*)	2003–2013	Chitwan NP, Nepal (Ruda et al., 2018)	NR	NR	NR	68	68 (10 years)
	1979–2006	Chitwan NP, Nepal (Packer et al., 2018)	NR	NR	NR	88	88 (27 years)
	2005–2016	Global (Bombieri, 2018)	NR	NR	NR	31	31 (11 years)
	2005–2011	India (Dhanwatey et al., 2013)	NR	NR	NR	103	103 (6 years)
	2005–2010	Maharashtra, India (Packer et al., 2018)	NR	NR	NR	94	94 (5 years)
	1979–2006	Chitwan NP, Nepal (Packer et al., 2018)	NR	NR	NR	88	88 (27 years)
Sharks							
Shark	2007–2018	Global (ISAF, 2018)	NR	NR	NR	984	984 (11 years)
	2018	Global (Naylor & Bowling, 2018)	66	34	0	30	130 (1 year)
	1950–2003	United States (California & Oregon) (McCosker & Lea, 2006)	NR	NR	NR	95	95^^ (53 years)

NR = not reported.

* This data figure concerns fatalities only, not all attacks.

**This data figure concerns attack victims, not attack numbers.

#Canada, China, Japan, Yugoslavia, Kazakhstan, Kyrgyzstan, Mongolia, Norway, Romania, Russia, Sweden, and United States.

##Afghanistan, Canada, China, Estonia, France, India, Iran, Italy, Latvia, Lithuania, Poland, Russia, Slovakia, Spain, and United States.

^Three of these cases were located in Minnesota, US, close to the Canadian border.

^^This study data concerns only great white sharks (*Carcharodon carcharias*).

Discussion

Coexisting with large carnivores

Humans' actual relations with wild creatures exist in a perceived relationship informed by local cultural values and stories, personal histories, economic and technological empowerment, education and biases. More accurate reporting of carnivore attacks can augment and influence the often ad hoc nature of local understandings. Many factors drive the perceptions of wild animal attacks as dread threats. However, there is also an emerging public sentiment across many

societies toward peaceful coexistence with wild animals and humane management techniques. Information from various regional studies can provide insights about practices applicable in compatible contexts. For example, a study in 2014 replicated a 1995 survey of public attitudes in the United States toward wildlife management, and found an increase in support for humane forms of predator management practices such as scare devices, fertility control, and non-lethal guard animals (Slagle et al., 2017, p. 13). Such results reflect a call for new and innovative practices for preventing human conflicts with large carnivores.

Aversive conditioning is an emerging approach toward peaceful coexistence with large carnivores and viewed as both safe and humane (Meadows & Knowlton, 2000). Aversive conditioning, "an operant technique that uses a negative stimulus to cause pain, avoidance, or irritation in an animal engaged in an unwanted behavior" (Mazur, 2010, p. 48), can take different forms such as rubber bullets, loud noises, and dogs—with the goal of altering existing habituation and keeping wild animals away from humans in areas where interactions can be problematic (Mazur, 2010). The use of domesticated animals as guards is a common technique to ward off large carnivores. For example, guard dogs are employed to keep wolves away from livestock (Cluff & Murray, 1995), llamas to protect sheep from coyotes (Meadows & Knowlton, 2000), and Karelian bear dogs to scare away habituated bears. These methods are growing in popularity and are reported to be extremely effective (Crugnale et al., 2019). Such examples are promising non-lethal options, and more humane alternatives to other non-lethal methods such as relocation of human-conditioned large carnivores, a method that is problematic and ineffective (Crugnale et al., 2019; Isasi-Catalá, 2010).

In part, coexisting with wild animals means humans must take responsibility to avoid attacks. Given children are at a higher risk of being attacked (Bombieri et al., 2018), one strategy toward coexistence is to employ close supervision in regions where habituated large carnivores live and are known to be active. For adult humans, unprovoked attacks can be avoided as well, but interactions and encounters are contingent on cultural and physical conditions. For example, in the Western world, people may need to take extra caution when running, hiking, camping, or cycling in habitats where carnivores are active, or instead choose to do these recreational activities on trails where large carnivores are not as active. In their research on coyotes within the United States and Canada, White and Gehrt (2009) recommend sleeping in closed tents and paying careful attention when walking with a companion animal. In developing nations, and especially for rural communities, different considerations are foremost: firewood, water, and animal husbandry practices require travel into carnivore habitat, and farming practices may leave people more vulnerable to attack. For example, in rural Tanzania, lion attacks on humans are more common at harvest time because farmers sleep in the

field to control the presence of bush pigs. Coexistence here requires controlling the numbers of bush pigs so that lions are not drawn to the area where farmers are (Packer et al., 2005).

Intentional provocations can, of course, always be avoided. For example, "attempts to … kill the animal," "[luring] an animal closer to themselves" (Hockings et al., 2010, p. 888), or "cornering [a] coyote" (White & Gehrt, 2009, p. 423) are all instances where the human is responsible for the attack.

Systematic records

Similar to Löe and Röskaft (2004), we recommend more systematic record-keeping of large carnivore attacks. This will minimize inconsistencies among databases and government reports. For instance, the data included in Table 2 do not feature attack statistics from consistent timelines, regions, or sources. In creating systematic records of sightings and attacks we urge scholars, management experts, and communities to adopt uniform terminology. If attacks were reported under the definitions of Provoked and Unprovoked (e.g., Quigley & Herrero, 2005), such consistency would allow for more definitive analyses of and insight into the drivers of human conflicts with large carnivores, and would in turn support improved management decisions. Similarly, if these terms entered the public and media discourse, the public would also be enabled to make better decisions for their safety, as well as gaining greater understanding, and possibly appreciation, of wild carnivores.

Several reports did thorough searches of a combination of government documents, academic literature, media reports, and databases (Mattson et al., 2011; McNay, 2002; White & Gehrt, 2009), but many others drew from a narrower range of sources that would have excluded some reports. In addition to an exhaustive academic search, we recommend scholars include available gray literature when documenting attack information. Such efforts will allow for the most accurate and conclusive reporting.

Finally, specific details of each attack are necessary but are not common in the literature. For example, some sources did not report where the attack resulted in a fatality, or whether human provocation was a factor (Beier, 1991; Bombieri et al., 2018). Regarding coyotes, White and Gehrt (2009) found 47% of all victims were attacked while performing a recreational activity (e.g., jogging or hiking), and 19% while resting or sleeping outside. The activities people are engaged in prior to an attack and their behavior during an attack are also important, as is information on habituation patterns, and on intentional and unintentional provocations. Additionally, poor health in an animal should be investigated beyond disease, to include considerations for injury (either natural or human-induced), malnourishment, or other factors that may be causing unusual aggression. Precise information on the locations of attacks, including proximity to human settlements

and even urban centers, will shed light on habituation patterns of species. Details of multiple attacks attributed to an individual animal should also be recorded and verified, where possible.

One way to include more information in record-keeping is to allow citizens to file attack reports online, where access to the internet is feasible. It is vital the communities who live among such species know how to report sightings. An inclusive approach for reporting would disseminate information (including how to report an attack and sightings) to all community members living in a shared ecological space with a large carnivore. White and Gehrt (2009) suggest recorded attack details for coyotes should include victim demographics, activities of the victim prior to the attack, coyote behavior prior to the attack, victim behavior during the attack, and presence of any companion animals in order to draw stronger conclusions about the nature of the attack. Further, we argue that photos to accurately identify species and individual animals are necessary for verifying sightings and gaining knowledge of habituation patterns. Löe and Röskaft (2004, p. 286) provide a table of 18 criteria used in various databases to describe encounters with or attacks on humans by large carnivores. Once a sighting is reported, appropriate information should be provided to the community, including how to avoid encounters and peacefully coexist with the large carnivore, as an educational and outreach response. Where possible, online reporting and email-generated responses with educational information could be provided.

Where online reporting is not feasible, we urge the development of methods suitable for the given community for gathering data and disseminating information. These methods could include appropriately trained workers or volunteers taking records of verbal reports, using techniques such as questionnaires addressing standardized criteria, maps for information on animal range, and species and individual identification photos.

Risk from attacks

From an empirical perspective, the actual risk of a large carnivore attack on a human is low when compared to other natural threats. For example, from 2009 to 2018, an average of 27 people died and 243 were injured annually from being struck by lightning in the United States alone (National Weather Service, 2019). In Canada and the United States combined, during a 32-year period from 1969 to 2000, 50 people were attacked by a wolf (McNay, 2002)—an average of less than two attacks per year. Similarly, during a 59-year time span from 1955 to 2014, there were 92 incidents of brown bear attacks—also an average of less than two per year (Penteriani et al., 2016). While it is difficult to record the number of people killed by lightning globally, estimates range between 6,000 and 24,000 per year (Perraudin, 2014). In 2018 there were 66 Unprovoked shark bites globally, resulting in four fatalities (van Hoose, 2019), a small number in comparison to the lowest estimation

from lightning deaths. Such comparisons illuminate the low risk involved with human fatality related to large carnivores when placed next to natural accidents, of which lightning strike is only one example.

We have compared these data to highlight how misconceptions of the actual risk posed by large carnivores to humans differ in magnitude from the media portrayal of such incidents in the developed world (McCagh, 2015) and the storytelling that often occurs in the developing world that leads to "man-eater" constructions (Kelly, 2019). Management decisions should be based on accurate records that reflect reality, as opposed to basing them on public perceptions. Disentangling actual risk from perceptions of the threat is one avenue for future research that would illuminate misinformation and combat retaliatory responses to large carnivore attacks. If the ultimate goal of peaceful coexistence between humans and large carnivores is to be attained, we must understand the reality of such interactions, in number, in magnitude, and in nature.

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The Face of the Beast: Bestial Descriptions and Psychological Response in Horror Literature

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Abstract

Current scholarship surrounding the predator mythos in culture and literature suggests a distinctive binary of wild–domestic. Scholars often argue that the uniquely terrifying aspect of the predator is in its unconscious capacity to invade our standards of civilization, disrupt order, and pass our final frontier of fear: that of being eaten alive. Other scholars, too, tend to read the terror of these predators with an almost colonial analysis, centering around the concept of the predators' ulterior motive to flip the cultural hierarchy of human above animals. However, what these scholars often neglect are the physiological and evolutionary drives that ultimately construct a genetic response to these predators' general anatomical outlines and features. As we undertake the crucial work of understanding humans' perceptions of their place in their environment, it is important to recognize that, aside from discussions of culturally constructed paradigms of dominance, we too are animals, with primal responses to our environmental conditions. These instinctive responses must be acknowledged as playing a part in our view of the "wild." The scholarship on predator–human interactions necessitates a close study of such relations. In horror texts—literature, films, video games, and other media—the depiction of fearful "beasts" relies on anatomically deconstructing the image of the predator to highlight key predatory features that generate instinctive responses in the audience. On display, in the horror genre, is the anatomy of our fear of predators.

Keywords: animals in literature, animal representations, evolution, horror literature, physiological responses, predators

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Introduction

The beast approaches. Its fangs are dripping; its eyes are gleaming; and a low growl emits from its throat. Behold the monstrous beast. As far back as our mythic history documents, animal monsters[2] have raged across our culture and literature. They become the objects (and subjects) of transformation in Ovid's *Metamorphoses*. They line the medieval bestiaries in a combination of myth and science. They terrorize the seas of Renaissance maps as both adornments and very real warnings: Here, there be dragons. And, in recent years, we have new monsters: ants that are 30 feet high in Gordon Douglas's 1954 film *Them!*, sharks that devour ignorant swimmers in Peter Benchley's award-winning novel *Jaws* (1974), zombie companion animals in Stephen King's *Pet Sematary* (1983), and a pack of killer wolves in the 2011 film starring Liam Neeson, *The Grey*.

As one can easily imagine, these monsters appear rather frequently in the genres of horror and thriller literature. They can be minor pests, such as the half-decomposed dogs of the *Resident Evil* video game series (Mikami, 1996–present), or they can be titular antagonists, such as in the often comedic horror film *Eight-Legged Freaks* (Elkayem, 2002). In these types of works, the monsters are rarely multifaceted characters. At no point in *Black Water* (Traucki & Nerlich, 2007) are we to feel sorry for the man-eating crocodile. We do not find ourselves analyzing the ethics of predation with the velociraptors in Michael Crichton's *Jurassic Park* (1990). So, despite the fact that, really, most of these fictional beasts are quite similar from a narratological stance at least, how is it that they continue to inspire such terror? How can we read a purely biological description of a predator's anatomical features in a novel and connect even these few words with as strong an emotion as fear? What makes these monsters an asset for the horror genre?

Current scholarship surrounding the predator mythos in culture and literature suggests a distinctive binary of wild–domestic. Scholars often argue that the uniquely terrifying aspect of the predator is in its unconscious capacity to invade our standards of civilization, disrupt any semblance of life, and pass the final frontier of fear for us; being eaten alive. Victorian scholar Claire McKechnie (2012) speaks of the cultural fear toward spiders and claims that the major contributing factor to their negative portrayal is due to their violation of human boundaries:

> As representative of the colonial aggressor, the spider trope gave legitimacy to, while expressing fears about, the authority and legality of the imperial endeavour. The spider represented the transgression of boundaries between inside and outside, home and abroad, self and other, security and danger. (p. 507)

2 Throughout this paper, I will use the following terms almost interchangeably: "beast," "monster," "animal monster," "predator," and "carnivore." While there are certain nuanced differences (e.g., "predator" has the connotation of hunting, while "carnivore" has the connotation of devouring), whenever I refer to any of these things, I am intentionally excluding human "monsters" and animal–human hybrids, such as werewolves and mermaids.

Here, the spider embodies this invasion of the domestic space. Australian cinema scholar Catherine Simpson tackles the problem of what she calls "eco-horror" films, such as the aforementioned *Black Water*, in which nature lashes out as an aggressive force to snuff out humanity as a form of Gaia-ic vengeance. She considers the terror of these conquering predators to be due, at least in part, to the threat they pose to our anthropocentric conception of the world:

> What these examples of Australian eco-horror display, where humans become prey for animals, is not always an acceptance of our "ecological identity," but more the existence and agency of the "more-than-human" world. (Simpson, 2010, p. 52)

Here, predators in horror manifest as not just colonial invaders as the Victorian spider but also as *conquerors*, seeking to shift our cultural balance to one more subordinate to animal space. Other scholars, too, tend to read the terror of these predators with an almost colonial analysis, centering around the concept of the predators' ulterior motive to flip the cultural hierarchy of human above animals.[3]

However, what these scholars often neglect are the physiological and evolutionary statistics that ultimately reveal there is a genetic response to these predators' general anatomical outlines and features. As we undertake the crucial work of understanding humans' perceptions of their place in their environment, it is important to recognize that, aside from discussions of culturally constructed paradigms of dominance, we too are animals, with primal responses to our environmental conditions. These instinctive responses must be acknowledged as playing a part in our view of the "wild." Zoologists and animal studies scholars[4] have yet to meld each other's fields of concentration into a cohesive work on the physiological response to predators in the rhetorical mode of literary description of these predators. Even in film, video games, and graphic novels, the anatomical forms of the predators can be deconstructed to highlight certain predatory features that generate instinctive responses. This dearth of zoohistoricist scholarship[5] on predator–human interactions necessitates a close study of such relations, especially in the context of horror narrative. Horror literature—including films, novels, graphic novels, and video games—relies on anatomically deconstructing the image of the predator in such a way that it appeals not to a scientifically realistic description but to the instinctive psychological reduction of predators that humans experience. The way that this article defines "instinct" is informed largely by cultural evolution writers, such as Paul A. Trout (2011) and Joseph Henrich (2016). So, when discussing instinct and psychological or physiological responses, I use wide strokes as a means of generating a point of departure from which other researchers can build. Horror literature itself is,

3 For examples of these other studies, see Lucic (2014), Neff (2016), and Soles (2014) in Further reading.

4 "Animal studies" here implies the humanities approach to the study of animals, including but not limited to the schools of philosophy, ethics, literature, and history.

5 "Zoohistoricism" here involves the study of animals through a natural historian lens, especially in the context of the humanities as affected by science.

of course, a very broad term, and I am using it the way Dominic Strinati (2000) defines it as a genre that "represents the need for suppression if the horror shown is interpreted as expressing uncomfortable and disturbing desires which need to be contained" (p. 82). Many of the terms, and ways I use them, will become clear through not only my analysis of the current research but also through the literary case studies following.

In our blood

Before actually delving into fictional works, it is crucial to set up a foundation of understanding human psychophysiology regarding predator interaction. This foundation will help in understanding just how thoroughly and completely the instinctive response to predators is not just toward a holistic image of the predator but in response to a predator's individual anatomical parts. When we understand the psyche of fear responses toward predators, we can apply that knowledge more confidently to anatomical descriptions of predators in horror literature.

The first major concept of human response to predators is in what can be called the "triggers of fear." These are essentially physiological sensitivities to specific environmental stimuli. Professor emeritus Paul A. Trout has done extensive research on the connection between Joseph Campbell's "mythic imagination" and evolutionary responses to predators. He talks about newborn chicks having comparable physiological sensitivities to humans:

> They will scurry in fright when a cardboard cutout of a hawk that has been placed on a string moves across a barnyard. But if the cutout is made to go backward or if the shape is changed to resemble a non-predatory bird, the chicks show no fear. The chicks have been programmed by evolution to fear a certain *shape* and *trajectory of motion* rather than a specific predator. (Trout, 2011, p. 67)

These same types of categories exist for humans. Trout elaborates some of these individual traits we recognize not just taxonomically—"this is a predator"—but also through fear response:

> Our ancient ancestors were primed by evolution to associate these features with a potential threat to their lives. To feel fear, they did not have to identify the specific kind of animal—they simply had to notice any of these physical features: staring eyes, an open mouth, flashing sharp teeth, a lolling tongue—these all spelled "danger," "predator." (p. 77)

Aside from these facial features, Trout includes our fears of menacing movements, blood, bones, certain sounds, tracking signs, and darkness.

It is crucial to observe that these stimuli are what construct our instinctive response to predators, not taxonomy. Hans Kruuk (2002), another predator specialist, conducted a study on wildebeests' responses to a stuffed hyena:

> But the wildebeest just seemed to laugh at my experiment, and totally ignored it. Later I realized that these animals react to a host of small signals from the predator, to how it walks, which way it looks, whether it has just eaten, and more. (p. 172)

And he notes that such concepts translate to humans, especially:

> A specific example is the behavior of people to one of their classic predators, the lion … When visitors on bush-walking safaris are taught what to do when walking in wild country in Africa, they have to be persuaded hard not to run away when a lion approaches, but to stand their ground or climb a tree. It is very difficult to get people to do this because of the almost irresistible urge to flee, which could be fatal. (pp. 175–176)

This type of fear is captivating because it overrides *logos* in favor of the more bestial *pathos*. This anatomically reductive instinct we possess can be stronger than what we are told will keep us alive.

So, why do we have this instinctive fear? What is its evolutionary reasoning? A major aspect of it is fairly straightforward: we are scared of being eaten alive. David Quammen (2003, p. 274) argues that our fear of predators is not some metaphorical fear related to dominance–submission. Instead, through his engagement with Shepard (1997), he argues quite the opposite: "Such fear arises from signals beyond memory, beyond oral tradition, beyond ancient poetry and cave art … it's programmed into human DNA." So, here we see how this kind of fear is not merely cultural, but also instinctive.

With this instinctive anatomical reduction (from here on, IAR) of predators, we create this almost hyperreal identification of that which we fear. Even as we know quite logically that dragons are not real and that dinosaurs no longer roam the earth, we can watch something like *Jurassic Park* or even Ridley Scott's *Alien* series and be afraid of these monsters that do not exist in reality. Cultural scientist Matt Kaplan (2012) argues that it is often a combination of real predatory features and the metaphorical danger of the unknown that keeps these monsters terrifying, especially in the context of *Jurassic Park*:

> The combination of such realistic traits in the dinosaurs along with the message that natural systems are totally unpredictable reinforces an image of the natural world as inherently dangerous to interfere with. (p. 188)

Watching the film *Jurassic Park*, we can break it down into the core IAR elements that Trout introduced. We see the flashing eyes, the sharp claws, the open mouth. So, altogether, predators are not just a taxonomical entity but also a subconscious construct composed of clearly identifiable anatomical parts.

When we come to look at the genre of horror literature, IAR appears a surprising amount. This genre in popular fiction does not lend its animal antagonists with the same mode of technical accuracy with which it renders Gothic architecture or clothing details. The predator thrives in outline and in focus of the IAR parts.

In our texts

In the examination of predators in texts (all cultural expressions: literature, film, video games, arts, etc.) of the horror genre, the narratological role of the predator takes certain precedence. In many cases, the predator is the primary antagonist, for example, the titular monsters of *Jaws*, *Cujo*, and *Arachnophobia*. In other works, the predators occupy the role of minion or even omen, such as the raptor imagery pervasive in Alfred Hitchcock's film *Psycho* (1960) or the bees of Bernard Rose's film *Candyman* (1992). Sometimes, this role is compounded more so that we have an anthropomorphic villain rather than typical predator antagonism. Prime examples include any werewolf novel or even Ridley Scott's *Alien* series (1979–2017), in which the aliens have their own system of communication. However, in the more frequent case of the bestial predator, the descriptions become anatomically reductive, centering on the physical characteristics of humans' IAR-based response of fear. In this way, horror writers are not just tackling the general question of what people fear but are actually tapping into genetic coding of humans' predator recognition.

On our pages

One example of this is in Stephen King's best-selling novel *Cujo* (1981). When the Saint Bernard dog starts showing severe symptoms of rabies, the character Brett perceives him as almost wolf-like: "The Saint Bernard's big, sad eyes were now reddish and stupid and lowering: more pig's eyes than dog's eyes … His muzzle was wrinkled back in a terrible mock grin that froze Brett with horror" (p. 98). Despite King's usually meticulous attention to details such as brand names, colors, and marks of degradation,[6] the Saint Bernard is the least realistically described and the most mythological in proportion. The earliest iteration of the Saint Bernard in the novel is actually in the young Tad Trenton's nightmarish, imaginary conversion of things in his closet into a monstrous canid: "Low to the ground it was, with huge shoulders bulking above its cocked head, its eyes amber-glowing pits … He heard its

6 For more information on King's use of meticulous detail, see Davidson (2015) in Further reading.

purring growl; he smelled its sweet carrion breath" (p. 4). Throughout the novel, the Saint Bernard retains this reductive description. We rarely see what colors its fur is. We rarely see precisely how tall it is. We rarely see any realistic portrayal of the dog.

Another great case study is in Clive Barker's *Books of Blood* series. Probably the most renowned of his animal antagonists is the great sow of "Pig Blood Blues." However, the predator aspects of the pig are confounded by heavy anthropomorphism as the animal is seemingly possessed and able to speak in a human's voice. A strong example of a Barkerian predator is in his short story "Twilight at the Towers." In this story, an antagonistic magician is able to summon a mystical tiger. The protagonist first encounters the tiger as it is devouring a witness of a prior murder:

> She was there. But so was the tiger … Its eyes were molten; its open maw impossibly large. And there, already in its vast throat, was Barbara. He met her eyes out of the tiger's mouth, and saw a flicker of comprehension in them that was worse than any madness. Then the beast threw its head back and forth to settle its prey in its gut. (1991, p. 165)

Here, again we have a predator reduced to eyes and a mouth. Even in other descriptions of the beast in the story, there is more emphasis on the glowing eyes and gaping maw than on the fact that the animal is striped.

A third case study is in Peter Benchley's 1974 novel, *Jaws*. As Benchley states in his nonfiction work on sharks, *Shark Trouble* (2002), he had a large hand in America's cultural mythos on sharks (pp. 32–41). His infamous shark tale encapsulates the innate fear of sharks, not to mention other denizens of the deep. So, how does Benchley describe the fish? In the novel's opening paragraph, it goes back to the eyes, the forward motion, and the titular jaws:

> The great fish moved silently through the night water, propelled by short sweeps of its crescent tail. The mouth was open just enough to permit a rush of water over the gills. There was little other motion … The eyes were sightless in the black, and the other senses transmitted nothing extraordinary to the small, primitive brain … it survived only by moving. (1974, p. 3)

Again, we have no description of the body of the beast, just those particular anatomical features in detail.

So, what we have is an almost subconscious writing formula for the descriptions of horrific predators, reducing them to a handful of specific criteria, rather than painting a realistic image of the monster. And this concept manifests in a clearly quantitative way, as observed in Table 1.

Table 1. Statistical appearances of instinctive anatomical reduction (IAR) in predator descriptions of five horror works

Title	Instances throughout work regarding predator descriptions					
	Eyes	Maw/ teeth	Claws	Growling	Movement	Non-IAR descriptors
Jaws	8	52	–	–	12	11
Cujo	21	24	10	24	11	10
"Twilight at the Towers"	2	11	43	8	5	3
*Winter Wolves**	31	18	11	16	13	12
The Hatching†	0	22	15	–	37	16

* This book (Wescott, 1989) was likely an inspiration for the 2011 film starring Liam Neeson, *The Grey* (Carnahan, 2011), discussed below.

† This book is a progressive apocalyptic novel featuring deadly spiders (Boone, 2016).

The data in Table 1 reveal that primary trends in horror literature limit descriptions of predators to IAR, highlighting the eyes, motion and trajectory, jaws, and claws of the beast as opposed to other characteristics such as musculature, fur dynamics, or even coloration. One could easily examine these findings and claim they are simply prominent physical attributes of these animals and therefore would have nothing to do with an inherited perception of predator anatomy. However, this starkly contrasts with similarly placed descriptions of fantastical and anthropomorphic monsters—for example, werewolves, the great sow of "Pig Blood Blues," or the many speaking monsters of the *Harry Potter* (Rowling, 1997–2007) universe—and completely human antagonists. Even with something like vampires, more attention is often given to their clothes or their intelligence than to their fangs and claws.

Still, this analysis creates an approach for quantifying predator descriptions in horror novels and short stories. But how do we analyze such appearances of predators in elements of popular literature outside of novels and short stories, such as films, graphic novels, and video games?

In our visions

Often, in these visual mediums, the predators occupy a liminal space in the artistic style of the depiction. As subjects and objects of horror, the predator must become more terrifying than it appears in reality. After all, it must become what Angela Carter (1993) has called the "carnivore incarnate" (pp. 110–118). In order to achieve this transformation, the artistic rendering often reduces the predator to a dark shape with glowing eyes and dripping fangs. (In the rare case that the predator does have more intimate detail, it is to highlight a fantastic monstrosity rather than a scientific characterization of the predator.)

A great starting place to examine this is Catherine Hardwicke's 2011 film, *Red Riding Hood*. In a film where color matters significantly in the plot—even in the name of the tale—we would expect a lot of separation of the wolf from the background. However, most of the time in the film, the wolf is a black silhouette on dark backgrounds. The only clear detail about the wolf for most of the film is his glowing eyes (occasionally we get a glimpse of his open jaws, too). Most of his movements are slow and deliberate as he hounds each of his human prey with cold intentionality. In this way, we have even a visual wolf relegated to the "rules" of IAR in horror.

This practice of silhouetting the monster in general with focus on the eyes and maw is far from rare in horror films focusing on predators. Here are a few examples:

First, there is the resurrected cat, Church, from the film *Pet Sematary* (Lambert, 1989). Multiple times in the film, Church is portrayed as a dark cat, typically in dark environments. In almost every shot of the uncanny cat, its mouth is open revealing fangs, its ears are back, fur bristled, and eyes glowing yellow. The original trailer for the movie shows this, too.[7]

Next, there is the wolf pack from the film *The Grey* (Carnahan, 2011). In one scene, the survivors of the plane accident huddle around a campfire in the frozen woods. Outside of the fire, there is just darkness, and all the survivors can see are pairs of eyes staring back at them, though one pair of eyes ventures a little closer to bare its fangs.[8]

Next is the *Tyrannosaurus rex* from *Jurassic Park* (Spielberg, 1993). What many might remember about this film is one of the early scenes when the park's electric security systems shut down and the monstrous T-rex attacks the main characters on the storm-drenched road. In this scene, the dinosaur is constantly framed by darkness and lightning, his mouth opens in a toothy roar, and his eyes are glowing.[9]

In video games, predators often become a touch more realistic than their film counterparts. This is often due to the player being able to move the camera at their discretion, so the creator cannot limit the player's view to a certain perspective of the predator. Essentially, the animal must look terrifying from all angles. Two of the major ways to accomplish this three-dimensional terror are to focus on the beast's trajectory and motion and to give the predator bestial sounds.

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7 See this link for the original trailer (timestamp 0:26): youtube.com/watch?v=JMao8sg4DPA

8 An example of this can be found in the original trailer for this film (timestamp 0:57): youtube.com/watch?v=eUP5Vr0lBvY

9 While the trailer never shows the full face of this dinosaur, it does show the glowing eye up close (timestamp 1:47): youtube.com/watch?v=Bim7RtKXv90

For example, in the case of the *Silent Hill* series (Toyama, 1994–2019), there is a canine monster—presumably undead—reminiscent of a greyhound to signify its speed. The creature, known as the Groaner, is cadaverous, emaciated, and hunts the player, often in packs. It is distinguished not just by its appearance but by its characteristic "groaning" sounds and the rapid speed with which it chases the player. So, even while the camera rarely gets to focus in on the Groaner, we still get that IAR response through its trajectory and motion and its sounds.

This visceral rendering of predators also appears in the video game *Bloodborne* (Miyazaki, 2015), in which we have a pig-like monster that is mostly depicted in low detail except for its gaping maw and stalking trajectory. It is massive in size and covered in deep, wrinkling folds of flesh. The folds are so large that they seem to cover its eyes, and its salivating mouth is open, revealing red gums and sharp rows of teeth. Its depiction is grotesque for certain, but generally it is a mass of wrinkled flesh except for its mouth, the only clearly distinguishable physical attribute.

And when the predators are not gross and fleshly, they often revert to the film trope rendering of silhouette forms, such as in the game *Limbo* (Jensen, 2010). This entire game is in grayscale. It is two-dimensional, and even the main character is a flat, black silhouette navigating a silhouetted terrain with a gray background. In this game, spiders appear frequently, stalking the player with sharp claws—the spider can impale the character's body with a sharpened leg, wrap them in silk, and eat them if the player is too slow. But what makes it horrifying is that all we see is this silhouette. The sharp points are distinct—its fangs and claws—and the rest of it is shadow.[10]

Pulling it back to pen and paper, we get to see predator representations and IAR appear in graphic novels and comics, also. With the option of heavy shading available, predators can appear in extreme silhouettes where a single color has the opportunity to stand out from the rest of the form. One strong example of this is Stephen King's story "The Crate" as it appeared in his graphic novella *Creepshow* (1982). In one of the pages, a dark-furred predator has escaped from a chained crate and kills and devours a woman who has been a prominent character in the story. The beast has vague details on his fur, but we get his fangs and eyes in sharp clarity. In the bottom-left panel, his form blurs into the shadows. The sharpest colors are the beast's yellow eyes and the red of the woman's blood and shirt. Other examples include comic books *The Dark Knight Returns* and *300* (Miller, 1986, 1998), in which the predators are mostly silhouetted except for those IAR-based features in sharp color.

10 Though the trailer shows the spider for only a second, and not one with noticeable fangs, it still shows the silhouetting (timestamp 0:45): youtube.com/watch?v=Y4HSyVXKYz8

All of these audiovisual works go through a deconstructionist approach to predator representation similar to their likenesses in strictly textual mediums.[11] They all find ways to make the body of the predator almost obscure while the IAR-based features become highlighted, whether that is through a textual focus or through the use of color. One major difference between audiovisual mediums and textual mediums regarding predator representations in horror is that the audiovisual mediums express the form of the beast primarily through shading or blackness, while the textual mediums create this same vagueness through a lack of body description (other than size, occasionally).

However, both forms of representation reduce the predator to these IAR-based standards. Whether we are dealing with a meticulous writer, artist, or director, the predator becomes inherently vague in order to highlight those physical traits of the predator of which humans are instinctively afraid.

Conclusion

Through this biological–physiological lens, a statistical approach to predator descriptions in horror literature becomes not only possible but quite revealing: when creators and consumers of horror literature question what makes them terrified of predators, the portrayals of the predators become a cyclical notion. That is, as creators ask themselves how a predator can be terrifying, their instincts, whether consciously aware or not, dictate these basic forms from IAR; consumers, in turn, respond through IAR with fear because of the creator's prowess in exploiting their audiences' natural instinctive responses.

This research can be used to further our understanding of animal predators, not just as cultural tropes, but also as subconscious constructs formed as responses to audiovisual stimuli, even in literature.[12] Further study could be conducted on comparisons of these descriptions in horror with horrific animals that are *not* predators, such as the hedge animals of Stephen King's novel *The Shining* (1977) or the 1986 film *The Fly* (Cronenberg, 1986). Researchers in social sciences can start to think interdisciplinarily about these instinctive responses to predators. When we stare into the face of the beast in cultural representations, what happens on a psychological level? What differences are there across gender, sexuality, race, class? The import of this study is that it provokes these kinds of conversations across disciplines and begs us to really ask what happens to us when we acknowledge these anatomical features and our responses to them. And beyond consumers of horror,

11 For more research on the aesthetics of predators in horror films, see the aptly named scholar Lionel Tiger's (2006) research in Further reading.

12 See Asma (2014) in Further reading for more research on human responses to fear as evidenced by horror literature.

this research speaks to general studies of beastly encounters: when encountering animals, how do we culturally construct that animal's image in our minds, and then how do we *reconstruct* that image when it comes to cultural texts?

Still, when we examine these predator descriptions in horror, we are able to break them down to their bare bones: IAR-based responses to predators. Whether an intentional compositional technique or not, the ascription of the portrayals of predators in horror to instinctive reductions belies a cultural subconscious that generally fears these attributes in predators. When we consider the appearance of the predator, we are not concerned with the size of its paws. We do not even concern ourselves with the state of its fur. We are concerned with one thing only. After all, we are staring into the face of the beast.

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Research and Theory in Human Ecology

The "Efficiency Concern": Exploring Wildfire Risk on Heirs' Property in Macon-Bibb County, Georgia, United States of America

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Abstract

There is heightened interest in heirs' property research, as a burgeoning social science literature and recent popular press articles have drawn attention to the inequities of this insecure type of property ownership. Economists and legal scholars charge that heirs' property ownership inhibits the ability of owners to efficiently manage property. We developed a novel methodology combining LiDAR techniques, GIS mapping, and Fuel Characteristic Classification System data to compare vegetative understory accumulation and wildfire risk for heirs' and non-heirs' parcels in rural Macon-Bibb County, Georgia, United States. Paired samples t-test of LiDAR-detected understory amounts indicated no significant differences for heirs' and adjacent non-heirs' parcels. However, surface-level wildfire spread more rapidly on heirs' parcels, but heirs' parcels had significantly less available fuel. Identification of wildfire risk for heirs' property owners can help public land managers better understand wildfire risks for this type of socially vulnerable real property owners.

Keywords: heirs' property, land parcels, LiDAR, US South, wildfire risk

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1. Introduction

This study considers potential inefficiencies associated with heirs' property, in terms of potential wildfire risk, in Macon-Bibb County in Georgia, a state in the southern United States (US). A tenancy in common or "heirs' property" describes inherited, real property, passed to subsequent generations via US state laws of intestate succession (Chandler, 2005; Emergency Land Fund, 1980; Mitchell, 2001, 2005). Property is usually classed as "heirs'" because someone dies without a will or other legal document formally conveying property to survivors. The joint co-heirs of these properties come to own fractional shares of the whole property. The lack of formal title stymies families' ability to generate wealth and then to transfer that wealth intergenerationally because heirs' property usually cannot be used as a financial leverage. Only rarely do creditors accept heirs' property as collateral for loans, for example. As well, heirs' property disqualifies owners from participating in various land improvement programs offered by state or federal governments, and can inhibit owners' ability to sell resources such as timber (Bailey et al., 2019). Heirs' property presents these difficulties because the titles are considered "clouded" or "unclear," arising from uncertainties about the identity of the many co-heirs who have fractional interests in and rights to property. For instance, the names of most living family members are not included on these property titles, only the names of deceased family members; this fact distinguishes heirs' property from "clear" or "marketable," outright ownership where property owners are explicitly named on property titles. These extended family members are in effect "undocumented" owners, and therein lies the messiness of this form of tenure.

Our study contributes to the heirs' property literature by considering the impact of heirs' property ownership and management on fuel loadings or understory accumulation on rural land. While it is clear that heirs' property owners have great difficulty in using these properties for financial purposes, it is less certain whether such co-ownership results in inefficient land management; in particular, inefficiencies that present in the form of excessive understory, resulting in increased wildfire risk. Our research is inspired by Deaton et al.'s (2009) qualitative research in the US state of Kentucky, which found that members of an heirs' property–owning family were constrained in their ability to reduce understory on their woodlands because family members could not reach consensus on whether to dissolve the heirship. We also base this inquiry on input from two professional foresters who, when asked if fuel loadings on heirs' property are greater than loadings on non-heirs' parcels, responded that the question merits empirical investigation (C. Bailey, South Carolina Forestry Commission, personal communication, December, 2016; S. Cook, North Carolina State University, personal communication, October, 2016). We are not aware of other studies that have examined this question.

Heirs' property ownership is especially prevalent among African Americans in the rural Black Belt South[2] (Craig-Taylor, 2000; Dyer et al., 2009; Johnson Gaither, 2016; Mitchell, 2005; Schelhas et al., 2017). In 1980, the Emergency Land Fund estimated that 41% of black-owned land in the South was heirs' property (Emergency Land Fund, 1980). These properties also appear to be pervasive in the mostly white, central Appalachian region of the US South (Deaton, 2007, 2012); they exist on Native American lands as a result of US government–instituted allotments (Bobroff, 2001); and are likely prevalent in Texas *colonias* along the US–Mexico border (Way, 2010). Members of each of these groups is more likely to be socially disadvantaged. Indeed, the spatial aggregation of such properties is cited as a primary factor contributing to persistent poverty in Appalachia and as a contributor to the generations-long wealth gap between African Americans and whites more generally (Deaton et al., 2009).

This kind of property ownership in the US is analogous to that described by de Soto (2000), who coined the term "dead capital" to reference real property in the developing world—assets that cannot be used to generate capital due to uncertain ownership and lack of written documentation. Consistent with de Soto (2000) and others' argument for secure property rights, Deaton et al. (2009) and Deaton (2012) raise the "efficiency" concern regarding heirs' property ownership. A basic tenet of heirs' property ownership is that co-heirs have the right to access and use property (similar to common property regimes); but also that any co-heir has the right to *exclude* activities of other co-heirs, which results, Deaton (2012) and Deaton et al. (2009) argue, in inefficient or less-than-optimal land uses from the perspective of maximizing revenue and quality of resources. They argue that such inefficiency may contribute to elevated risks for a variety of environmental threats, including wildfire.

We do not attempt to quantify via economic analysis efficiencies associated with excessive understory accumulation on heirs' and non-heirs' properties. Rather, we draw conceptually on the "right to exclude" stipulation of heirs' property ownership: any heir, no matter the size of her or his fractional ownership, can prevent any use of the property that requires all co-heirs to agree. In such scenarios, inefficiencies result because all co-heirs are made worse off (e.g., in economic or environmental terms) due to the obstinacy of a single owner or sub-group of owners. Heirs' property extent is difficult to assess because of the lack of record-keeping or uniform methods of identifying these properties (Pippin et al., 2017). However, county taxing

2 The Black Belt South covers a geographical subregion of the US South, from Virginia southward through the Carolinas and into east Texas (Wimberly & Morris, 1997). One of the first noted figures to describe the region this way was Booker T. Washington at the turn of the twentieth century, where he used it to refer to the region's abundant, black soil. The meaning of "Black Belt" has changed over time, such that it is now synonymous with southern (especially rural) counties with African American populations equal to or higher than the national average.

authorities sometimes include notations[3] in their land parcel records that can be used to make conservative estimates. Using these indicators, we identified roughly 238,000 heirs' parcels across 13 states in the US South, containing 1.42 million hectares (3.5 million acres) of land, with an assessed value of $28 billion.

1.1. Approach

The following sections review the heirs' property literature, as it relates to land management efficiency. This is followed by a non-exhaustive review of landowners' views and practices of wildfire risk mitigation. Next, we present the methodology for this project, where we first use remotely sensed data to assess understory vegetation for non-industrial, private heirs' properties and non-industrial, private, non-heirs' properties. Also relevant for this analysis of wildfire risk is understory composition; that is, the type of vegetation typical for the study area. To do this, we use the US Department of Agriculture Forest Service's Forest Characteristics Classification System to describe fuelbeds common across Macon-Bibb County. Combined, these two assessments indicate both the quantity and quality of fuel or understory and how these may vary depending on heirs' property status.

2. Literature review

2.1. The efficiency problem

The familiar tragedy of the commons situation occurs when multiple users of a common resource have the right to use that resource but do not have the right to exclude others from using the same. Consequently, the resource is overused and degrades to the point where net returns to users are zero. Heller (1998), Buchanan and Yoon (2000), Deaton (2007), and Deaton et al. (2009) characterize a sort of mirror image of commons inefficiency, what they describe as the "anticommons" problem, which exists when co-owners exercise their exclusionary right.[4] In the case of heirs' property ownership, a co-heir can exclude other co-heirs' use of the property by an outright refusal to consent to an activity; or a co-heir can set his or her "price" for participation (i.e., the transaction cost) prohibitively high, such that the proposed action is not carried out (Fennell, 2011). This may not involve

3 These estimates are from an analysis of Digital Maps Products and CoreLogic data for tax years 2016–2017. CoreLogic used the notations "heirs' of," "et al.," "estate of," "deceased," and indicators of multiple or fractional ownership (e.g., ½ interest, 33% interest) to identify heirs' parcels. The validity of such notations in the identification of heirs' parcels was discussed with attorneys with the Georgia Heirs' Property Law Center, with county-level taxing authorities in Leslie County, Kentucky; Maverick County, Texas; and Macon-Bibb County, Georgia. Each of these sources confirmed our use of at least one of these descriptors to identify heirs' properties.

4 Chang (2012) makes this argument conditional, asserting that tenancies in common are "tragic" (as per "tragedy of the commons") *only* in cases when property is not optimized due to co-owners' inability to exit the tenancy at will.

monetary costs alone but also the time and energy to convince other co-heirs of the benefits of a proposed project. Non-agreement by co-heirs that hold out and high transaction costs reduce the benefits that might otherwise be realized for all co-heirs (e.g., wildfire risk reduction).

Generally, timber management activities such as thinning are not a priority for non-industrial, private forestland owners in the southeastern US, even for landowners with clear title. But, not surprisingly, larger, industrial landowners invest more in management activities than do smaller, non-industrial, private landowners (Arano & Munn, 2006). Still, Deaton et al.'s (2009) case study of two central Appalachian counties in Kentucky offers insight into the underutilization dilemma faced by heirs' property owners. In the case of the "Jones" family, very little was done to improve or manage the property for 24 years following the death of the family patriarch. One family member commented that the lack of timber harvesting on the property had resulted in excessive accumulation of understory, which he believed detracted from the overall quality of the mature trees.[5]

Underscoring Deaton's Appalachian findings is Baba et al.'s (2018) analysis of African American heirs' and non-heirs' property landowners in Alabama, which found that heirs' property owners were less likely than owners with clear title to engage in long-term land management planning. However, Walters (2012) did not find that "family land" (analogous to heirs' property) in Saint Lucia, West Indies, differed significantly from other land tenure regimes in terms of apparent conservation; but Ojanen et al.'s (2017) comprehensive review of 103 studies from 1990 to 2014 addressing environmental impacts of various property rights regimes (e.g., state, private, community, mixed, open-access—access and harvesting rights open to all) found that open-access property regimes were less favorable than any other system. Specific to forest operations, comparisons between private and state land management showed that in five of six cases, privately owned properties had better outcomes.

2.2. Wildfire risk in the US South

Wildfire risk is important to consider for the southern US because wildfire occurrence is consequential in the region—the South leads the nation in terms of annual number of wildfires (Andreu & Hermansen-Báez, 2008). Roughly 423,000 wildfires were recorded in the South Atlantic, East South Central, and West South Central between 2002 and 2013, which accounted for 48.9% of all wildfires in the US during the period (Brusentsev & Vroman, 2016). These fires consumed 6,236 hectares (15,410 acres) (Brusentsev & Vroman, 2016).

5 Under certain circumstances, land that is left to regenerate naturally may improve ecologically, and this may be true for heirs' properties in some cases. However, it is also true that some intervention is necessary to maintain the integrity of the land. Because of inattention to the land by absent or disincentivized co-heirs, the land could be ravaged by invasive plant or animal species that hinder more desirable species (Barlow & Bailey, 2017).

Important to these calculations is that roughly 86% of forestland in the South is owned by non-industrial, private landowners. Wildfire mitigation efforts by this segment of forestland owners is an important consideration in wildfire risk reduction, which is crucial to efforts such as the Keeping Forests as Forests (KFAF) initiative, a forest conservation project across the 13 states of the South. Long-term, private forestland ownership and management are key KFAF goals, which necessarily include the identification of socioecological risks for forestlands, with perhaps special efforts needed to identify elevated risks for minority and/or lower-wealth, underserved rural landowners such as heirs' property owners (Bailey et al., 2019; Collins, 2005; Goyke et al., 2019; Johnson Gaither et al., 2011; Schelhas et al., 2016). Fischer (2011, p. 260) underscores this need: "Understanding factors in private forest owners' decisions to reduce hazardous fuels is … important. The practices of non-industrial private or family forest owners are of particular interest because of the location and extent of their lands." We would add that the high proportion of private land ownership in the South compels more strongly the need to evaluate private landowner risks in this part of the country, particularly risks for lower-wealth and underserved populations.

An extensive literature on attitudes regarding non-industrial, private landowner wildfire mitigation has developed in recent years. McCaffrey's (2015) review of the literature on the social acceptability of fuel management and, more generally, people's attitudes during and after wildland fires found four main factors influenced landowner engagement with mitigation: (1) social context of mitigation, (2) trade-offs with alternative amenity values, such as aesthetics and or wildlife habitat, (3) apparent effectiveness of actions, and (4) ability to implement specific activities. The opportunity to receive payments from bioenergy feedstock has also been reported as an incentive for thinning overstocked forest stands (which could include understory reduction). However, Gan et al. (2013) report on the difficulty of engaging landowners in the task—there were more than 2 trillion kg (2,226 million dry tons) of biomass on the ground across the 13 states of the South in 2013, but fewer than 10% of private landowners surveyed indicated they could be induced to reduce fuel loadings even if given technical assistance, the ability to sell biomass, or the chance to participate in government cost-share programs.

Further, Schelhas et al.'s (2016) qualitative study (n = 60) of African American property owners in selected Alabama, North Carolina, and South Carolina counties indicated that only about 13% had conducted a prescribed burn. And while about 52% had thinned or harvested timber, it is not clear whether the reference here is to timber harvesting primarily for revenues or whether landowners consciously thinned to reduce wildfire risk. Half of these landowners had heirs' property, but there was no comparison of mitigation activities for heirs' and non-heirs' owners. Research also indicates that landowners who live on their land are more likely to implement wildfire mitigation practices (Fischer, 2011). This is instructive for understanding

heirs' property owners' participation in fuel reductions, as some research indicates that absentee ownership is indicative of heirs' status (Dyer et al., 2009; Georgia Appleseed Center for Law & Justice, 2013).

3. Methodology

3.1. Heirs' property estimation

We selected Macon-Bibb County as our study area because at 32.7866° N, 83.7199° W, the county is situated in the northernmost area of Georgia's Upper Coastal Plain, an area of the state with high wildfire risk. The county covers a total land area of 646.87 km^2 (249.76 $miles^2$). Also, we were able to obtain Computer Assisted Mass Appraisal data sets for Macon-Bibb County, with heirs' parcels clearly indicated for the county for the tax year 2016 (Pippin et al., 2017). Parcels identified as heirs' (those with the notation "HEIRS OF" next to the owners name in the tax records) are based on information held by local tax officials about landowners and the intestate transferal of these properties. We verified with the Macon-Bibb County tax assessor's office (see footnote 3) that the notation "HEIRS OF" denotes jointly held, private property. The term "et al." is also used in Macon-Bibb County, but these parcels were not included in our analyses because we did not discuss this specific notation with the county taxing official.

3.2. Understory density estimation

Understory accumulation was estimated using remotely sensed light detection and ranging (LiDAR) techniques, which use an active sensor, often mounted on an airplane, to send narrow bands of light in the form of laser pulses to the ground (Renslow, 2012). Pulses are reflected off objects and surfaces of the earth and, much like radar, the distances to objects are calculated based on the timing of the returned pulse to the sensor. The resulting LiDAR data are processed as three-dimensional points, referred to as 3D point clouds, that locate or identify solid objects on the earth's surface. In our case, we wanted to identify vegetative understory in the 1- to 6-meter height range (Figure 1). We used 2011–2012 LiDAR data downloaded from the National Oceanic and Atmospheric Administration by the Georgia Department of Natural Resources and the Environmental Protection Division of Georgia (OCM Partners, 2019).

Using ArcMap 10.3, LiDAR point clouds detecting understory were converted to a raster layer, aggregated at 1 m^2 resolution. Raster data are GIS-specific information in the form of pixels, organized into rows and columns that form cells comprising a grid or matrix. Each cell contains information; in our case this was number of point clouds. Vegetation density for each 1 m^2 pixel was calculated by dividing the

number of LiDAR points within a given pixel by the total number of points for the entire parcel, resulting in proportional values of understory for each pixel, for each parcel. These proportions were reclassified into three classes using natural breaks of low, medium, and high, coded 1, 2, and 3, respectively.

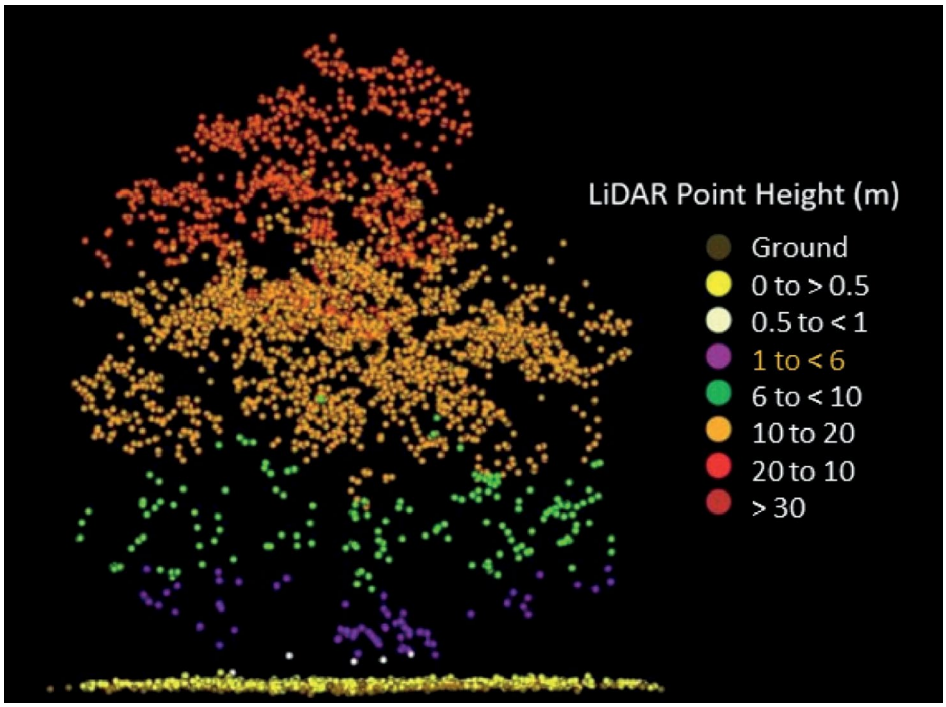

Figure 1. Illustration of 3D LiDAR point cloud displaying light pulses from ground to 30-meter height

Note. This study estimated number of pulses in 1- to 6-meter layer (understory).

For classification purposes, heirs' parcels were assigned a value of 10 and non-heirs' a value of 20. Both types of parcel data were then converted to a raster layer so that the understory and parcel values could be combined. For example, after the attributes of the two raster layers were added, pixels located in an heirs' parcel (HP) were assigned values of 11, 12, or 13, indicating low (11), medium (12), and high (13) vegetation density, respectively; and pixels in a non-heirs' parcel (NHP) were assigned the values of 21, 22, or 23, indicating the same low to high density.

We then compared the proportion of low, medium, and high-density vegetation for HP and NHP. Comparisons were made for heirs' property "neighborhoods," which consisted of an HP and adjacent NHP within a 250-meter buffer of the HP perimeter. For each HP neighborhood, the respective proportions of high, medium, and low vegetation density pixels for both the HP and adjacent, aggregated NHPs in that neighborhood cluster were calculated.

We also used Google Earth to visually inspect each neighborhood to help ensure that land cover for HPs and NHPs were similar. As stated, only non-industrial, private landowners were included in the analysis. The visual inspection allowed for further refinement of the data by identifying properties that had different cover and uses. In 15 cases, HP with forest cover was adjacent to large, private agricultural operations with little or no forest cover. These HP neighborhoods were excluded from the analyses.

3.3. Fuel characteristic classification system (FCCS)

The FCCS organizes and categorizes fuelbeds (measured or averaged physical fuel characteristics depicting a particular fire environment) to assess potential fire behavior (Ottmar et al., 2007; Riccardi et al., 2007). FCCS stratifies fuelbeds into six major types: canopy, shrubs, nonwoody vegetation, woody vegetation, litter–lichen–moss, and ground fuels (also duff) (Ottmar et al., 2007).

To classify fuels (understory), we utilized a 30-meter resolution geospatial data layer of FCCS fuelbeds developed as part of the Landscape Fire and Resource Management Planning Tools program, LANDFIRE (Rollins & Frame, 2006), based on Landsat satellite imagery. Data for each parcel in Macon-Bibb County was extracted (www.landfire.org). Forty distinct fuelbeds were identified for Macon-Bibb County, which included loblolly pine and slash pine plantation; longleaf pine, three-awned grass, and pitcher plant savanna; pond pine, gallberry, and fetterbush shrubland; smooth cordgrass and black needlerush grassland; and red maple, oak, hickory, and sweetgum forest.

Fuelbed data are input into fire behavior models to predict fire potentials—surface fire behavior, crown fire potential, and available fuel potential (Riccardi et al., 2007; Sandberg et al., 2007). Each dimension of fire potential can be broken down into component parts. *Surface fire behavior potential* consists of surface reaction, spread, and flame length (Sandberg et al., 2007). *Crown fire potential* ranks the potential for surface fire to move into the canopy—it comprises crown initiation, transmissivity, and spread. *Available fuel potential* is an estimate of combustible biomass, assuming extremely dry conditions, which consists of flame, smolder, and residual components (Goodrick & Stanturf, 2012; Sandberg et al., 2007). Each subcomponent is measured on a scale of 0 to 9. With the exception of surface reaction and surface spread,[6] the measures are to be understood as potentials only and hence defined as unitless measures.

6 Surface reaction is measured in kilowatts per square meter (kW/m^2). Surface spread is measured in meters per minute (m/min).

We calculated mean parcel scores for each of the nine measures using the zonal statistics tool in ArcMap 10.3. Mean scores were computed for each HP and its adjacent, aggregated NHP neighbors. Because of overlap between neighborhoods, analyses were restricted to only those neighborhoods that did not intersect with others. This reduced the sample size to 34.

4. Results

4.1. Heirs' parcel distribution

The total number of HPs in our study area was 820, roughly 1% of the 69,369 Macon-Bibb County taxed parcels for 2016. Similar to the findings in Dyer et al. (2009), we found a greater concentration of heirs' parcels (n = 618, 75.4%) in the larger, incorporated area of the county, in the city of Macon. However, for our study, we analyzed properties outside of incorporated areas only, as we expect that any significant amount of fuel accumulations would occur outside of cities and subdivisions. Total land area in unincorporated parts of the county is 419.58 km^2. There were 113 HPs in unincorporated areas of the county, but 15 of these were excluded from the analyses because of insufficient forestland cover.

4.2. Understory density of heirs' and non-heirs' parcels

Mean low, medium, and high-density understory vegetation for HPs and NHPs were compared using a paired samples t-test. The analysis failed to find a significant difference between HP and NHP for any level of vegetation density (Table 1).

Table 1. Mean percent vegetation density of heirs' and non-heirs' parcels in Macon-Bibb County, Georgia

	Mean vegetation density (%)		
	Low	Medium	High
Heir	72.67 (17.78)	21.53 (14.72)	5.80 (4.37)
range	0.01–93.90	4.95–84.10	0.31–17.02
Non-heir	73.43 (13.21)	20.68 (9.65)	5.89 (3.99)
range	39.44–100	0–40.77	0–19.79
p value	Not significant	Not significant	Not significant

Note. n = 34. Standard deviation is in parentheses.

4.3. FCCS fire potentials

Scores for the nine fire potential subcomponents of surface, crown, and available fuels are presented in Table 2. For all three surface measures, there is a pattern of slightly higher scores for HPs for each subcomponent, although the paired samples t-test indicated that HPs were significantly higher for surface spread only. Given the low sample size, we chose a significance level of $p = 0.10$. There were also significant differences for available smolder and available residual, but in both cases NHPs had higher scores.

Table 2. Mean fire potential estimates based on fire characteristic classification systems for Macon-Bibb County, Georgia

	Land parcels	
	Heir	**Non-heir**
Surface reaction p = not significant	2.82 (0.98)	2.66 (0.61)
range	0.71–5.96	0.77–3.70
Surface spread $p = 0.07$	4.66 (1.81)	4.02 (0.88)
range	1.56–9.00	1.73–9.00
Surface flame length p = not significant	2.61 (0.77)	2.41 (0.46)
range	0.75–4.22	0.79–3.17
Crown initiation p = not significant	0.56 (0.72)	0.60 (0.29)
range	0–2.77	0.10–1.29
Crown transmissivity p = not significant	1.39 (1.88)	1.42 (0.85)
range	0–9.00	0.28–3.60
Crown spread p = not significant	0.52 (0.69)	0.54 (0.27)
range	0–3.21	0.10–1.25
Available flame p = not significant	0.43 (0.28)	0.49 (0.14)
range	0.01–1.40	0.11–0.74
Available smolder $p = 0.03$	0.32 (0.29)	0.40 (0.22)
range	0–1.05	0.12–0.84
Available residual $p = 0.01$	0.16 (0.16)	0.24 (0.15)
range	0–0.59	0.07–0.61

Note. $n = 34$. Standard deviation is in parentheses.

5. Discussion and conclusion

This exploratory analysis of wildfire risk for heirs' properties is the first attempt of which we are aware that examines this association. Although most indicators of potential wildfire risk were not significantly different for heirs' and non-heirs' parcels, one measure—surface spread—could be distinguished by tenure. And this particular indicator, because it is an actual physical measurement of surface-level wildfire risk, is fundamental to overall wildfire risk. The other potential risks (crown behavior and available fuel) could not occur without surface fire. Still, our findings are limited to just one county, so the question of how heirs' property ownership impacts environmental risk remains.

Again, while heirs' property is bona fide private property (as opposed to open or common property), heirs' property also contains elements of common property ownership—and herein lies the potential for inefficiency, or what Heller (1998) refers to as the "tragedy of the anticommons." Fennell (2011, pp. 10–11) argues that an anticommons problem (such as heirs' property ownership) is one of *assembly*—for example, gaining permission from co-heirs to conduct an activity such as hazardous-fuels reduction on family land on which none of the co-heirs currently lives. Fennell (2011, p. 10) makes the point that in any anticommons scenario "the worry is the same: that a value-enhancing assembly—one that could leave every party better off than the status quo—will fail to occur as a result of strategic holdout behavior and other transaction costs." Related, we have had numerous discussions with attorneys with the Georgia Heirs' Property Law Center who relay that one of the biggest challenges in resolving heirs' property ownership cases is identifying legitimate heirs—that is, collecting defensible information about who the actual heirs are. Heirs' property resolutions begin with the creation of family trees that help to clarify how co-heirs are related. This task can be difficult because in many cases co-heirs may not even know one another.

In the present case, understory clearing is probably non-controversial. But while the benefits of understory clearing may be uncontested by co-heirs, implementation can be inhibited in cases where funds are needed to accomplish this task—for instance, corralling co-heirs—who, even where familiarity and co-ownership can be established, may be dispersed across the country or the globe—to assume a loan to hire a crew for the work, or convincing them of the need to pay for specialized equipment or chemicals used for thinning. Non-monetary costs such as attending meetings to get information about publicly funded cost-sharing agreements can also prevent the assemblage needed to move forward on environmental risk reduction activities.

Fortunately, for heirs' property owners, the inertia of co-owned property management can be overcome by the dissolution of the tenancy in common, as any heir may petition a court for partition of the heirship. The dissolution may be done in a way that provides unambiguous ownership of physical portions of the property, called a "partition in kind." In such cases, each co-heir receives a separate title to a portion of the property, which resolves the problem of fractional ownership interests. Land partitioning in this manner is supported by African American and other land rights advocates who argue that individual co-owners can then use their "clear" property titles as leverage for wealth building. Also, for historically disenfranchised groups such as African Americans, this solution helps to stabilize land losses by keeping land within black family networks.

However, Heller (1998, 2008) argues that physical partition can result in land being divided into very small parcels,[7] or what Heller (1998, p. 77) refers to as "big inch" parcels that render land useless from both an economic and ecological perspective. So, while a court-ordered physical division of heirs' property may solve the assembly problem in social terms, these divisions could produce an ecological disassembly with negative consequences for longer-term environmental sustainability. Haines et al.'s (2011) findings from the US state of Wisconsin lend support to this caution. That research compared changes in forestland for land that was divided into smaller parcels and land that was not divided. Results showed that forest parcelization leads to fragmentation, which makes it more difficult and expensive to harvest timber, for example. Also, additional landowners may have conflicting land management goals that thwart goals of optimal ecosystem management.

Since Heller's (1998, 2008) writing, changes have been made by the US Uniform Law Commission to address heirs' property partitions in a way that reinforces family members' ability to both clear heirs' property titles and retain land *intact*. This is codified in the 2010 Uniform Partition of Heirs Property Act.[8] An important stipulation allows family members who do not want to partition the property to purchase the interest of family members who do. This helps families to assemble the disparate shares while changing the quasi-common property regime (the classification applicable to heirs' property) to a legal form with clear, unambiguous title—still held by the family. This increases the chances that the value of long-held family land can be increased both in economic and ecological terms.

Fennel (2011, p. 10) notes that anticommons scenarios do not always result in inefficient outcomes. Landowners in general do not adhere to strict and distinct actions regarding the stewardship of their lands (Walters, 2012). Even if land is

7 Haines et al. (2011) clarifies the distinction between land "parcelization" and "fragmentation." The former involves the legal process of subdividing land, and the latter is specific to ecological outcomes, which can result in diminished ecosystem services.

8 www.uniformlaws.org/committees/community-home?CommunityKey=50724584-e808-4255-bc5d-8ea4e588371d

collectively held, for instance, in some seasons or cases, a more individualistic approach is applied to land activities, but in other cases, decisions may be made by the wider collective of extended kin. Indeed, the heirs' property phenomenon and its impact on risk reduction is too complex an issue to be restricted to the simple question of whether a property is classified as heirs'. For instance, Dyer and Bailey (2008) and Schelhas et al. (2017) highlight the multilayered meanings and ad hoc caretaking of heirs' property by family and concerned others that, while not systematic, can result in efficient land management for some properties. Relevant to this study is that wildfire risk may be reduced for heirs' parcels in instances when family members live on the property, as indicated by Fischer (2011). For roughly 58% of our sample, the physical location of the heirs' parcel was the same as the mailing address for the owner, indicating that at least one heir lived on the property; and 20% had an out-of-state mailing address for the owner, which indicates that the remaining 22% of these property owners may live relatively close to these properties. It may be that on-site residence (although we do not know how this rate compares to NHP owners) and the relatively high percentage of in-state heirs' property owners in Macon-Bibb County effectively reduce understory accumulation, compared to situations where fewer owners are living on the property or in-state.

There is no commonly understood and practiced response to the maintenance of heirs' property in the US because no statutory or customary tradition informs either its physical or financial upkeep. As a result, co-heirs' efforts to mitigate natural disaster may be situational, varying greatly by factors such as internal family relations and attachment to the land among family members.

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Hungry Ghosts: The Impact of Food as a Workplace Health Concern among University Staff and Faculty

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Abstract

The indoor biome is of growing interest among human ecologists, yet relatively poorly studied at present. Food systems offer one approach to understanding the intersection of human well-being and institutional structures within an indoor ecology case study. This study examines a food system within a Canadian university setting, with particular reference to the issue of food security—the ability of an individual to access sufficient nutritious food for a healthy life—among university faculty and staff. The results suggest that institutional structures affect employee perceptions of their precarious food and nutritional security. While university students have been studied regarding their food security status, university staff and faculty have never been similarly studied. Findings suggest that poor food security levels among staff and faculty lead to challenges in work performance and in the overall well-being of the university as a community. University leaders should take seriously issues of food security among their employees as well as their students.

Keywords: food security, institutional food systems, tertiary institutions, workplace health

> How full of briers is this working day world.
> William Shakespeare, *As You Like It* (Act III, scene 2)

Introduction

Universities are peculiar institutional ecosystems. Their principle reason for existence is to offer advanced education for students, in addition to conducting research. Thus, the most visible members in the university community are students and the faculty who do the teaching and research. Given their critical value to the university, it is not surprising that a considerable amount of research considers the challenges

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that students face, including poor food security. Rarely acknowledged and never studied in terms of their work challenges or critical contributions to the university community are the university staff, "ghosts" who keep the university running. Faculty, while less invisible than staff, may also find that their workplace challenges are invisible to decision-makers. Neither faculty nor staff have ever been studied with regard to their food security, leaving them not just ghosts but, as this research suggests, hungry ghosts.

Our places of employment can have a significant impact on our health and well-being. The United States Center for Disease Control and Prevention observes that "most working-age adults spend a substantial portion of their waking hours in their workplaces" (Goetzel & Ozminkowski, 2008, p. 305). Some workplaces have a clear, and often direct, impact on worker health due to inherent risks, as for firefighters. Other workplaces offer subtle impacts through institutional structures, cultures or expectations. These impacts can, over time, be as profound as acute health challenges. This study examines Canadian university faculty and staff well-being as measured by their perceptions of the institution's impact on their level of food and nutritional security (subsequently referred to as f&n security), in other words, their ability to eat in a healthy way. Understanding how a workplace's structures and cultures impact worker well-being is a critical step in implementing actions to improve employee well-being, an important consideration as healthy workers benefit the workplace through increased productivity, commitment to the success of the employer, and money saved through lower use of benefits and less absenteeism (Goetzel & Ozminkowski, 2008).

Human ecology offers a useful lens for understanding the interrelationships of worker well-being, food systems, and institutions. Dyball and Carlsson (2017, p. 26) note that human ecology explicitly links "the interrelationships between humans, their cultures and their ecosystems." While many such studies focus upon human interactions within natural ecosystems, Stokols (2018) and Wakefield-Rann and Fam (2018) argue that the most rapidly expanding biome in the world is the indoor environment. Understanding these indoor environments is imperative as "indoor environments can represent atmospheres permeated by hazard and insecurity … when human needs are miscalculated or inadequately provided for" (Wakefield-Rann & Fam, 2018, p. 19). People spend substantial hours in indoor environments, including their workplaces, which "amplifies whatever positive or negative effects those settings may have on their health, behavior and development" (Stokols, 2018, p. 27). However, Stokols (2018) notes the relative paucity of studies on indoor environments. Thus, human ecology confirms the importance of critical examination of an "indoor ecosystem," such as a workplace, including its culture and systems services.

Davila (2018, p. 28) argues that, within human ecological study, food systems are understood as the "interactions between biophysical and human systems that influence all aspects of food activities." He notes that food systems studies are useful frameworks for understanding human ecology, which in turn can offer a useful frame for understanding subtle and sometimes hidden discussions around food activities, including the implications of institutional and political forces for f&n security as well as the interlinkage of institutions, human well-being, and ecosystems.

Research context

Universities are rather unique workplaces, opaque to outsiders and often to their own employees. They are highly stratified, with three distinct groups of employees: administrators (who hold decision-making powers), faculty (the most visible employees who teach and do research) and staff (who do everything else from facility maintenance to IT), with subdivisions within those broad categories. Given their rather specific workplace niches, while the different groups work in related ways to support university structures and functions, they are also relatively discrete in their functions (or silos) and often regard each other as quite distinct groups. There are also very clear hierarchical differences in relative power and authority (administrators "on top," followed by faculty and then staff) and related income levels. While some jobs within a university come with direct work-related health risks (e.g., facilities and maintenance or field-based research), overall universities are not generally thought of as high-risk places to work. However, preliminary research on universities is demonstrating that they can be places with significant impacts on employee health, as Parizeau et al. (2016, p. 193) note, "many of our academic institutions do not adequately foster working and learning environments that support wellness."

Institutional cultures and expectations within universities have changed over the last few decades to stress increasing productivity and output (students graduating and research publications), which can come at the expense of the health and well-being of faculty and the staff supporting them:

> We experience academic cultures and practices that valorize overwork, including expressions of martyrdom, talking about not sleeping or eating and about working all the time, an expectation of always being available for work purposes, and discussions of having children as a problem for work. (Parizeau et al., 2016, p. 197)

As Mountz (2016, p. 208) describes institutional expectations,

> The imagined "ideal worker" is … able to perform long hours physically and emotionally and unencumbered by "outside demands" like family or personal needs. She is highly efficient and able to operate on sparse amounts of sleep or nourishment.

As one study concludes, "[faculty] have all encountered insufficient time and energy to prioritize mental and overall wellbeing" (Parizeau et al., 2016, p. 198). A last challenge is often the new nature of university employment in North America where universities increasingly employ poorly paid and usually temporary contract faculty to teach their courses, rather than better paid tenure-track or tenured faculty. Staff are usually paid far less than faculty, and also face high levels of job insecurity.

Thus, as academics turn their gaze inward, their research suggests that institutional structures affect employee health through an institutional culture which emphasizes or only rewards accomplishments that undermine individual goals of work–life balance or genuine workplace well-being. All faculty, speaking from empirical observations, are well aware of these unwritten but quite clear requirements for success, as denoted through jokes, wry observations or outright desperate confessions around the inability to meet work demands and the costs to the individual. However, the limited studies on university workplace wellness cited above are lacking: the few studies that do look at work in universities in relation to well-being focus exclusively upon *faculty*; no studies have been undertaken on the costs of institutional requirements to *staff* health and well-being.

In considering the measurement of health and/or well-being, one measure of interest is the issue of food security and access to adequate quantities of nutritious food (f&n security). The growing academic field of food security studies posits the critical aspect of nutrition in understanding individual or population health and well-being. A very basic definition of poor food security is "the inability to access and procure, through conventional avenues, nutritionally adequate foods capable of supporting an active and healthy life" (Micevski et al., 2014, p. 258). Research suggests that there are serious consequences to poor nutrition for the individual and, by extension, to society which must bear the collective costs of these consequences; thus research is beginning to document the nature of f&n security in different populations (Mammen et al., 2009; Tarasuk et al., 2014, 2016).

McIntyre et al. (2012) note that while Canadian government programs have worked to move people off social assistance and into employment, this has, for many, simply resulted in them becoming "working poor" and remaining food insecure.[2] Tarasuk et al. (2016) note that in 2014, 12% of Canadian households reported some level of food insecurity, with just over 8% either moderately or severely insecure. Many of these households were lower income, including 33.5% of female-led households with younger children who were food insecure. Tarasuk et al. (2016) also noted a disproportionate number of Aboriginal and visible minorities among the working

2 The terms food security and food insecurity are often used interchangeably. However, food insecurity often refers to the inability to acquire food due to financial challenges, whereas food security may include multiple factors at play.

food insecure. Material life costs may also be a factor, such as expensive housing or the costs of living (living in colder climates and having higher heating costs, for example) (Mammen et al., 2009).

Woolf et al. (2011) note that choices to eat healthily are critical in contributing to an individual's health and welfare. If good food is unaffordable, inaccessible or marginalized by unhealthy 'fast' foods, people will have their personal choice to eat healthily unavoidably shaped by outside contextual circumstances. Woolf et al. (2011) also make clear that all efforts to educate or counsel better choices for health will have little effect under these circumstances, noting that health initiatives require partnerships and linkages between major players in an individual's life, such as linking home, *work*, and community.

Poor access to healthy food creates serious consequences for an individual, including "poorer physical and mental health and higher rates of chronic conditions, including depression, diabetes and heart disease" (Tarasuk et al., 2014, p. 5). However, the costs of low food security are more than physical; they can affect mental and emotional well-being (Williams et al., 2012). For some people, including some of this study's participants, struggling to obtain food is a critical dimension, but struggling with institutional structures controlling access to food while feeling judged by those institutions for needing aid is worse (this study demonstrated that, for some, solutions to poor food security required anonymity, suggesting a fear of judgment by others in the workplace).

Universities are becoming key populations studied regarding food security; however, all such studies focus upon university or college students (Cady, 2014; Canadian Federation of Students-Ontario, 2012; Chaparro et al., 2009; El Zein, 2017; Farahbakhsh et al., 2015; Frank, 2018; Gaines et al., 2014; Hanna, 2014; Hughes et al., 2011; Martinez et al., 2018; McArthur et al., 2018; Meldrum & Willows, 2006; Micevski et al., 2014; Munro et al., 2013; Patton-Lopez et al., 2014; Payne-Sturges et al., 2018; Watson et al., 2017). What is not studied are the correlate levels of food security experienced by the other members of the post-secondary 'community': staff and faculty.

This research gap is likely due to an assumption that, with regular employment options and, in the cases of some faculty although not necessarily staff, above national median salaries, access to healthy food is not a concern. However, when the issue of food is examined through a lens of workplace institutional structures and cultures and the link to well-being, this assumption is called into question. The nature of the university as a *place or an institutional ecology*, as noted above, comes with specific structures that challenge a worker's ability to maintain well-being, including healthy eating. There are other considerations suggesting a need to investigate the issue of food as an indicator of well-being among staff and faculty: while poor food

security is often linked with financial insecurity, many circumstances can contribute to poor food security, even among relatively well-paid faculty, through workplace expectations or culture.

There is one last consideration: whether universities, as employers, should have as an operational expectation the ethical imperative to consider the well-being of their employees. While they are employers in much the same way as any other place of business, universities are considered to have a special role within society that is quite different than other workplaces. They are generally expected to be ethical leaders, modeling such ethics for the benefit of the students within their walls (Seligsohn, 2016). Indeed, their exceptional position as critical social leaders places upon universities a greater burden of modeling ethical practices, observable internally and externally (Duke, 2019; McNay, 2019). There may well be an ethical imperative to model consideration for the health and well-being of their employees as part of their institutional ecology, even when the society within which a university sits does not.

Methodology

The case study community

This project assessed issues related to f&n security at the University of Northern British Columbia (UNBC), a small university located in Prince George, British Columbia, Canada (est. 1990). In 2015, as a component of the development of a campus-wide food strategy by UNBC's Office of Sustainability (which was never completed), the author was asked to undertake research into the issue of campus food quality and access as well as personal factors affecting food concerns and potential institutional responses. The project took a *community* f&n security approach, investigating the issues at an institutional level through inclusion of all community members: staff, faculty, and students (see Booth and Anderson (2017) for a broad overview of the study findings). This article specifically examines the self-assessment of their level of f&n security by UNBC's staff and faculty. The research project explicitly did not meet the current requirements of academic food security studies, as it did not utilize validated research instruments such as the Household Food Security Survey Module utilized by Statistics Canada. Rather, the research model had to meet several investigatory needs outside of food security studies, including perceptions of the food services provider and recommendations for campus food options. However, as this research illuminates the issue of f&n security as it relates to workplace structures, cultures, and worker well-being in a never-before studied population, the findings may nonetheless be of interest.

UNBC employs a substantial number of faculty, including tenured, tenure-track, senior laboratory instructors, and contract faculty as well as non-union librarians.[3] As of September 2015, the UNBC Faculty Association reported 343 members (personal communication, September 15, 2015). UNBC also employs staff in a wide variety of positions. Most are members of the Canadian Union of Public Employees (CUPE), a few others belong to an Exempt group (exempt from union membership, quasi-managerial positions). As of September 2015, 392 staff were employed at UNBC (personal communications, CUPE president, September 15, 2015; Exempt group head, September 16, 2015).

As a workplace ecosystem, UNBC shares some institutional structures linked in the research literature with food concerns among students, including a location isolated from non-university businesses such as grocery stores (Canadian Federation of Students-Ontario, 2012). As well, UNBC has contracted with a for-profit company for campus food services, which has an exclusionary lock on food services with the exception of a student-run pub serving lunch. These exclusionary rights limit outside food being brought on to campus for community events, as well as restricting competing food sales. During summer operations, however, food service becomes quite restricted as the student pub closes and only one outlet offers deli and coffee shop foods; this does not operate on weekends or in the evening in the summer. Staff and faculty have some limited access to refrigeration and microwave ovens, which facilitates bringing prepared meals from home, although not all are within easy walking distance. Staff tend to work regular hours, with a half-hour lunch break; some essential services, facilities and security staff for example, undertake shifts when food services are closed. Faculty work irregular hours depending upon teaching, research, and service commitments, and are less likely to be present on the campus for consistent blocks of time, and so may have more flexible access to off-campus food sources. While one food alternative existed at the time of the study, a farmers market, the food items were comparatively expensive. It should be noted that UNBC has not, to date, developed a "food strategy" or policy that addresses community f&n security or any other aspect of food, other than the contract for the company operating the university cafeterias.

3 Tenured faculty have considerable job security; having passed multiple reviews, they can be terminated only under limited circumstances. Tenure-track faculty, striving for tenure, have good job security, but may be terminated if they fail to pass regulated reviews. Senior laboratory instructors are considered permanent appointments, but have lesser job security and are subject to biannual reviews. Contract faculty have no job security. They are hired short-term, contract to contract, carry heavy teaching loads and are very poorly paid in contrast to other faculty. Professional librarians have permanent positions, subject to regular review, with relative job security.

Other studies (Mammen et al., 2009) indicate that situational factors can influence f&n security, so the city of Prince George, BC (where the main campus is located), is also a consideration. UNBC is located in the north-central portion of the province, and while Prince George is the largest interior city, it is relatively isolated: most provisions must be imported over considerable distances, affecting food prices and availability. While housing costs are considerably less expensive than larger cities, Prince George experiences long, cold winters with reduced daylight hours, making heating fuel and electricity necessary and significant expenses.

As a final situational factor, UNBC has institutionally recognized (during talks planning for 2015 labor negotiations) that its faculty are among the lowest paid in Canada (personal communication, Faculty Association executive, November 2014), suggesting that faculty might face some financial insecurity in comparison to colleagues at other universities. In 2015, the salary floor for a lecturer was $55,393 annually and for an assistant professor it was $65,030. For UNBC staff, financial insecurity is considerably greater. The 2012–2018 CUPE Collective Agreement lists the lowest starting salary as $30,885 per year. A staff member must reach a position at level 4 to be paid $39,457. As of 2015, Statistics Canada reported that the market basket measure of poverty threshold for a family of four in British Columbia communities with populations of 30,000 to 99,000 (e.g., Prince George) was $36,446.[4] A CUPE member who was a single parent of three in an entry-level position in 2015 was well below the Government of Canada's measure of poverty: f&n security would be a significant concern.

Study methodology

In this research, UNBC was treated as a case study (Lauckner et al., 2012; Yin, 2003). Case study methods examine "a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clear" (Yin, 2003, p. 13), and are used when examining questions of process. This study utilized data from multiple sources, including situated local knowledge (the author has been employed by UNBC for over two decades) and focused upon specific situational factors and employee concerns. The Faculty Association, CUPE, and the Exempt group's executive committees supported this research by reviewing and contributing to survey and interview questions, through participation themselves, by promoting member participation in the survey, and through distributing and promoting the results of the research to their membership and others (although they are not responsible for the research). Institutional approval and research ethics for the project was obtained. Anonymity was guaranteed to all participants.

4 Statistics Canada. Market Basket Measure (MBM) thresholds for the reference family by Market Basket Measure region, component and base year. Table 11-10-0066-01. www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110006601

Data collection was undertaken in two phases during the 2015 fall semester. Initially, semi-structured interviews were conducted with key informants identified through local knowledge and snowball techniques; this included the staff union executives (the Faculty Association executives declined to participate in this phase), the Women's Centre director, and Wellness Centre counselors, who posted a link on their website and invited their service users to participate. Interview questions focused upon perceived levels of f&n security and concerns as well as factors creating these concerns, and reported consequences or impacts. Interviews were audio-recorded and analyzed by reviewing recordings and free coding for key themes and ideas.

For the second phase, interview results were used to develop a web-based survey. The survey invitation was emailed to all faculty and staff members utilizing Faculty Association and CUPE/Exempt mailing lists. The survey was active for five weeks with email reminders sent out twice. Survey questions included a range of demographic questions, questions related to participants' perceptions of their relative access to food, personal risk factors, personal and institutional consequences of the lack of easy access to healthy food, as well as options for addressing community f&n security. Participants were asked to answer a question using closed responses and then were asked if they wished to provide more detail through a follow-up open-ended response option. Sample questions related to f&n security are included in Table 1.

Table 1. Sample of survey questions related to food and nutritional security

Thinking about the last year, have there been days when you can't eat as much as you should for good health or in a healthy way (for example, fruits, vegetables and good quality proteins)?
If there are days when you feel you cannot access adequate food, is this due to: [Lack of time (to shop, cook or to eat)], [lack of money], [lack of knowledge]?
If you were to experience a serious personal or financial crisis that affected your security around food, who would or could you talk with at UNBC? If there is no one, please say so.
Has an inability to eat healthily or regularly ever affected your ability to do your job well?
On a scale of one to five (with one being very food insecure, three being uncertain and five being very food secure) how food insecure do you think you are right now?

The survey results were analyzed using descriptive statistics and thematic free coding for the open-ended responses (Babbie, 2008). This article does discuss some of the statistical analysis for context; however, it was felt that the voices of the participants were of particular importance in articulating the impacts of poor f&n security, and in understanding the impact of institutional culture and structures on well-being. These are real people suffering real consequences and their voices are profoundly important in foregrounding this circumstance (often hidden by a statistic).

Results

Food and nutritional security challenges among staff

UNBC has both union and non-union staff; both groups participated in the survey and are reported on collectively (although the non-union group tend to be paid better as their positions are quasi-managerial). Of a possible 392 staff, 131 responded, a response rate of 33.4%. Table 2 summarizes sample demographics.

Table 2. Demographic characteristics of staff (CUPE/Exempt) sample (*n* = 131)

Gender	Salary level	Age	Relationship status	Dependent children	Disability
Male: 19%	Med–High: 67%	26–55: 83%	Spouse/Partner: 70%	Yes: 38%	Yes: 9%
Female: 81%	Low: 33%	56+: 11.5%	Live alone: 30%	No: 62%	No: 91%

Access to high-quality and affordable food appears to be a serious concern for UNBC staff. In the survey, food security was defined as having access to sufficient healthy food to maintain good health. While 7% actually identified as being either very food insecure or food insecure (5% were uncertain), when asked in another way, 39% also reported that they cannot eat in a healthy way due to poverty (15%) or due to a lack of time (57%). Gender is an important factor as 8.4% of all women reported being food insecure as opposed to 4.8% of all men. Age was also important—participants over the age of 36 had higher levels of poor food security. Oddly, staff with permanent positions reported the highest levels of insecurity; 12.5% for those part-time and 8.4% for full-time positions. Another anomaly is that those reporting higher salaries also reported the highest level of food concerns (9.5% for those with high salaries and 10.8% for those with moderate salaries in contrast with only 2.9% with low salaries), demonstrating that poor food security can be related to other factors besides poverty. These challenges produced consequences for the workplace: 13% of staff reported that being unable to eat well affected their ability to do their job.

Workplace structures and expectations, including time constraints, had significant consequences:

> Challenging to eat at work due to lack of area to have food, often eat at desk or do not eat at all until later in day due to meetings or full schedule. (staff)

> I often had insufficient time to shop for groceries or visit the University Farmers Market and to cook, and so I did not eat enough, which exacerbated stress. This is more problematic in that I can't afford paying to enter the cafeteria and don't feel that that is the right way to manage a community's relationship with its food. (staff)

UNBC's restricted on-site food options caused concern among staff who did not have time to prepare food to bring from home.

> Food is too high priced for all, held by a monopoly vendor. (staff)

> The selection on campus was poor and time did not allow opportunity to seek other sources. (staff)

Many staff believe that low salaries and/or part-time or casual positions contribute to food challenges among their colleagues, with potentially serious consequences.

> I have colleagues that are in extremely precarious situations. I have provided food to colleagues on more than one occasion. (staff)

> I know there are quite a few members that cannot make it from payday to payday. (staff)

> Food costs too much and other financial obligations comes [sic] first. Situationally, we have been running out of vegetables a few days before payday. (staff)

Family obligations can create particular vulnerabilities, both due to low income and time issues.

> Some members are single parents in fairly low-paying jobs and their circumstances may not give them the ability to supplement their income … a large portion of take-home pay is going towards rent, leaving them less income for food. (staff)

> To save money I forgo a lot of fruit like berries for example so that my children can have healthier lunches for school and so the food can go further. (staff)

> There is no flex time in our office, and working through lunch and going home early or having altered hours has never been discussed, much less offered. I can only come to the conclusion that UNBC simply doesn't care one iota about the health or well-being of its staff or their families. (staff)

Food and nutritional security challenges among faculty

Of a possible 343 UNBC faculty members, 53 completed the survey, a response rate of 15.5%. Of these, 64% were tenured or in a tenure-track position. Table 3 presents the sample demographic.

Table 3. Demographic characteristics of faculty survey sample (*n* = 53)

Gender	Salary level	Age	Relationship status	Dependent children	Disability
Male: 43%	Med–High: 64%	36–55: 71%	Spouse/Partner: 67%	Yes: 44%	Yes: 11%
Female: 56%	Low: 36%	56+: 17%	Live alone: 33%	No: 56%	No: 89%

Of the faculty respondents, 8% directly identified as being either food insecure or very food insecure. Another 6% were uncertain. This is a rather surprising level of f&n security among faculty, given that those rating themselves as food insecure were not contract faculty (assumed to be the most vulnerable), but in permanent positions. There was a gender component: slightly more men (8.6%) than women (6.7%) rated themselves as being moderately to severely food insecure. Age was also a factor as 22.2% of those in the 56–65 years old category stated they were food insecure, compared with 7.1% of the 36–45 years old faculty. Food security challenges cut across positions as well: 20% of librarians and 20% of senior laboratory instructors rated themselves as severely food insecure, while 8.3% of tenured faculty rated themselves as moderately food insecure. Tenure-track faculty indicated they were generally secure. Unexpectedly, 14.3% of those who indicated that they were on the high end of the pay scale felt food insecure, as did 11.1% of those at the mid-level, while half of those at the low end felt food secure.

However, f&n security has other dimensions: two key factors cited were time constraints and work demands as the largest causes of poor food security among faculty (95% of respondents).

> For the most part, my access to healthy food is quite high. I think time to prepare it properly is the greater issue. (faculty)

> Scheduling meal times (lunch in particular) does not seem to be a UNBC priority. (faculty)

> Simply time crunch—lack of time to make purchases and limited opportunities on/near campus to do so. (faculty)

Stressful work conditions, including a sense of overwork, also affect faculty food security.

> I have access to healthy foods but my working conditions prevent me from having adequate breaks and time for self-care, including healthy eating and exercise. (faculty)

However, there was also a recognition that some members of the faculty are more financially vulnerable as well.

> Very new faculty or [contract faculty] may have a salary inadequate to feed a family. (faculty)

> One-income families struggle with cost of bills and providing for families. (faculty)

Overall, 48% of faculty reported being unable to eat well and 15% said that this affected their ability to perform their job.

Finally, as one faculty respondent notes, everyone may be potentially vulnerable to food challenges, as "unforeseen circumstances can occur, potential for homelessness, potential for loss of regularly budgeted money" can happen to everyone. When asked if they had someone they could turn to for assistance in the event of a financial crisis, 42% indicated that they had no one to turn to for aid. Thus, UNBC's faculty may be as vulnerable to poor food security as more poorly paid staff, if for different reasons. Table 4 compares reasons for poor food security between the two groups.

Table 4. Comparisons of poor food security across groups

	Faculty	Staff
Lack of money	5%	15%
Lack of time	53%	57%
Lack of knowledge	3%	2%

Solutions to poor food and nutritional security

Participants were asked to suggest solutions for addressing poor food security at UNBC as a basis for sustainable community food policies. The solutions tended to address issues of time constraints (by having healthy options easily available) and issues of low income (through ensuring solutions be inexpensive). Interviews and surveys pointed to the need for more diverse, inexpensive, and healthy food options on campus for everyone. It was also noted just how invisible food challenges are for the institution, leading to "hungry ghost" faculty and staff. In ranking possible institutional responses to workplace food security issues, the most popular were expanding existing campus programs that provide fresh, inexpensive food. This included supporting the expansion of the Good Food Box Program (a monthly provision of 20 pounds of local fresh produce for $20; with free boxes for those in need) (faculty 45%, staff 34%) and the weekly on-campus farmers market (faculty 36%, staff 21%). As of 2019, the farmers market no longer operates, due to a lack of use by the university community.

As an alternative to the for-profit cafeteria, there was moderate support for aiding the student-run coffee shops to sell take-out food items (faculty 26%, staff 31%) (they do as of 2019, but the food is costly), or for establishing a community kitchen (faculty 19%, staff 24%). Developing a campus food cooperative received strong support (faculty 36%, staff 42%). Developing more campus food banks was popular with staff (faculty 17%, staff 24%) (the current food bank serves only students). Food banks can, according to the key informants, come with both a stigma for use and difficulty in accessing healthy options via the bank—these issues would need to be taken into account if more sophisticated food banks were used to address campus food security.

> Anonymous registry—posted needs from the UNBC community that can be filled by those who have, and picked up confidentially by those who have not. (faculty)
>
> More private access to food boxes … there needs to be a level of confidentiality associated with accessing food through the proposed services. (faculty)
>
> I am aware of a co-worker that was extremely worried about her f&n security during the faculty strike earlier this year. She is a single mom with no family in town and was extremely embarrassed to have to visit the food bank to feed her family. (staff)

Other, creative, options were suggested that both address and acknowledge the institutional workplace context of UNBC as well as the need to address food challenges with a community-minded set of approaches, along with reminders that UNBC is in the business of education.

> Partner with local and regional organizations; greenhouse, food options/types for year-round growth in the northern region; ongoing education and awareness for public and corporations; development of programs for corporations to get involved. Community garden development, break down some of the barriers to these opportunities. (staff)
>
> Education as to cooking, food budgeting (to reduce waste). (staff)
>
> More potlucks and more events that focus around food. (staff)
>
> Workshops, lectures, courses on daily shopping for food with healthy choices and extending the budget to be able to have the healthier choices. (staff)
>
> Food vouchers at campus eateries for those in need for as long as need be. (staff)
>
> It might be useful to access a kitchen where people can come together as group cooking. They get to divide food. (faculty)

Finally, faculty and staff expressed concern about the impact of the for-profit company monopolizing on-campus food services.

> As this university is situated so far away from any other sources of food, there should be more options for cheaper food … Sometimes if I run out of time to make lunch I am stressed out about spending money here on food due to being on a budget. (staff)
>
> UNBC needs food diversity and variety that includes very healthy, whole food options that aren't inaccessible due to cost. This would require a moral investment into options that are not motived by profit margins and corporate policy. (staff)
>
> Cancel or alter the portion of the contract between the university and the cafeteria-catering company that disallows people … to bring in food from outside. This means the community cannot support small/local businesses. This also contravenes some community/grassroots efforts, for example, if community members cook and bring food to campus to support their friends, even if this is not technically catering, these people are sometimes admonished. (staff)

In the end both staff and faculty were clear, food and nutritional security is a community concern. The majority from both groups (80–85%) wanted all potential solutions to food workplace challenges to be available to all members of UNBC, not just the students, supporting a key concept:

> Treat food as the centre of our community. (staff)

Discussion and conclusions

As an indoor biome where we can spend a third of our day (Goetzel & Ozminkowski, 2008; Stokols, 2018; Wakefield-Rann & Fam, 2018), a workplace can significantly affect our health and well-being. The place of this study, UNBC, is no exception as the university's structures and work expectations create circumstances where its employees find they are challenged in their ability to eat for best health, confirming some preliminary research suggesting universities are health-threatening workplaces (Mountz, 2016; Parizeau et al., 2016). In this research, faculty and staff well-being was threatened by all obstacles to healthy eating (from all causes of poor food security), affecting 39% of non-instructional staff and 48% of faculty; levels significantly higher than in the general population of British Columbia where 11.9% of households face some level of f&n security (Sriram & Tarasuk, 2015).

This research has demonstrated that the causes of f&n security vary across UNBC's populations. Far more faculty than staff identify time constraints and institutional structures as a cause of poor food security rather than poverty. As Mountz (2016) and Parizeau et al. (2016) document, faculty can often feel pressured to put in far more than 35 or 40 hours a week, particularly on the road to tenure and promotion or in hopes of a tenure-track position. If this pressure results in poor f&n security, the impacts to individual and institution are the same as if they were created by poverty. However, a surprising number of UNBC faculty also appear to suffer from financial insecurity, leading to difficulties around healthy eating. Given that faculty often postpone substantially their entry into permanent employment while completing the required advanced degrees, while at the same time acquiring substantial student loans, it would not be surprising that even well-paid (by national median salary standards) faculty may still face challenges around healthy eating.

In contrast, staff clearly suffer from constraints both of time and money due to low salaries, and may be far more vulnerable overall with less power to alter their work circumstances or to argue for better compensation. Whatever the cause, however, in both populations, the consequences affect the entire university community as 13% of staff and 15% of faculty believe that they cannot perform at their best as teachers, supporters, or facilitators due to poor food security. This circumstance should raise concern among the UNBC community, especially among the decision-makers. As one staff member notes, "Food insecurity can affect anyone, even those you may

think would never have to deal with that life challenge." Academic community leaders might need to pay heed to the accuracy of this statement in the interests of broad community well-being.

Poor food security is recognized as creating poor physical and mental health in those experiencing it (Mammen et al., 2009; Tarasuk et al., 2014, 2016; Williams et al., 2012; Woolf et al., 2011). Comments from study participants illuminate what statistics may obscure; the high personal cost of perceived f&n security for UNBC staff and faculty and the consequences of believing your employer is indifferent. While access to relatively good health care through the employer may offset somewhat the physical impacts of poor access to good food, little offsets the mental and emotional impacts of being, and knowing, you are food insecure (Williams et al., 2012). Further, having to witness colleagues suffer from insecurity can also be troubling, as this study documents.

If the demands of the job undermine personal lives, family lives, and contribute directly to poor f&n security (food systems demonstrating the interlinkage of institutions, human well-being, and ecosystems (Davila, 2018)), which also affects both personal and family well-being, individuals can find themselves in a very difficult context. A failure of the employer to see the consequences to the larger university community through not addressing the work–life imbalance and institutional contributions to poor access to adequate nutritious food raises pragmatic concerns, as "poor health is associated with reduced employee performance, safety, and morale" (Goetzel & Ozminkowski, 2008, p. 305). It also raises moral and ethical issues. Is it indeed the obligation of a post-secondary employer to be responsible not just for its acknowledged vulnerable clientele—the students—but for vulnerable employees as well? Should it consider doing so in the best interests of being a genuine community and for the entirely pragmatic reason that hungry employees cannot do their jobs well? Or should the university care only about one portion of its community and not another (in this case, literally leaving them to starve)? These are questions that institutions should consider within their individual contexts and institutional philosophy, while keeping in mind that universities face greater societal expectation to be models of ethical behavior (Duke, 2019; McNay, 2019; Seligsohn, 2016).

Solutions do exist, outside of the challenge of increasing salary levels and making jobs more secure and long term. As participants in this study have suggested, it is possible to develop community-level responses that might involve reconsideration of facilities (community kitchens, food preparation areas), investing more broadly in food creation or facilitation of access in situ (campus gardens, campus-based food co-ops, reconsideration of food banks, and community-supportive solutions such as a farmers market), or using food as a community-building tool through shared meals. Education through workshops or information provision or collaborative cooking events can assist both food insecure individuals as well as building a stronger sense of community within a university. Fair wage and employment structures must also be

considered. The relative utility of each solution, however, is contextual within each university, as the faculty and staff of each institution face different circumstances, opportunities and constraints. Within UNBC, for example, fair wages would be important (although a challenge within current fiscal constraints), but reviewing job requirements for better scheduling structures and workload demands are also critical.

A key first step in implementing functional solutions is for institutions themselves to recognize and acknowledge that workplace structures do impact employee health and well-being, and the importance of viewing these impacts as a direct consequence of the institutional ecology and its culture. Indeed, it would be helpful if researchers also recognized these realities, as all previous studies of food security at universities focused solely on the students, ignoring the wider institutional community. If those who teach and support students, particularly vulnerable students, are themselves vulnerable and unable to perform their responsibilities due to poor f&n security as a component of worker health and well-being, then the mission and purpose of universities are at risk, as is their position as a moral actor within larger society. If we are to teach, learn, and create just and sustainable solutions to societal challenges, universities must start by ensuring their own community of learning is one where all can find security and something healthy to eat. Human ecology theory suggests that in analyzing human ecological systems, we must examine the social and ethical dimensions of such systems by asking, "are they fair or ethical?" Dyball and Carlsson (2017) suggest that the study of human ecology posits that the attainment of an institution or a world that is

> just, sustainable and worthwhile … is a collective effort with unavoidable political challenges to overcoming entrenched barriers, including those that involve disparities of power, as well as those arising from the underlying cultural values ("paradigms") that legitimize everyday assumptions about what constitutes normal, everyday behavior. (p. 26)

Finally, beyond philosophy, supporting the health of its employees does, in the long run, support the health of the institution (Goetzel & Ozminkowski, 2008). Thus, addressing these academic "hungry ghosts"—present but rarely visible to academic decision-makers—feeds many needs and members of a university.

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Trees and Trash: Examining the Link Between Urban Forest Engagement and Blight in Atlanta, Georgia, United States

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Abstract

Research conducted in various contexts suggests that urban greenspace, primarily trees, helps to reduce crime rates and other negative aspects of place. This study contributes to that literature by examining residents' reporting of activities they do to create, maintain, and protect the urban forest in Atlanta, Georgia (USA), and the association of this involvement with blight measures. Using binary logistic regression, we found that urban forest engagement did not mediate egregious blight conditions but did reduce the presence of litter. Rather, residence in predominantly African American communities was the most consistent predictor of more substantial indicators of blight. Except for litter, these are overwhelming conditions, often involving absentee property owners. Redress requires municipal-level, bureaucratic

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interventions, which can be complex. Urban forest engagement appears relatively ineffectual in combating the worst kinds of blight but may aid in reducing more pedestrian forms.

Keywords: Atlanta, blight, environmental justice, urban forest

Introduction

Trees and other vegetation in cities have been shown to promote a greater sense of psychological and emotional well-being (South et al., 2018; Svendsen, 2009), to improve human cardiovascular functioning (Kondo et al., 2018), and to improve social relations among residents living in public housing communities (Kuo et al., 1998). As well, studies have found an inverse association between a wide range of reported criminal activity and urban vegetation (Branas et al., 2011; Kuo & Sullivan, 2001; Schusler et al., 2018). In this study, our point of departure is an examination of the association between people's engagement with the City of Atlanta's urban forest (defined as the network of trees and other vegetation across cityscapes) and household measures of blight, operationalized as damaged houses and other structures, illegally dumped garbage, discarded furniture, discarded tires, junk cars, abandoned houses, litter, and lack of code enforcement.

Similar to other studies (Gilstad-Hayden et al., 2015; Troy et al., 2012; Troy et al., 2016; Wolfe & Mennis, 2012), we argue that people's *participation in and with greenspace* is a crucial factor in this relationship. This interaction can occur when greenspace serves as a physical location for positive, social interaction or when humans are motivated to care for and protect both mundane, urban open spaces, and those of particular socioecological significance (Ernstson, 2013; Johnson Gaither, 2019; Kuo et al., 1998; Locke et al., 2016; Murphy-Dunning, 2009). For instance, in the University of Illinois's series of studies on resident responses to greenspace in Chicago housing projects, findings indicated that crime rates for both property and violent crimes were lower around buildings with more trees. Researchers argued that residents' presence in these out-of-doors spaces functioned as informal surveillance of the neighborhood, contributing to crime reduction. These treed areas served as a space for community gatherings, which helped to increase neighborhood social ties (Coley et al., 1997; Kuo et al., 1998; Kuo & Sullivan, 2001). Also, Kondo et al.'s (2016) study of crime reduction related to vacant lot greening and reuse proposed that crime reduction near community gardens and orchards occurred because these uses required residents' time and attention. Residents were actively involved in the restoration and maintenance of these spaces.

Our research is distinguished from the extant literature in that we make an explicit link between community engagement with urban trees and meaning generation: As such, we draw theoretically from symbolic interactionism, which posits that

people both create and assign meanings to the material world, and that they act toward physical objects and spaces based on these assigned meanings (Blumer, 1969). Related, this study also draws from Lee's (1972) proposition that human behavior toward an environment can be understood best in terms of the meanings people assign to spaces and places. What this indicates for the present study is that when people purposefully create, maintain, and advocate for urban trees and other greenspaces, the places where this engagement takes place are imbued with positive associations and meaning.

Kondo et al.'s (2016) study and similar others rest on the assumption that crime rates go down after neighborhoods are greened. However, it may be that neighborhood greening projects can reduce crime rates, or, in the case of the present study, blight, a priori. We suggest that blight is less likely in neighborhoods and communities where people routinely participate in activities to recognize, maintain, and promote urban forest, other factors remaining constant. Importantly, this engagement signals (i.e., conveys the meaning) to neighborhood residents and others that these spaces are to be respected; they are not receptacles for refuse but should be protected (Brown & Bentley, 1993). Troy and colleagues (2012, 2016) refer to this scrutiny as the "cue to care" or "eyes on the street" explanation of urban greening benefits. However, neither of these explanations make explicit reference to meaning. It is only implied.

In addition to human ecology, our study also has implications for the social justice and geography of justice literatures because efforts to mediate urban blight can have the unintended consequence of stimulating gentrification (Branas et al., 2016). We address this issue in the discussion and conclusion section.

Study objectives

To examine the association between urban forest engagement (UFE) in Atlanta, we specify seven binomial logistic models where UFE is a predictor of the respective inventoried blight measures, along with four sociodemographic control variables. We examine this association further by modeling resident responses to questions about neighborhood social stressors, two of which are blight proxies—lack of code enforcement and illegal trash dumping. UFE is defined as any positive activity engaged in by ordinary residents to establish, maintain, or protect urban forests.

Apart from the regression models, we examine the relationship between tree canopy cover and the respective blight indicators across five sociodemographically demarcated strata in the city using chi-square analyses. This analysis is presented to show the association between physical aspects of the urban forest and blight by subarea of the city. Based on the above-referenced studies showing positive associations between urban tree cover and social outcomes, we expect to find an inverse association between blight and canopy cover across the city.

Study area

The setting for the study is the City of Atlanta, which encompasses an area of 342.9 square kilometers (132.4 square miles; 342.9 hectares) in the United States (US) state of Georgia. In 2018, the city had an estimated population of 498,044 (US Census Bureau, 2019b). The larger, Atlanta–Sandy Springs–Roswell, Georgia Metropolitan Statistical Area (metro Atlanta), of which the City of Atlanta is a part, is the largest metropolitan area in the state of Georgia and has the ninth largest population of any metropolitan area in the country (US Census Bureau, 2019a). Metro Atlanta is the premier southern metropolis in terms of economic growth and cultural distinctiveness. Since the early 1980s, the Atlanta metro region has emerged as a destination city for immigrant groups from around the country and the world. Immigration to Atlanta suburbs has created distinctive ethno-racial communities that defy historical black–white bifurcations (Hernández-León & Zúñiga, 2000; Walcott, 2002; Yarbrough, 2007). The Atlanta region has also been dubbed the African American "mecca," attracting tens of thousands of professional-class African Americans to its suburban counties (Frey, 2004). Observers note that the region's economic growth has occurred disproportionately in the northern, upper-income suburbs, which include some of the same towns and counties that have undergone significant racial and ethnic diversification over the past 30 years (Henderson, 2004, p. 199).

Literature review

Atlanta's blight problem

Blight is a multidimensional phenomenon that can take a variety of forms and span the rural-to-urban continuum. The Metropolitan Institute at Virginia Polytechnic and State University defines blight as a characteristic of buildings and private living quarters where structures are vacant, abandoned, or otherwise substandard (Vacant Properties Research Network, 2015, p. 5). Blight is also indicative in public spaces strewn with litter, illegal dumping, and graffiti; it includes vacant lots or "unwanted or highly regulated uses that may have blighting influences, such as adult businesses, junkyards, or heavy industrial uses" (Vacant Properties Research Network, 2015, p. 5). Carpenter et al. (2015, p. 5) define blight as "a local proliferation of vacant, abandoned, and 'problem' properties that may result when a variety and combination of social, economic, and financial conditions are at play." This definition is similar to that used by the City of Atlanta Police Department's Code Enforcement Section, which describes blight as code violations such as decayed or damaged leaking roofs, overgrown, littered vacant lots, graffiti, or dilapidated buildings (Atlanta Police Department, n.d.).

While blight is a public nuisance, and those contributing to blight may be subject to criminal prosecution, blighted conditions are not considered to be a form of criminal violence. Nevertheless, blight is associated with a wide range of compromised social and human health conditions, ranging from mental and emotional stress to increased rates of infectious disease (Garvin et al., 2012; Kondo et al., 2018; South et al., 2015; South et al., 2018). Regarding the latter, Lockaby et al. (2016) found that Atlanta neighborhoods with the highest occurrence of West Nile virus also had the highest frequency of illegal tire dumping, the dumped tires acting as water containers for mosquito breeding. Further, Branas et al.'s study (2016) in Philadelphia, Pennsylvania, found that firearm violence was greater near abandoned buildings that had not received cleaning and vegetation installations, compared to those that had greening installations.

Blight presents most often as copious amounts of trash placed in inappropriate places or as dilapidated structures, but it can also appear as unkempt nature in cities, the result of shifting social structures that diminish the livability of urban spaces. Brownlow (2006), for instance, details the absolute degradation in both social and ecological terms of Cobbs Creek Park in West Philadelphia, Pennsylvania, a transformation that occurred when the formerly all-white Cobbs Creek community transitioned to overwhelmingly African American from the 1950s to the early 1970s. Brownlow (2006, p. 228) and Roberts-Gregory & Hawthorne (2016, p. 19) argue that in such cases a "culture of neglect" emerges when both public and private investment in communities dissipate; significantly, the magnitude and pervasiveness of such disregard erode residents' sense of social control to the extent that public spaces, including and perhaps especially, urban greenspaces, can convert to arenas of fear and chaos (Troy et al., 2012).

In 2014, the City of Atlanta conducted more than 23,000 code enforcement inspections, and roughly 40% of this number was either known or likely blighted vacant properties (Immergluck, 2015, p. 3). Investigations of these properties were estimated to cost from $1.67 to $2.96 million annually. Immergluck (2015) also estimated that a "distressed vacant property" within 500 feet (150 meters) of an occupied, single-family home reduces the value of that single-family home by 3.15%. Such effects are expected to be cumulative up to a certain point.

Miller Runfola and Hankins (2010) mapped blighted or derelict properties in 45 randomly selected census block groups in Atlanta and found that blight conditions were higher in majority African American, south Atlanta communities. Relevant to the present study, they also found that civic engagement, in the form of voting and community organizing, did not lessen blighted conditions. However, Osborne Jelks et al. (2018) contend that in Atlanta, resident-led monitoring and cleanup of neighborhoods is a more effective recourse for blight remediation than generalized civic participation. This kind of civic engagement goes beyond petitioning municipal authorities for redress; rather, it places community activists on the ground, physically

in communities to not only call out blighted conditions but also to inventory and remediate dereliction (Greenberg, 2001; Osborne Jelks, 2008; Osborne Jelks et al., 2018). Of course, residents are limited in the impact they can effect, but this sort of activism places people in out-of-doors spaces where their activities can be witnessed by others.

Along similar lines, we propose that neighborhood-level UFE can also help to minimize blight-contributing behaviors, even those involving derelict properties. If people are purposefully engaged in community spaces—for instance, pruning, planting, holding community meetings, or posting notices about tree care activities—these activities in concert and over time have been shown to deter crime in other settings (Kondo et al., 2016). Related, Fisher et al. (2015, pp. 67–68) argue that long-time urban environmental stewards—that is, those who devote a large portion of their time to local environmental activism—represent a distinct category of civic actors because their engagement extends beyond traditional political participation to include "co-management" and design of urban space (Overdevest et al., 2004). This characterization is similar to Ernstson's (2013) concepts of management capacity and protective capacity, whereby natural areas within cities are established and perpetuated by a linked network of concerned residents, technical and scientific experts, and political allies. Osborne Jelks et al. (2018) describe this process for predominantly African American communities within the Proctor Creek watershed in south and west Atlanta.

South Atlanta tree legacies

UFE presupposes the existence of trees and other vegetation. Some studies have found that lower socioeconomic status and minority communities have less or inadequate access to urban greenspaces compared to others (Flocks et al., 2011; Heynen, 2006; Landry & Chakraborty, 2009; Mills et al., 2016; Pham et al., 2012; Shen et al., 2017). However, this is less the case in Atlanta than in other cities. To better understand contemporary distributions of Atlanta's urban forest, it is helpful to consider sociohistorical processes involving white flight out of the city proper in the 1960s and the 1970s and the consequent occupation of these spaces, first by middle class and then by largely working class and poor African Americans, in the decades that followed (Kruse, 2005; Lands, 2009).

When African Americans ventured out from their cramped, downtown-proximate quarters after World War II and gradually moved closer to, and eventually into, all-white neighborhoods on the city's south side, whites initially mounted strong resistance (Kruse, 2005). Innocuous-sounding neighborhood improvement organizations were formed, like the Southwest Citizens Association and the Mozley Park Homeowners' Protective Association in the late 1940s (Kruse, 2005, pp. 65, 77). These groups were created for the express purpose of legitimizing white supremacist articulations of localized rights, which undergirded efforts to

block black entrance. After these efforts failed to halt black movement into white neighborhoods, white Atlantans abandoned the south and west parts of the city en masse during the 1960s and 1970s, retreating to suburban places that became accessible with improved transportation corridors and automobile usage. By 1980, whites represented just 32.4% of Atlanta's population, a decline of 56.6% from 1970 (Kruse, 2005). Importantly, many of the city's southside, formerly all-white neighborhoods now contain copious amounts of canopy cover, in terms of tree densities on private lots, along streets, and in public parks (Giarrusso & Smith, 2014). Boone et al.'s (2009) examination of the intersection between neighborhood succession and greenspaces in Baltimore, Maryland, and Johnson Gaither's (2014) similar look at Latino migration to Hall County, Georgia, suggest that populations that supplant one racial or ethnic group may inherit, so to speak, the existing green infrastructure (or, conversely, the environmental burdens) left by the exiting group. Although residents in these now "minority-majority" neighborhoods may be the default beneficiaries of urban forest cover established decades ago, it is important to look at people's engagement with this resource and how this interaction may lessen the appearance and production of blight at the household level.

Materials and methods

Household survey administration

We administered a UFE survey door-to-door to a stratified, random sample of the resident population of Atlanta from April 2015 to July 2015, and from May 2016 to August 2016. The survey included a scale to measure UFE, a module with questions related to neighborhood social stressors (e.g., crime, unemployment, public education quality, illegal trash dumping, lack of affordable housing, and the lack of code enforcement—i.e., city enforcement of laws or codes regulating nuisances such as blighted properties or conditions), an inventory of blight on and around the respondent's home, and questions soliciting sociodemographic data about the household. The UFE scale contained statements intended to measure both active management and protection of the urban forest. For instance, "Someone in my household spends a lot of time caring for trees around our home" is an indicator of household-level management of the urban forest; and "People in my household are very interested in increasing the number of trees we have in this neighborhood" is an indicator of urban forest protection. Table 1 contains the complete set of statements administered.

A total of 610 households were contacted and included people living in houses and those in apartment or other non-institutionalized, multi-unit dwellings. Oversampling was done to account for an anticipated non-response rate of roughly 20%. Excluding bad addresses (those with no access, e.g., gated residences,

abandoned or boarded-up homes, no physical address present), the effective sample size was 490 (response rate 80.33%). Of these, 318 observations contained data for variables used in the analyses presented in this paper. However, because of missing data, the effective sample size varied between 251 and 305.

After administering the UFE, social stressor, and sociodemographic modules to respondents, the surveyor went to the end of the respondent's driveway or other appropriate place near the home and inventoried the presence of 11 blight indicators within eyesight of the respondent's home. These were damaged homes or other buildings (which appeared occupied, i.e., those with broken windows, sagging roofs etc.), illegally dumped garbage on streets, discarded tires, discarded furniture (which appeared to be dumped rather than for pick up), junk cars, houses or other building structures that appeared to be abandoned, litter, graffiti, discarded shopping carts, security bars on windows, and damage to concrete from tree roots. The presence (1) or absence (0) of each indicator was recorded.

Logistic model specification

To examine the association between UFE and observed blight, we selected seven of the 11 inventoried indicators, as follows: damaged homes (occupied), illegally dumped garbage, discarded tires, discarded furniture, junk cars, abandoned buildings, and litter. We judged that the first six of these constituted a similar kind of blight or degree of offensiveness. We decided security bars and tree root damage were imprecise blight measures: security bars are more indicative of safety concerns, and tree root damage has more to do with spacing between tree plantings and sidewalks or other pervious surfaces. There was an insufficient number of positive responses to model either shopping carts or graffiti. Litter was the only "less offensive" blight measure that was analyzed. For the seven selected indicators, we specified binary logistic regression models.

In addition to our models for observed blight, we examined resident perceptions of blight by specifying two binary logistic models from the social stressors module of the survey—lack of code enforcement and illegal dumping, which were dependent variables. Residents' indication of whether the stressor impacted their neighborhood (1) or not (0) was recorded.

Explanatory variables were: UFE; whether the household was in a predominantly African American part of the city; homeownership; length of years at residence; and education level. UFE was measured with a five-point Likert scale developed by the authors (Table 1). The scale measures household members' reported interest in and management of, or care for, neighborhood trees. It also measures household members' perceptions of their neighbors' civic and political engagement, as this relates to the protection of neighborhood trees.

An initial set of statements measuring UFE was reviewed in February 2015 by 12 professionals in urban- or environment-related positions, including a college instructor/researcher, environmental justice advisor (US Environmental Protection Agency), epidemiologist (Agency for Toxic Substances and Disease Registry), and environmental consultant. Statements were modified based on input from these professionals. After this, a preliminary survey containing 15 UFE statements was administered from February to May 2015 by Morehouse College students working with the project (n = 100).

A final scale consisting of 14 UFE statements was administered to a stratified, random sample of households (Table 1). We used explanatory factor analysis to examine the underlying scale structure. Analyses were conducted both in SAS 9.4 and in R statistical software. For the SAS analysis, factors were extracted with the principal factor method followed by an oblique rotation. The number of factors retained for rotation was determined by the size of eigenvalues, eigenvalue break points, and factor loadings (Hatcher & Stepanski, 1994). R was used to perform a 10-iteration parallel analysis, which acts as a check on conventional exploratory factor analysis. Parallel analysis addresses traditional eigenvalue cut-off method limitations (e.g., factor overestimation) by averaging n random resampled data sets (derived from the original) and suggesting a lower bound eigenvalue cut-off (Hayton et al., 2004).

A two-factor solution was supported considering both the SAS criteria and parallel analysis. We then reviewed the rotated factor pattern (Table 1) produced by the SAS analysis to identify scale items with a loading of 0.40 or greater for a given factor, and less than 0.40 for the other factor (Hatcher & Stepanski, 1994). In both the SAS and R analyses, Factor 1 loadings were suggestive of urban forest *management*, and Factor 2 loadings indicated urban forest *protection*. Urban forest management has to do with routine activities to establish and care for trees at the household level; protection relates to neighborhood-scale efforts to promote and advocate for the urban forest.

One item with a relatively low loading was omitted from the management factor and two from protection (Distefano et al., 2009). These are indicated in Table 1. Items 5 and 6 for the management factor were reverse coded, and items 1, 2, and 5 for protection were reverse coded. Scale reliability was assessed with Cronbach's alpha for both the 14-item scale (n = 299; α = 0.81) and reduced 11-item scale (n = 305; α = 0.82). See Table 1 for scale items and corresponding factor loadings.

There are several important issues to consider with exploratory factor analyses. First, factor loadings are sensitive to method of extraction, rotation, number of factors interpreted, and sample size (Costello & Osborne, 2005). Following Hatcher (1994) and Fabrigar et al. (1999), we are confident that the extraction, rotation, and number of factors retained are appropriate. The robustness of factor structure

is also important to consider. Costello and Osborne (2005) found fewer errors of inference for the factor structure of scales with larger sample sizes. For scales with a 20:1 item ratio (i.e., sample size to number of scale items), 70% of samples examined had correct factor structure, compared to only 10% with a 2:1 ratio. The ratios for our sample are roughly 21:1 for the 14-item scale and 28:1 for the 11-item scale—well within recommended standards. The combined scales were included as the UFE explanatory variable in the logistic regression.

Table 1. Urban forest engagement: Factor loadings for urban forest management and urban forest protection

Rotated factor pattern (n = 299)		Scale items
Factor 1	Factor 2	
		Urban forest management
.63	–.01	1. Someone in my household spends a lot of time caring for trees around our home.
.73	–.01	2. At least one member of my household feels that it's important to personally care for neighborhood trees.
.58	–.10	3. Participating in environmental cleanup activities in this neighborhood is important to the people who live in my home.
.63	.07	4. People in my household are very interested in increasing the number of trees we have in this neighborhood.
.63	.05	5. No one in my household is interested in personally caring for neighborhood trees. (reverse coded)
.43	.26	6. No one who lives here knows how to get involved with neighborhood improvement groups. (reverse coded)
.27	.25	7. Someone who lives here works with other people to care for trees in this community. (omitted)
		Urban forest protection
.08	.27	1. Most of the people in my neighborhood would not be interested in forming a group to plant more trees in this neighborhood. (omitted)
.08	.50	2. I don't think people in my neighborhood have the political connections to demand that the city plant more trees in this neighborhood. (reverse coded)
.11	.48	3. I see a lot of people caring for trees in this neighborhood.
–.04	.64	4. Residents in my neighborhood work with tree experts to help decide what kinds of street trees the city should plant in this neighborhood.
–.01	.18	5. Most people in my neighborhood focus their organizing efforts on issues that do not relate to tree preservation. (omitted)
–.03	.55	6. The city council representative for this neighborhood is interested in tree preservation.
–.01	.65	7. My community is connected with other communities across the city that are concerned about preserving trees in Atlanta.

Variables

A dummy variable (BLACKATL) was created to indicate if the respondent lived in a predominantly African American area of the city (1) or not (0). Homeownership was also binary and coded 1, renters 0; for education, an associate's degree through graduate-level education was coded 1 and high school or below, 0. Length of residence scores ranged from 1 to 5: 1 = less than one year at residence, 2 = one to five years, 3 = six to 10 years, 4 = 11 to 20 years, and 5 = more than 20 years. Homeownership and length of residence were included to control for people's attachment to their homes and communities.

Urban forest canopy and vegetation characteristics

We also examined the association between tree canopy cover and blight for subareas of the city. These data were not collected as a part of the household survey. Canopy extent was measured by the Georgia Institute of Technology with 2008 Quickbird Satellite imagery (Giarrusso & Smith, 2014). Using this imagery, we calculated canopy cover for five substrata in the city—Northside, Eastside, Southeast, West Central, and Southwest (Figure 1). Again, these estimates were computed to provide a measure of how canopy cover and the seven observed blight indicators varied across areas of the city with differing socioeconomic configurations. The strata were defined by the research team based on our knowledge of racial and socioeconomic demarcations in Atlanta.

Figure 1. The five substrata of the study area, City of Atlanta

The use of satellite data to estimate canopy cover is an established protocol and has been used to evaluate the spatial distribution of tree canopy in urban landscapes (Landry & Chakraborty, 2009; Locke et al., 2016). For instance, Landry and Chakraborty (2009) used high-resolution imagery to evaluate the spatial distribution of street-tree canopy and social equity in Tampa, Florida. Although there are limitations with using satellite imagery to evaluate canopy cover, such as autocorrelation, these limitations can be addressed through statistical modeling (Locke et al., 2016).

We gathered ground-level vegetation data for a more complete understanding of how tree condition possibly influences blight. If vegetation is relatively low to the ground, dense, and in poor health (dead or dying), this could influence people's perceptions about the overall human attention to an area and possibly increase the likelihood of blight-producing activities or actions on the part of residents, absentee landlords, and others traversing the area. However, we determined that these characteristics were not likely to be perceptible by the untrained eye. As such, these data are not a central part of this analysis but are included in the Appendix for reference (Table A and Figure A).

Results

Socioeconomic composition, canopy cover, and blight by strata

Before discussing household-level regression model results, we present sociodemographic, canopy cover, and blight data for the five substrata of the city (Figure 2). Means for selected sociodemographic variables were computed for census tract groups comprising each of the five strata, using data from the 2009–2014 American Community Survey (Social Explorer, 2017) (Table 2). Northside is predominantly non-Hispanic white and has the lowest mean childhood poverty and vacant housing rate. Eastside is adjacent to downtown and has undergone significant gentrification and white population increase in the past 30 years. The racial mix in Eastside is much more varied than in Northside or the three other substrata, which are predominantly African American. Majority African American areas are differentiated because of the distinct histories and contributions of communities within these areas.

Canopy cover is highest for the most affluent and one of the least affluent strata—Northside and Southwest, respectively (Figure 2). Statistical differences for canopy estimates are not reported because the universe of canopy for the city was provided by satellite, and all differences among strata are substantive. To measure blight at the same scale as canopy cover, we aggregated both our inventoried and social stressor measures of each blight indicator to the substrata scale. Unlike canopy cover, blight distribution follows expected socioeconomic patterns, with more blight in lower-wealth, minority communities—Southwest, West Central, and Southeast.

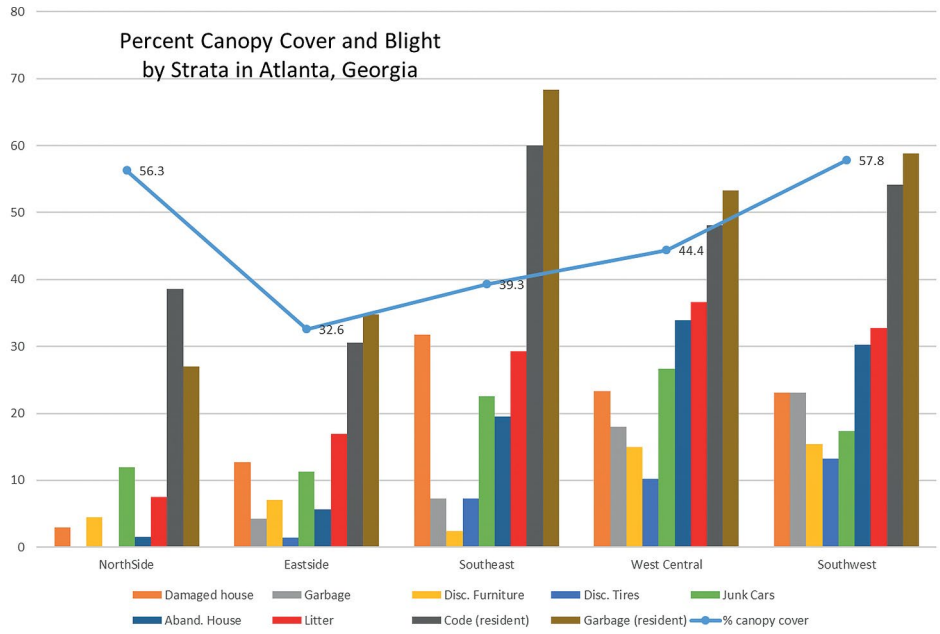

Figure 2. Canopy cover by strata and blight indicator

Table 2. Selected sociodemographic indicators for five substrata, City of Atlanta

Sociodemographic indicators	Substrata				
	Northside (*n* = 27)	Eastside (*n* = 49)	Southeast (*n* = 27)	West Central (*n* = 25)	Southwest (*n* = 22)
Population	122,328	176,851	87,910	67,171	105,985
Mean population (density/km^2)	1,627	2,543	1,305	1,533	1,184
Child poverty (mean %)	9.36	25.64	48.35	51.19	50.27
White (mean %)	71.99	54.85	12.39	6.76	2.46
Black (mean %)	10.75	32.85	77.57	87.6	91.56
Asian (mean %)	5.61	4.92	1.19	1.12	0.31
Hispanic (mean %)	9.72	4.9	7.2	4.86	4.02
Vacant houses (mean %)	15.86	14.79	28.1	30.4	19.9

Source: Social Explorer (2017).

Table 3. Observed blight indicators: Surveyor-inventoried and resident-identified (chi-square text)

	Surveyor-inventoried							Resident-identified	
	Damaged houses	Dumped garbage	Discarded furniture	Discarded tires	Junk cars	Abandoned structure	Litter	Lack of code enforcement	Dumped garbage
x^2	19.44	24.45	9.45	14.09	7.61	36.85	20.37	10.96	25.53
p value	<0.0006	<0.0001	0.0509	0.0070	0.1071	<0.0001	0.0004	0.0270	<0.0001
n	291	290	291	291	290	291	291	251	251

In Table 3, the chi-square analyses show strong, significant differences across strata for each blight measure, except for junk cars where the significance is marginal. Interestingly, household perceptions of illegally dumped garbage were much higher than inventoried garbage, although the former measure was aimed at perception of the neighborhood rather than the area immediately around the respondent's home. Like the inventoried measures, respondents' perceptions of lack of code enforcement and illegally dumped garbage varied by substrata with a higher percentage of respondents in the predominantly African American areas of the city indicating that both these conditions were problematic.

Logistic model

The probability of a given blight indicator either being in view at the household or being identified by a householder was modeled as a function of UFE, BLACKATL, homeownership, length of residence, and education level. Holding constant other covariates, a significant and negative coefficient on UFE would suggest that people's participation in urban forestry–related activities reduces the incidence of blight around people's homes, regardless of model covariates.

UFE was not significant in any of the inventoried blight models except litter (Table 4). However, BLACKATL was significant for both observed blight (damaged house, dumped garbage, discarded tires, abandoned structures, litter) and for respondent-indicated blight measures (code enforcement violations and illegal dumping), indicating an increased likelihood of one of these blight measures if the household is located in a predominantly African American area of the city. Also, those with higher education were less likely to have damaged houses, discarded furniture, and junk cars near their homes. Those who had resided longer at their residences for a longer time were somewhat less likely to have discarded furniture in view of their homes.

Table 4. Binary logistic regression of surveyor-inventoried and resident-identified blight indicators

	Surveyor-inventoried							Resident-identified	
	Damaged house (*n* = 281)	**Dumped garbage (*n* = 280)**	**Discarded furniture (*n* = 281)**	**Discarded tires (*n* = 281)**	**Junk cars (*n* = 280)**	**Abandoned structure (*n* = 281)**	**Litter (*n* = 281)**	**Code enforcement (*n* = 244)**	**Dumped garbage (*n* = 274)**
Intercept	–0.21 NS	–2.96 (0.020)	–0.55 NS	–3.62 (0.030)	–0.39 NS	–1.86 (0.083)	1.83 (0.037)	–0.24 NS	–0.89 NS
Black Atlanta	1.14 (0.002)	2.40 (0.0002)	0.58 NS	3.15 (0.003)	–0.47 NS	2.40 (<0.0001)	1.08 (0.001)	0.61 (0.03)	0.99 (0.0002)
Homeowner	–0.67 (0.087)	–0.60 NS	0.27 NS	0.06 NS	–0.38 NS	–0.12 NS	–0.027 NS	–0.04 NS	0.12 NS
Length of residence	–0.10 NS	–0.05 NS	–0.36 (0.080)	–0.49 (0.046)	0.13 NS	–0.02 NS	–0.16 NS	0.09 NS	0.03 NS
Education	–0.79 (0.028)	0.04 NS	–1.01 (0.0389)	–0.59 NS	–0.73 (0.044)	–0.17 NS	–1.01 (0.003)	–0.05 NS	–0.15 NS
Urban forest engagement	–0.22 NS	–0.11 NS	–0.20 NS	0.12 NS	–0.35 NS	–0.35 NS	–0.72 (0.003)	–0.15 NS	0.05 NS
Model x^2 (likelihood ratio)	39.36 (<0.0001)	29.69 (<0.0001)	13.21 (0.022)	30.44 (<0.0001)	17.64 (0.0034)	45.09 (<0.0001)	53.03 (0.001)	7.81 NS	17.10 (0.0043)
Percent correct predictions	0.75	0.77	0.71	0.82	0.68	0.78	0.78	60.4	63.3
Frequency of 1 response	0.20	0.11	0.10	0.08	0.18	0.17	25.27	0.45	0.46

Note. Number in parenthesis is *p* value.

In terms of substantive impacts, the probability of an African American, living in a predominantly black area of Atlanta, who is a homeowner, lived in the home for six to 10 years, with education beyond high school, and a score of 5 on UFE, having garbage near the home would be 0.14; while the probability of someone living outside of a predominantly black area of Atlanta, with similar characteristics for the other variables, would be 0.06—less than one-half that for a black Atlanta resident. The probability of living near an abandoned structure for someone living in a majority African American community would be 0.17 with the above characteristics held constant; but just 0.02 for someone living in either Northside or Eastside. The blight measures we used are limited in that they indicate only the presence or absence of blight, not the degree of disamenity. Additional study examining the extent of blight and its relationship with the urban forest is warranted.

Discussion and conclusion

This study contributes to the established body of research examining links between urban forests and community integrity. We add to this literature by highlighting the importance of meaning generation when residents manage and advocate for the urban forest. Earlier social theorists worked from the premise that humans act dialectically to both create and receive meaning in a given environment, and that they behave in those environments based on constructed meanings. We argue that if residents actively participate in the establishment and maintenance of, and advocacy for, the urban forest, this is one way that the inhabitants of that place convey to each other and to visitors, interlopers, or others that the place is relevant, consequential, and significant. Both those familiar and unfamiliar with that place respond in a similar, positive manner, for instance by not doing things that contribute to a blighted appearance. Other studies suggest the importance of such signaling, but none are explicit about the role of socially constructed meanings and how engaging with urban vegetation establishes those meanings for residents and non-residents alike.

Our research is also novel in that it examines this association for a city in the US South, which is distinct historically, socioculturally, and climatically from northern and midwestern cities where similar issues have been examined. The consistency of race and place (i.e., BLACKATL) in predicting outcomes for both the inventoried blight and social stressor models indicates that residents in Atlanta's predominantly African American communities are more likely to experience and express concerns about derelict conditions. Results suggest that in these communities, blight and other persistent social stressors minimize the urban forest import. We would argue that blight has a more profound impact on UFE than the other way around. If people must contend daily with blighted conditions near their homes, it is less likely that they would have the time or interest to care and advocate for trees.

Blighted conditions like derelict properties and illegally dumped trash obscure the importance of the urban forest, which may be judged as insignificant in comparison with the volatility and disorder wrought by decaying conditions. However, results indicate that litter, being the least innocuous and most remediable blight indicator, may be reduced by UFE.

Results suggest that litter, being a relatively remediable form of blight, may be reduced by UFE, but that other, more intractable, forms are not affected. Our findings indicate that larger, structural processes are in play that limit what ordinary people can do to combat blight in the form of dilapidated structures, for example. In Atlanta, like some other US cities (Schank, 2019), the municipal government is very careful not to usurp the rights of private property owners when attempting to mitigate blight, even in cases where private property is a public eyesore and presents a human health risk. Atlanta's blight remediation program allows for demolition of blighted properties within 120 business days of reporting, but the process of addressing even a single blighted structure can extend beyond this time frame. The city has first to locate property owners to inform them of a complaint; sometimes these owners want nothing to do with the problem (Lee, 2018). In such cases, a court order is necessary to demolish the property. These circumstances involve extra-local actors and procedures that are not controlled by neighborhood residents. Resident management and protection of the urban forest are comparatively small forces when considered in the context of this intricate bureaucracy.

Urban greening organizations in Atlanta aim to plant, protect, and maintain trees and educate the populace about the relevance of trees to urban ecosystems and human communities in the city. While certainly beneficial, we suggest that such organizations might also use their political and social capitals to help alleviate derelict conditions in the same south Atlanta neighborhoods where they plant trees. In this way, the most immediate conditions and concerns of place are acknowledged before or in concert with green interventions. This way of engaging community is more likely to build trust and respect rather than resistance.

A very good example of this participatory approach is given by the New Haven Urban Resources Initiative, a Yale University–funded program in the US city of New Haven, Connecticut (Murphy-Dunning, 2009). Here, community residents identify areas of their communities that they want to green; they work with the university to design the programs, but the site selection, physical labor, and longer-term vegetation maintenance are performed by residents. This establishes ownership at the start of the program, which increases chances for success. Also important is the fact that residents decide for themselves the relevance and importance of urban greening to their communities.

Our study has implications for the geography of justice literature because efforts to remediate urban blight can have the unintended consequence of stimulating gentrification. In the US, residents of blighted, inner-city communities are lodged in a difficult space. On one hand, persistent blight endangers health and well-being; but on the other hand, when housing shortages in cities like Atlanta push an otherwise reluctant real estate market into areas of the city with extensive blight, this can stimulate house grabbing and remodeling, resulting in dramatically higher housing values and displacement of long-time residents, many of whom are poor and African American. During the last economic downturn, both foreign and domestic real estate speculators purchased hundreds of rundown homes in some historic, west Atlanta neighborhoods where many of the residents are lower wealth and African American. Properties are held in expectation of improvements in real estate markets and infrastructure projects in those parts of the city (Saporta, 2018; Vashi, 2019; Wheatley, 2016). Real estate markets have improved significantly across the US in recent years, including in the City of Atlanta. As well, large, green infrastructure projects are drawing wealthier, white people to south and westside Atlanta neighborhoods (Immergluck & Balan, 2017; Johnson Gaither, 2019). There has been a concomitant criticism of these trends, but some amount gentrification is inevitable and is already evident in west Atlanta. Observers caution that the city's attention to a green sustainability agenda must incorporate a human component that protects the rights of poor people to remain in place. This issue falls within the realm of urban sustainability, a sustainability that involves the necessary intersection of urban ecologies with human systems contending with blight abatement, housing security, and a host of other social justice concerns.

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Appendix

Vegetation data were collected using the i-Tree Eco model protocol (Escobedo & Nowak, 2009). Data from 443 one-tenth acre (0.04 ha), randomly distributed plots were collected and analyzed for a 346.32 km^2 area of Atlanta. Sampling began in September 2013 and ended November 2015. Plots were located on the following land use types: residential, institutional, commercial, transportation corridors, industrial, and vacant areas. Data were collected during tree leaf on season and included land use, ground and tree cover, tree attributes by species, stem diameter, height, crown width, crown canopy missing and dieback, and distance and direction to residential buildings.

Using these data, examination of tree structure revealed significant differences across strata (Table A). Compositionally, the Eastside stratum had the highest number of species (59), and Southeast had the lowest number of species (45). Eastside's high value is attributed to a greater number of samples taken in that strata. To compare species richness across strata, a rarefaction and extrapolation analysis was used, which showed that Northside was the most species-rich and Southwest and West Central were the least species-rich (Figure A). Eastside also had the highest Simpson's reciprocal index, indicating a more even distribution of species.

Table A. Structural characteristics of the urban forest by strata as defined in the text for Atlanta, Georgia

	Northside (n = 86)	Eastside (n = 119)	Southeast (n = 67)	West Central (n = 110)	Southwest (n = 60)
Area (ha)	9,219.1	5,913.7	5,988.2	6,183.6	7,327.8
Species richness	48	59	45	51	51
Simpson's reciprocal index (percent canopy cover)	17.0	33.6	12.0	14.7	10.1
Mean (standard error) of diameter at breast height (cm)	26.4 (1.1)[b]	29.0 (1.3)[ab]	25.7 (1.2)[b]	32.0 (1.2)[a]	26.9 (0.9)[b]
Density (stems/ha)	78.4 (15.3)[bc]	57.2 (6.2)[c]	113.1 (25.0)[ab]	82.5 (12.5)[bc]	177.7 (32.1)[a]
Basal area (m^2/ha)	6.4 (1.1)	6.3 (1.0)	10.1 (1.6)	10.4 (1.3)	15.1 (2.2)[a]
Crown condition (%)	91.6 (1.2)[b]	95.9 (0.8)[a]	93.0 (1.1)[a]	93.4 (1.0)[a]	94.3 (0.8)[a]

[a] Significantly different from "b" and "c" at $p \leq 0.05$ level.

[b] Significantly different from "c" at $p \leq 0.05$ level.

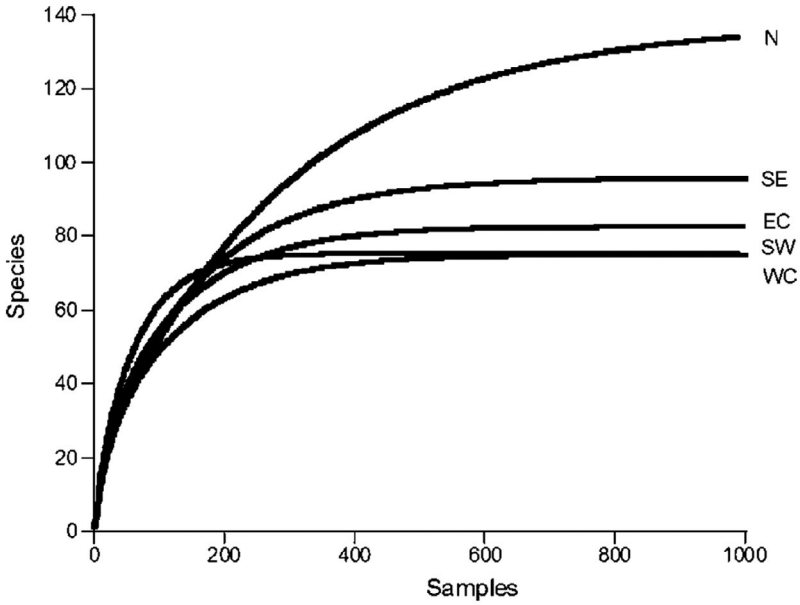

Figure A. Rarefaction and extrapolation curves for each strata based on species occurrence and abundance

Key: EC = Eastside, N = Northside, SE = Southeast, SW = Southwest, WC = West Central.

Reconceptualizing Climate Change Denial: Ideological Denialism Misdiagnoses Climate Change and Limits Effective Action

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Abstract

Despite increasing scientific evidence supporting the need for immediate and transformative action, effective responses to address climate change remain stymied. Scholars have identified climate change denial as a factor in thwarting policy responses to climate change. We examine new forms of climate change denial that are critical to recognize as the general public and policy-makers consider actions to limit warming. Here we apply a Marxist conception of ideology to broaden our understanding of climate denialism (Marx & Engels, 1977). We introduce the concept of "ideological denialism," which conceals underlying contradictions and perpetuates the current social order. The ideological denial of climate change involves recognizing climate change as a problem, yet fails to diagnose the root causes and prescribes solutions that maintain the current system. We argue that ideological denialism typically stems from a failure to recognize a growth-dependent economic system as a root driver of climate change. We examine degrowth as a possible means to reorganize social relations with potential to more effectively reduce greenhouse gas emissions and limit global warming.

Key words: climate change, contradictions, degrowth, denialism, ideology

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> It is vital, when encountering a serious problem, not merely to try to solve the problem in itself but to confront and transform the processes that gave rise to the problem in the first place.
>
> David Harvey (1973, pp. 136–137)

1. Introduction

The Intergovernmental Panel on Climate Change (IPCC) special report released in October 2018 describes the significant impacts from global temperature increases and states that "rapid, far-reaching and unprecedented changes in all aspects of society" are necessary to keep Earth's temperature within 1.5 degrees Celsius above pre-industrial levels (IPCC, 2018). Despite overwhelming evidence and increasingly dire predictions, including the possibility of "Hothouse Earth" (Steffen et al., 2018), current policies and international agreements will fail to prevent warming to temperatures that will have severe impacts on ecosystems, society, and the economy (IPCC, 2018). Climate denialism has been identified as a prominent reason as to why effective policies to reduce greenhouse gas emissions have not gained enough support, especially in the United States, with scholars primarily focusing on moneyed and special interests intentionally misleading the public (McCright & Dunlap, 2000, 2003, 2010, 2011).

Here, we aim to broaden the concept of climate change denialism. In addition to actors protecting their financial interests, who have undoubtedly undermined efforts to address climate change, we argue that new forms of denial apply even to those who agree that climate change is occurring. These new forms of denial are based on what we call an "ideological" form of denialism that fails to identify the root causes of climate change and therefore promotes insufficient solutions that maintain the current social order, a social order whose basic structure drives climate change. As stated in the IPCC special report (2018), the scope and scale of climate change demands radical societal change. Radical, from the Latin *radicalis*, means relating to the root. In this context, climate action necessitates identifying and overcoming the root causes of greenhouse gas emissions. As we will illustrate with evidence later, a growth-dependent economic system is a central root driver.

Rather than focusing solely on obvious climate denialists—those who claim no scientific evidence exists that humans are changing the climate—a need has emerged to better understand the forms of denial that continue to prevent those who do believe in anthropocentric climate change from taking effective action. In addition to persuading those reluctant to address climate change, we also need to "preach to the choir," coaxing the already persuaded to understand that, due in part to ideology, they have both misdiagnosed the problem and are relying on limited solutions that will not only fail to effectively achieve deep emissions cuts but may

even distract attention from effective and just mitigation strategies. As we will illustrate, prominent proposed and implemented solutions are not radical in the sense that they fail to address the root drivers of climate change. Climate change "solutions" that do not address root drivers of emissions effectively deny the reality of the problem and the social transformations necessary to address it. In Section 2, drawing from Foster (2010) and others, we develop the notion of "ideological denialism" to conceptualize the paradox of climate change solutions that effectively deny the reality of climate change.

In this paper, we first conceptualize "ideological denialism." We next identify six different forms of climate change denial: literal denial, neo-skepticism, techno-optimism (including three variants), individualism, market fundamentalism, and green growthism. After reviewing the forms of denialism, we propose and explore "degrowth" as a viable and necessary response, an approach that begins to heed Foster's (2010) call for a strategy that calls into question the social formation that drives climate change. We conclude, briefly, by summarizing ideological denialism and detailing its implications related to climate change.

2. Ideological denialism

We use the term *ideology* as Marx did, as "ideas and practices that reproduce contradictory social relations" (Gunderson, 2017, p. 271). Ideology obscures or masks social contradictions, fashions social unity in spite of division, narrows political horizons, and limits actions toward social change. As opposed to remaining only a taken-for-granted practice or an immaterial, intellectual "ism," ideology also exists as unreflected activities governed by rituals within specific institutions or "ideological state apparatuses" (Althusser 1971). The content of ideology in the form of ideas reproduces the status quo through reification and legitimation. Reification refers to the process by which humans are dominated by their own material and immaterial artifacts (the objective dimension of reification), yet these artifacts appear as fixed and unchangeable rather than as human creations that can be changed (the subjective dimension of reification that concerns us here) (Lukács, 1971). One aspect of subjective reification important for this project is blinding consciousness to possible alternative social futures (Lukács, 1971, p. 192). This blindness to possibility was famously described by Marcuse (1964) as "one-dimensional" thinking (see Conclusion). The implication of possibility blindness is this: "reification effectively prevents questioning and changing established social relations in modern societies" (Kavoulakos, 2017, p. 69).

Along with reification, ideology masks social contradictions and reproduces the status quo through legitimation via consent. Gramsci's (1971) conception of "hegemonic ideology" shows how culture and civil institutions generate social acceptance of

ideas (ideology) that ultimately prevent social change. The concept of hegemony is often employed to make a distinction between power through domination won through coercive institutions (the police, military, state bureaucracy), on the one hand, and power through consensus (hegemony) won through civil institutions (e.g., church, family, unions), on the other (Ramos, 1982). A Gramscian conception of ideology also showcases "how the ideas of elite political and economic actors come to be seen as common sense to the general public, and how control in modern societies is maintained though consent to 'ruling ideas' rather than through direct imposition of force" (Norgaard, 2011, p. 11). We argue that these "ruling ideas" give life to different forms of climate denialism, dramatically limiting the suite of options seen as solutions to climate change. Further, the concept of ideology adopted here, as contradiction-concealing ideas and practices that reproduce existing social conditions, lends itself to comparison with the notion of *denial*.

Denialism has received significant attention due to how it influences society's responses to climate change. In her study of climate change perspectives from educated, economically stable people in Norway, Norgaard (2011) outlines how denial emerges through social interaction. Rather than focusing on the psychological realities that limit humans from viewing climate change as an immediate risk that requires action, Norgaard (2011, p. 9) suggests that "the notion of socially organized denial emphasizes that ignoring occurs in response to social circumstances and is carried out through a process of social interactions." Norgaard (2011) draws from Cohen (2001) in formulating denialism. Cohen crafted a three-part denial typology: literal, interpretive, and implicatory. Literal denial refers to someone asserting something is not true despite evidence to the contrary. Interpretive denial focuses on contesting or distorting facts and evidence in an attempt to change the meaning associated with ideas or events. Lastly, implicatory denial, the variant that Norgaard focuses on, conceals information such that individuals and, more importantly, society, do not act upon it. She develops the idea of socially organized denial, in which individuals distance themselves from information based on "norms of emotion, conversation, and attention" (Norgaard, 2011, p. 211). This leads to individual apathy and a situation where people "find real change unnecessary" (Norgaard, 2011, p. 225).

Foster (2010) also draws on the concept of denial to diagnose why society has failed to adequately address climate change. He too focuses attention on dominant views held by those convinced that climate change is happening. He contributes to this line of thought by identifying as denial prominent strategies put forth by environmentalists, a use of the concept that we extend in this article. Mainstream strategies are labeled a form of denial because the strategies remain woefully inadequate to addressing the systemic factors causing climate change. Recently, Foster (as quoted in Ferguson, 2018, n.p.) stated that "the willful delusions here are in some ways more dangerous than that of straight-out climate deniers, since they

are subtler and infect those who are ostensibly on the side of change." He marshals evidence that climate change poses significant threats to society, notes that the current trends represent an unsustainable pathway, and suggests the only ways to address the situation require radical alternatives. In particular, Foster raises tipping points as specific climate change consequences that pose grave threats to society. Still, environmental discourses refrain from engaging the gravity, scope, and extent of the drivers causing climate change. Foster (2010) explains:

> However, rather than addressing the real roots of the crisis and drawing the appropriate conclusions, the dominant response is to avoid all questions about the nature of our society, and to turn to technological fixes or market mechanisms of one sort or another. In this respect, there is a certain continuity of thought between those who deny the climate change problem altogether, and those who, while acknowledging the severity of the problem at one level, nevertheless deny that it requires a revolution in our social system. (p. 4)

Foster (2010) points to what we mean by the ideological denial of climate change, a mode of denialism that:

- acknowledges the reality, human origins, and severity of climate change and desires immediate action;
- often misdiagnoses the structural drivers of climate change;
- limits more effective actions; and
- reproduces rather than challenges the social formation that drives climate change.

In comparison to Norgaard's (2011) notion of the socially organized implicatory denial of climate change, which illuminates how climate change knowledge is severed from action, the notion of ideological denialism illuminates *ineffective action despite climate change knowledge*. As argued in the following section, there are four dominant forms of ideological denialism in mainstream climate policy today: techno-optimism, individualism, market fundamentalism, and green growthism.

3. Forms of climate change denial

In this section we detail six forms of denial associated with climate change. These forms include what is typically referred to as climate change denial, denying the existence of climate change or its human origins, as well as climate "neo-skepticism," denying the severity of possible consequences to society. We then go beyond these frequently identified forms of denial and categorize additional ideological-denialist forms that involve relying on solutions to climate change that focus on individual, technological, or market approaches and fail to address the root drivers increasing emissions. Although some of these approaches hold potential for positive change, they have been construed narrowly and fail to "engage the nature of

society," as Foster (2010) calls for. Each overview below represents only a cursory introduction. We offer discrete descriptions to clearly articulate each form but do not contend they are mutually exclusive.

3.1. Literal denial

The overwhelming scientific evidence that climate change is occurring has not translated into social consensus. Theories abound as to what has created this discrepancy. Some attribute it to evolution and brain wiring (see Walsh, 2019), while others attribute it to climate change not animating a moral response, or to psychological barriers (e.g., Mooney, 2011). Undoubtedly, many factors have contributed to literal climate denialism. However, substantial evidence suggests that a well-organized denial campaign has had a significant influence (McCright & Dunlap, 2000).

Climate change has important implications for society. As a result, certain groups initiated efforts dating back decades to intentionally forestall action to address climate change. The conservative movement in the United States began a campaign in the early 1990s to sow seeds of doubt about climate change in the American populace (McCright & Dunlap, 2000). This effort, supported by the fossil fuel industry, successfully altered climate policy in the United States by helping to thwart ratification of the Kyoto Protocol (McCright & Dunlap, 2003). Fossil fuel interests, especially ExxonMobil (Supran & Oreskes, 2017), have funded think tanks and nongovernmental organizations as front groups to create controversy around climate change. Oreskes and Conway (2010) show how non–climate scientists and industry representatives attacked the IPCC and climate change reports to invalidate the notion that humans are causing climate change. These efforts to create climate denialism have led to confusion on the part of the public and political paralysis in taking action.

Diethelm and McKee (2009) outline five characteristics of denialism: identification of conspiracies, use of fake experts, selectivity in sources, creating impossible expectations of research and evidence, and using misrepresentation and logical fallacies. The conservative movement in particular has used these tactics effectively in a strategic effort to create confusion about climate science and negate policy interventions (McCright & Dunlap, 2010). Overall, denialism has resulted in the public viewing science as uncertain or contradictory (Oreskes & Conway, 2010) and deep divisions between individuals affiliated with different political parties (McCright & Dunlap, 2011). This denial of the scientific evidence effectively influenced public opinion, stalling motivation to create policy responses (McCright & Dunlap, 2010).

3.2. Neo-skepticism

The term *skepticism* figures prominently in recent debates about climate change. Skepticism represents a foundation for scientific inquiry. It entails scientists critically analyzing claims to ensure they are scientifically credible and supported by evidence. Skepticism has taken on a different form in regard to climate discussions. A new variant, neo-skepticism, adds another dimension to this term. Coined by Perkins (2015, p. 287), neo-skeptics "do not deny anthropogenic global warming, but minimize its projected effects and see mitigation efforts as unjustifiable." He uses two *Wall Street Journal* articles to illustrate neo-skepticism, highlighting how scientists express uncertainty or minimize the extent of possible impacts. In the article "Climate Science Is Not Settled," Steven Koonin (2014), a computational physicist, acknowledged that humans have influenced climate, stating "that is no hoax: There is little doubt in the scientific community that continually growing amounts of greenhouse gases in the atmosphere, due largely to carbon-dioxide emissions from the conventional use of fossil fuels, are influencing the climate." He went on to contend, however, that science remains unable to predict what will happen in the future, based on uncertainties, thus calling into question the value or possibility of taking action.

Similarly, in "The Global Warming Statistical Meltdown," Curry (2014), a professor at the Georgia Institute of Technology, does not dispute climate change but challenges climate sensitivity to carbon emissions, arguing we have time to address climate change without implementing policies aimed at drastically reducing emissions.

Stern et al. (2016, p. 653) argue that in contrast to literal denialist arguments, neo-skeptics marshal legitimate concerns and thus "raise important questions about ultimate impacts and response options." These concerns, however, often mask underlying interests and motivations. For example, Curry (2014) highlights work that she and her collaborators have done that indicates climate warming could be less than projected, a claim based on their statistical examination. She goes on to say, "this slower rate of warming—relative to climate model projections—means there is less urgency to phase out greenhouse gas emissions now, and more time to find ways to decarbonize the economy *affordably*" (emphasis added). This statement highlights her interest in the costs associated with addressing climate change and the emphasis on economics. Although Curry's analysis focused on the goal of remaining within 2 degrees Celsius above pre-industrial levels, more recent analyses suggest the world has only a 5% chance of not exceeding a 2-degree increase by 2100 (Raftery et al., 2017), that the 2-degree threshold is arbitrary and represents more of a political than scientific threshold, that consequences have already materialized well below the 2-degree threshold, and that each additional 0.5 degree temperature increase portends significant consequences (Schleussner et al., 2017). Keeping global temperatures below the 2-degree threshold by century's end seems not only unlikely

but increasingly implausible (Steffen et al., 2018). Despite this, neo-skeptics continue to argue that, while climate change is occurring, what we know about the impacts is either uncertain or not consequential enough to warrant immediate or significant action. Neo-skepticism therefore denies that climate change is a significant risk, or denies that the consequences are detrimental enough to avoid, and therefore denies the need for action.

3.3. Techno-optimism

Whereas the literal denial of climate change and neo-skepticism are commonly identified as forms of climate change denial, the rest of our analysis focuses on four expressions of the ideological denial of climate change: individualism, market fundamentalism, green growthism, and, in this section, techno-optimism. Solutions to environmental problems often take a Promethean or techno-optimistic form. As Dryzek et al. (2009, p. 266) explain, "Prometheans have faith in the capacity of humans to manipulate complex systems for their own advantage." Techno-optimists believe that technology can be used effectively to solve environmental problems. Mol's (2001) ecological modernization framework embodies this position. Mol (2001, p. 58) states, "environmental deterioration is conceived of as a challenge for socio-technical and economic reform, rather than the inevitable consequence of the current institutional structure."

Techno-optimism has received significant criticisms. For example, York and Clark (2010) discuss the social factors that influence environmental problems, and show how they cannot be addressed simply by technology. Foster (2010) argues that the focus on technology in climate policy is a form of denialism (see Section 2). Despite the critiques leveled, techno-optimism remains in fashion as an appropriate response to climate change. Here we focus on three variants of techno-optimism: calls for geoengineering, energy efficiency, and alternative energy.

3.3.1. Techno-optimism: Geoengineering

The IPCC defines geoengineering as "a broad set of methods and technologies that aim to deliberately alter the climate system in order to alleviate impacts of climate change" (Boucher et al., 2013). Geoengineering can take different forms: either removing carbon from the atmosphere (e.g., iron fertilization of oceans, bioenergy with carbon capture and storage) or reducing incoming solar radiation (e.g., mirrors in space, stratospheric aerosol injection). For example, stratospheric aerosol injection (SAI) is an approach that has gained widespread attention. Based on evidence that the Mount Pinatubo eruption in 1991 cooled Earth by 0.5 degrees Celsius (Robock et al., 2010), SAI would use various means to inject sulfur particles into the atmosphere to reflect incoming solar radiation and reduce global temperature

increases (Keith, 2013). Proponents suggest the benefits of this approach outweigh the costs, it represents the only approach able to stave off global catastrophe, and it does so in a technologically feasible, relatively cheap, timely manner (Keith, 2013).

Techno-optimism in the form of geoengineering has significant shortcomings. SAI, for example, has unknown consequences for weather patterns, precipitation, and agricultural production (Robock, 2008); could potentially cause widespread drought; could lead to ozone depletion and increased ocean acidification; and poses grave risks due to human error or strategic militarization (Boucher et al., 2013; Robock, 2008). In addition, if SAI efforts, once initiated, do not continue, greenhouse gas levels that continued to increase would result in rapid warming and severe consequences.

Although perhaps technically feasible, geoengineering strategies do not address the root drivers of climate change. Narrowly construing the problem and potential solutions, geoengineering is the pinnacle of what Marcuse (1964) called technological rationality, which "molds all social and environmental problems into technological problems requiring technological solutions" (Gunderson, Petersen, & Stuart, 2018, p. 6). SAI in particular proposes to literally mask the problem of climate change, leaving its causes intact (Gunderson et al., 2019), and, therefore, represents a denial that sociostructural change is necessary for mitigation.

3.3.2. Techno-optimism: Energy efficiency

Energy use plays a significant role in carbon emissions. As a result, a commonly proposed solution revolves around energy efficiency improvements. If we just used our energy resources more efficiently, the argument goes, we could reduce emissions. This assumed relationship has important policy implications. Although conceptually intuitive, the realities of energy use and efficiency do not represent a panacea. William Stanley Jevons interrogated the relationship between efficiency gains and resource use in the context of coal (York, 2006). He showed that efficiency in coal use decreased its costs and led to increased consumption, a relationship now known as Jevons' paradox. This paradox has been empirically illustrated as it relates to climate change. York and McGee (2016) found that countries with greater efficiencies have higher rates of carbon emissions, energy use, and electricity consumption. In addition, York (2006) shows how vehicle efficiency in the United States did not lead to reduced fuel consumption, in part due to changes in vehicle weights and types, drivers, and miles driven.

The counterintuitive outcome of the potential gains of energy efficiency being neutralized *due to* efficiency gains, and, in some cases increasing energy use, has been termed the *rebound effect*. For example, Freire-Gonzalez (2017) analyzed the rebound effect in households using energy efficiency improvements in the 27 countries of the European Union. The results from the analysis showed that seven countries

had rebound effects above 100%, in which more energy is consumed than prior to implementing improvements, and most countries showed at least a 50 percent rebound, meaning the rebound effect neutralized half the efficiency gains.

Sorrell (2009) differentiates between direct and indirect rebound effects. Direct rebound effects result from efficiency improvements reducing the marginal costs associated with service that then lead to increased consumption. Sorrell identifies five indirect rebound effects that include embodied energy effects (the energy used to create the energy improvements), respending effects (purchasing goods with savings from energy efficiency), output effects (output increases by producers with savings from efficiency), energy market effects (lower energy demand causes price drops, which leads to increases in energy consumption), and composition effects (reduction in the price of energy-intensive goods due to efficiency gains will decrease their price and lead to more consumption). This evidence suggests that, despite widespread support, energy efficiency alone will not be an effective solution to climate change, and may increase energy use, and its false promise helps to support the continuation of business as usual. Faith in energy efficiency, therefore, represents a form of techno-optimism supporting the denial of necessary social changes.

3.3.3. Techno-optimism: Renewable energy

Few solutions to climate change have received as much attention as switching to renewable energy. The United Nations Development Programme (n.d.) states: "The role of renewable energy solutions in mitigating climate change is proven." Renewable energy represents an attractive solution because it presents an opportunity to replace, or more importantly displace, fossil fuel–based energy with carbon-free sources. Doing so would enable society to meet energy demand without contributing to climate change. Despite its potential, however, renewable energy development has not materialized into an effective response to climate change.

The idea of renewable energy reducing greenhouse gas emissions relies on the assumption that renewable energy production will displace fossil fuels. Empirical analyses suggest displacement does not occur and that renewable energy production might counterintuitively increase overall energy use, an outcome known as the *energy boomerang* effect (York, 2012; York & Bell, 2019). York (2012) conducted a cross-national study to assess whether increases in alternative energy production led to fossil fuel displacement. His analysis showed minimal displacement, a one quarter of a unit displacement of fossil fuel–based electricity by one unit produced via renewables. In addition, York (2016) found that increases in total energy and electricity production have occurred in conjunction with carbon intensity reductions from renewable energy. Expanding renewable energy thus does not necessarily displace fossil fuels and could lead to increases in development and energy consumption (York, 2012; York & Bell, 2019). Thombs (2017) coined the term "renewable energy paradox" to describe the counterintuitive outcome that renewable

energy has little effect in developed countries in reducing carbon emissions, which he attributes to outcomes associated with the treadmill of production (see Section 4.2). This production, which never ends, also involves increasing material throughput and concomitant energy demands. Renewable energy, according to Thombs, and supported by York and others, merely creates additional capacity for production rather than displacing fossil fuel–based energy consumption. In short, at this time, renewable energy development is merely energy *addition* rather than marking an energy *transition* (York & Bell, 2019). The latter requires an explicit political program to simultaneously reduce fossil fuel development.

This evidence suggests that reliance on renewable energy is insufficient to meet carbon emission reduction targets. Trends and realities raise additional concerns. York (2016) has additionally shown that decarbonizing energy supplies and reducing carbon intensity, including increasing renewable energy capacity, has led to increases in both energy use and electricity production. World energy use is expected to increase by 28% and natural gas consumption by 43% by 2040 (IEA, 2017). Renewables are currently dominated by hydropower, and although wind and solar are projected to increase proportionally over this timespan they will still only account for roughly 10% of total energy production. The increase in overall energy consumption will rely heavily on fossil fuels. Even without the boomerang effect, emission reductions from renewables would be minimal. With the boomerang effect they will remain marginal. Failing to recognize these relationships represents a denial of (1) the inherent limitations of renewables, (2) the fettering of renewable energy development under current social conditions, (3) the inability of renewable energy development to displace fossil fuel development via market forces (i.e., fossil fuel development must be directly and rapidly reduced through political programs), and (4) the necessity for social changes that reduce overall energy use due to (1).

3.4. Individualism

Responses to environmental problems and climate change, particularly in the United States, often focus on individual actions. Norgaard (2011, p. 192) attributes this to the fact that "Americans are so immersed in the ideology of individualism that they lack the imagination or knowledge of alternative political means of response." Public campaigns around "reduce, reuse, recycle" have contributed to the notion that individuals are responsible for addressing climate change. Vandenbergh et al. (2007) suggest focusing on "low hanging fruit" to address climate change and promote buying the right lightbulbs among six other individual actions. The recommendations put forth by Al Gore in his documentary *An Inconvenient Truth* also focus on individual actions. Individual actions to address climate change have centered on driving hybrid or electric vehicles, not having children, and not flying, among others.

Brulle and Dunlap (2015) note that most social science research on climate change comes from the economics literature, which focuses on individuals as rational actors. They cite Szerszynski and Urry (2010, p. 3) who state that this "has led to a focus on human practices as individualistic, market-based, and calculative, and has thus helped to strengthen a tendency towards a certain set of responses to climate change, ones based on individual calculation, technology and the development of new markets." Shove (2010) states that, "framing the problem of climate change as a problem of human behaviour marginalises and in many ways excludes serious engagement with other possible analyses, including those grounded in social theories of practice and transition" (p. 1274).

Focusing on individual actions creates societal ideas about how climate change has occurred (due to individual actions) and shapes ideas about how society should respond to it (through changes in individual actions).

Fixating on individual action diverts attention away from the structural changes needed to significantly reduce greenhouse gas emissions. Studies have indicated that implementing household actions to reduce emissions makes people less likely to support systemic changes that might have greater effects (carbon taxes, for example) (Werfel, 2017). Even if individuals do take action to reduce their carbon footprint, the financial savings they gain often go back into activities that act to shift the impacts elsewhere (Wapner & Willoughby, 2005).

Most analyses that focus on individual or household actions pinpoint and quantify direct rather than indirect emissions, ignoring the most significant contributions to greenhouse gas emissions. According to Captick et al. (2014), direct emissions come from personal or home use while indirect emissions include those emissions "arising from consumption activities, through carbon embedded in products and services, such as food, consumer electronics, clothing and recreation" (p. 431). The authors note that estimates vary but that indirect emissions greatly exceed direct emissions. For example, according to the US Department of Energy, residential use represents only 34% of total energy use in the US, with commercial and industrial sectors using the majority (EIA, 2018). Failing to acknowledge indirect emissions not only focuses attention on relatively minor contributions but also creates the illusion that sufficient action has been taken.

Lastly, focusing on individual actions can mask the structural drivers of emissions. Brulle and Dunlap (2015, p. 8) state, "the core critique is that the individual-level focus of these disciplinary approaches tends to neglect institutional, social and cultural perspectives." Although the majority of emissions come from companies and states, not individuals (Heede, 2014), significant attention continues to focus on individual actions. Global shifts in policy, away from regulation and toward free market governance, have entrenched this thinking with significant consequences:

> A political–economic settlement designed to increase capital accumulation through deregulated markets and accelerating consumption results in reliance on tools for individual behaviour change. This is at best extremely limited as a means of engendering sustainable consumption, and at worst self-defeating. Questions of power and collective responsibility are marginalized, and the contradictions between neo-liberal capitalism and sustainable consumption are obscured. (Webb, 2012, p. 110)

Wapner and Willoughby (2005, p. 79) put it succinctly: "for most people most of the time, lifestyle changes are ecologically irrelevant." And yet, they remain a prominent focus in climate change discussions and contribute to a denial of the sociostructural changes necessary to reduce greenhouse gas emissions. A society that rapidly reduces emissions would certainly require significant lifestyle changes, but social structures would need to be reformulated to allow for and encourage the wide spread of necessary changes.

3.5. Market fundamentalism

Climate change has been referred to as a market failure, most famously by Nicholas Stern (2008) who called it the "biggest market failure the world has seen" (p. 1). A market failure arises when "firms have not met the full cost of their production and have imposed significant costs arising from pollution on society generally" (Andrew, 2008, p. 394). The Kyoto Protocol initiated a global market-based approach to reduce emissions, as did the emissions trading system in the European Union. Both failed early on to reduce emissions (Andrew, 2008).

Markets represent a space in which commodities can be bought and sold. Polanyi (2001) differentiated between commodities created explicitly for exchange and fictitious commodities. Carbon, and more specifically carbon emissions, represent a fictitious commodity. Kaup (2015, p. 291) argues that carbon markets are constructed by first setting a limit of emissions that will not negatively affect global climate, second turning carbon into a measurable credit, and third creating a market where carbon credits can be bought and sold. Carbon markets intend to reduce emissions but do not compel such an outcome. As the Kyoto meetings and resulting trading schemes highlight, carbon trading prioritizes economic outcomes first and foremost (Lohmann, 2010).

Lohmann (2010) identifies two kinds of primary carbon market—cap-and-trade, and carbon offsets—and shows how they operate. He suggests that "carbon markets isolate and objectify a new product that is difficult to define" (p. 237), and in so doing separate emissions from their political roots, leading to apolitical actions. Carbon markets create a market-based approach to a problem that dissolves the need for political and social action. Despite the shortcomings of carbon markets, many proponents of taking action on climate change support them. This includes perhaps the two most widely known climate activists, Al Gore and Bill McKibben,

both of whom strongly support markets—illustrating the dominance of market fundamentalism. Foster (2010, pp. 4–5) uses the following quote from McKibben on this point: "There is only one lever even possibly big enough to make our system move as fast as it needs to, and that's the force of markets." This perspective denies the root causes of climate change, supports the same mechanisms driving greenhouse gas emissions, and masks the need to make social–structural changes.

3.6. Green growthism

In recent decades many approaches to addressing environmental sustainability have centered on green growth. Aimed at meeting both economic and environmental goals simultaneously, green growth has emerged as a central framing in climate and broader environmental discourses (Hickel & Kallis, 2019). More specifically, green growth is often described as a win–win proposition—continuing economic growth while simultaneously meeting environmental outcomes and goals. In contrast to market fundamentalism (which represents a belief in the best mechanism to use), green growth (which could include market mechanisms) is a system in which proponents believe it is possible to address environmental harms while still growing the economy. Hallegatte et al. (2011, p. 3) explain succinctly: "green growth is about making growth processes resource-efficient, cleaner, and more resilient without necessarily slowing them," a seductive proposition but one that has many limitations and shortcomings.

The promise of green growth relies on decoupling environmental harm from economic activity and growth. Theoretically possible, such decoupling has not yet materialized (Hickel & Kallis, 2019). Hickel and Kallis (2019) distinguish between relative and absolute decoupling. The former traces environmental impacts per unit of economic activity while the latter emphasizes overall reductions. Evidence exists to show relative decoupling, but not absolute (Schor & Jorgenson, 2019). Absolute decoupling has not occurred for many reasons. Green growth lends itself to GDP (gross domestic product) measures, a metric that inadequately addresses environmental outcomes and well-being. Green growth also relies heavily on technological advances but these often center on efficiency improvements, which the above discussion shows to be inadequate in terms of reducing material throughput. Proponents argue that decoupling will emerge as economies transition away from material-based economies to ones based on services, but dematerialization has not occurred (Hickel & Kallis, 2019). Lastly, evidence that developed nations have shown movement toward decoupling often fails to include the offshoring of emissions, those generated through shifting production to other countries (Hickel & Kallis, 2019).

Green growth represents a denial of the fundamental relationship between economic growth and greenhouse gas emissions, which is an empirically illustrated positive correlation (Schor & Jorgenson, 2019; Stern, 2006; York et al., 2003).

Economic growth, in terms of GDP, directly relates to increased material production and includes carbon. For example, GDP growth of 1% equals a 0.6% growth in material use (Wiedmann et al., 2015) and a 0.5–0.7% increase in carbon emissions (Burke et al., 2015). Green growth denies this relationship and therefore fails to see a central root cause of climate change: a society structured around ever-increasing production and economic growth.

4. Discussion

> Capital opposes reality and truth.
> Enzo Paci (1972, p. 427)

4.1. Returning to the concept of ideological denialism

The forms of denialism outlined above all act to counter effective actions to reduce global carbon emissions. Although inaction on climate change is typically associated with the literal form of denialism and campaigns by fossil fuel companies and conservative actors to convince the public that climate change is not occurring, our conceptualization shows that denialism occurs from a broader range of actors. In particular, denial of important relationships and realities occurs even with individuals and groups who acknowledge anthropocentric climate change and who want immediate and effective actions to reduce emissions. These approaches, however, continue to implicitly or explicitly deny the root causes of climate change, thereby counteracting effective action. They contribute to ideological denialism—that is, ideas and practices underlying responses to climate change that:

1. Acknowledge that climate change is real and primarily driven by human activities, and that we should take immediate action to mitigate its current and projected serious harms.
2. Implicitly or explicitly misdiagnose the underlying social drivers of climate change, a misdiagnosis that is often embedded in proposed or real ineffective actions and laws.
3. Limit the suite of effective actions that could be adopted to challenge the social drivers of climate change. These limits are erected by either: (a) assuming that an ineffective strategy (e.g., lifestyle changes) are "realistic" and effective themselves, or (b) adopting ineffective strategies (e.g., carbon markets) in order to suppress strategies that would challenge the social drivers of climate change.
4. Maintain, rather than challenge, the current social order that drives climate change.

This conceptualization builds upon and extends the three forms of denialism put forward by Cohen (2001). Rather than implicatory denial, in which climate change does not lead to moral implications and respective action (as Norgaard (2011) extends and applies in the context of climate change), ideological denial represents a failure to identify the proximate, causal drivers of the problem due to ideological beliefs proffered through culture, media, social norms, experience, and values.

Each form of denial outlined above has one fundamental characteristic in common: they all directly or indirectly focus on, maintain, or support continued economic growth necessitated by an adherence to the principle of capital accumulation. The relationship between economic growth and greenhouse gas emissions is the underlying contradiction that is concealed in some way by all of the solutions analyzed above. The discourse surrounding these forms of denial supports continued growth. For example, some neo-skeptics, as indicated by the quote from Curry (2014) above, focus on affordability: this translates into taking actions to address climate change in ways that do not infringe on economic growth. Geoengineering enables our economic system to continue unfettered, a primary rationale put forward by proponents (see Gunderson et al., 2019). Focusing on energy efficiency relies on technological improvements to existing energy production sources but does not in any way challenge the structure of energy systems whose operations are predicated on economic growth. Individual lifestyle changes not only do not challenge growth but can even promote growth: reliance on individual actions by consumers to address climate change is sometimes predicated on individuals buying more consumer products as the solution. This emphasis maintains and expands the hegemonic stature of economic growth in our society. Carbon markets and green growth have obvious associations with economic growth. Promoting renewable energy production as a solution to climate change, without simultaneously implementing programs to phase out fossil fuels, translates into more energy consumption and growth. Lastly, outright "literal" denial has been shown to be a result of deliberate efforts to protect the economic growth imperative. Collectively, all these forms of denial support economic growth propelled by capital accumulation at the cost of failing to reduce greenhouse gas emissions.

4.2. Addressing the root drivers of climate change

Techno-optimism, individualism, market fundamentalism, and green growthism in aggregate represent the ideological denial of climate change, a refusal to diagnose *the root causes* of climate change and what makes currently proposed solutions ineffective: the ever-increasing economic growth required by a growth-dependent capitalist system. This is well articulated by the treadmill of production (ToP) model, as introduced by Schnaiberg (1980) and elaborated by Gould et al. (2004). The ToP posits that as Western economies accumulate capital, technology replaces labor to increase overall profits. This leads to higher sunk costs and a necessity

to increase productivity to continue and sustain further profit levels. This results in a treadmill of higher and higher levels of production. Increasing production depends on withdrawals from the environment (resource extraction) and additions to the environment (pollution), therefore increasing environmental impacts. ToP emphasizes production as the driver of impacts rather than consumption: consumers have relatively little power to influence firms. The goal of ever-increasing accumulation (in terms of profit and collective economic growth) drives production, consumption, and the associated harms to the environment (Gould et al., 2004). Our current capitalist system is driven by the ToP and will continue to result in increased material and energy throughput as well as greenhouse gas emissions, until we transform this system.

Therefore, an effective (or radical) solution to climate change has to start from the premise that this system, and economic growth in particular, is a significant driver of greenhouse gas emissions. A movement that has emerged in Europe and is spreading globally takes this reality as a starting point.

4.2.1. Degrowth

Degrowth presents an alternative to the sustainable development approach to addressing social and environmental concerns that supports economic growth. Rather than seeing economy and environment as equals, degrowth positions the economy within the environment. Degrowth focuses not solely on reducing material throughput but also squarely on prioritizing human and ecological well-being (Schneider et al., 2010). Meeting global emissions targets and preventing negative climate change consequences necessitates dematerialization, something that cannot happen under a growth paradigm (Hickel & Kallis, 2019). Degrowth provides the framework for both reducing material throughput and focusing on well-being. It provides a path toward new social relations in a way that green growth, for example, cannot (Schneider et al., 2010).

Degrowth aims to create social relations that could overcome ideological denialism. In a society focused first and foremost on well-being, several proposed solutions to climate change criticized above would take on new meaning. To put this differently, calls for lifestyle changes, greener technology, and the expansion of renewables are not inherently a form of ideological denialism. Indeed, they are essential for achieving deep emissions reductions. These strategies are a form of ideological denialism when they do not simultaneously call for fundamental changes in existing structures of ownership and governance. For example, degrowth centers on ensuring that we do not have more but rather enough (Kallis & March, 2015). In this context, alternative energy and energy efficiency policies and actions could be deployed in a way that would reduce overall energy use and demand (Gunderson, Stuart, Petersen, & Yun, 2018). Furthermore, degrowth seeks to engage not just on how energy is produced but also who owns and has access to it (Kunze & Becker,

2015), further enabling renewables and efficiency measures to meet broad societal needs. Additional activities aimed at well-being have co-benefits related to energy use and carbon emissions. Complementary interventions—such as work-time reduction, low energy strategies in transportation (individual and system wide), low energy strategies aimed at individuals, new energy systems, bartering and alternative currencies, local agriculture, cooperatives, and co-housing, among others—in coordination provide opportunities to dematerialize society and drastically reduce emissions, while meeting human and non-human needs (Kallis et al., 2012). Collectively, these approaches present a viable pathway for meeting societal goals.

These initial steps and pathways hold great promise but require additional, systemic changes. Obviously, fossil fuel use has contributed greatly to greenhouse gas emissions. Not only do they have tremendous climate implications but they have social implications as well. Economic consolidation has led to 90 companies creating two thirds of all emissions since 1854 (Heede, 2014). This consolidation has led to powerful lobbies that have leveraged trillions in subsidies annually for the fossil fuel industry. Although fossil fuels have undoubtedly led to material well-being and myriad benefits to humanity, greenhouse gas emissions now pose a significant threat to humanity (Steffen et al., 2018). This reality has led some to call for buying out and nationalizing fossil fuel companies in order to then leave fossil fuels in the ground, negating further emissions and ameliorating the social and ecological consequences associated with fossil fuel extraction. Nationalizing or buying out these industries would open the door for a rapid reduction in carbon emissions and could also avert an economic disaster. In short, the future depends on our ability to keep fossil fuels in the ground and alter social relations in ways that reduce energy and material throughput in socially desirable ways.

5. Conclusion

Our goal here is not to cast blame or suggest that everyone who disagrees with this analysis must be an ideologue or a denialist. Rather, our analysis points out that ideological denialism functions long before it underpins coherent climate policies and academic discussion. To put this differently, our goal was not to dismiss ideas by labeling them with pejorative terms, but, instead, to bring to light ideas and practices that delay serious climate action despite good intentions.

The six forms of denialism we outline focus on climate change as a singular issue and put forth narrow solutions, failing to untangle the disparate social relations that have collectively caused the problem. Denialism, and ideological denialism in particular, obscure the root causes by focusing on climate change solutions that deny the need for sociostructural change and maintain the structural drivers of climate change situated in a growth-based paradigm. Ideology, manifested through

ideas and practices, reproduces societal contradictions (Gunderson, 2017). These contradictions cannot be overcome through technology, markets, and individual actions. The hegemony of economic growth, compelled by the basic structure of the capitalist system, has created social norms and world views that conceal contradictions and limit viable solutions.

Degrowth, by contrast, seeks to uncover the proximate causes of climate change and the associated societal pathologies that created it (uneven power relations and associated societal outcomes: marginalization, vulnerability, and injustice). In particular, it diagnoses our social formation, which is structurally compelled to prioritize economic growth over other societal goals, as a central root cause. In doing so, degrowth begins identifying appropriate solutions, briefly described above, that could address this root cause.

We hope that the concept of ideological denialism will serve as a useful addition to Cohen's (2001) literal–interpretive–implicatory denial typology, as adopted and deepened by Norgaard (2011) in the context of climate change. Expanding from Foster (2010), ideological denialism refers to the ideas and practices underlying climate change responses that (1) acknowledge the reality, human origins, and severity of climate change and desire immediate action, (2) yet misdiagnose the structural drivers of climate change, (3) thereby limiting more effective actions, and (4) reproducing the social formation that drives climate change. The most harmful thread uniting the strategies that emanate from ideological denialism is an inability to envision alternative social futures, or an alternative to our current economic system. Marcuse (1964) termed this "one-dimensional" thinking, an outlook that is blind to possibilities latent in present social conditions, with a consequence perfectly captured in Murray Bookchin's (1990, n.p.) statement that the "assumption that what currently exists must necessarily exist is the acid that corrodes all visionary thinking." By undermining the ability to visualize social alternatives that address climate change, ideological denialism is both an outcome and reinforcer of one-dimensionality. Importantly, this denial has kept environmentalists and others who actively want to reduce greenhouse gas emissions from promoting solutions to the systemic problems causing climate change. This includes policy-makers, academics, and everyday citizens who cannot see any alternatives outside our growth-dependent capitalist order. As a result, significant effort is necessary to overcome the ideological denialism that is currently widespread and deeply ingrained. Only by creating social awareness and solidarity around the need to organize society for well-being, instead of capital accumulation and continual economic growth, can we have any hope for drastically reducing climate change impacts in a socially just way.

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Manufacturing the Urban Rift: Manufacturing as a Moderator of the Urbanization–CO_2 Emissions Relationship, 2000–2013

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Abstract

Previous research suggests that the urbanization–CO_2 emissions relationship is contingent on various structural factors. We aim to advance this area of scholarship by investigating how manufacturing influences urbanization's association with national-level CO_2 emissions. In particular, we focus on the extent to which manufacturing is a moderator of the urbanization–CO_2 emissions relationship. To do so, we use an interaction between standard measures of urbanization and manufacturing in panel models of national-level anthropogenic CO_2 emissions for an overall global sample as well as various reduced samples of nations defined by income level and region. We find that emissions are positively associated with this interaction for our global sample as well as for samples restricted to high-income nations and for nations in Asia. These results highlight the role that the organization of manufacturing and production plays in shaping national economies and, in turn, the urbanization–CO_2 emissions relationship in different regional and structural contexts.

Keywords: climate change, CO_2 emissions, manufacturing, sustainability, urbanization

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Introduction

According to the United Nations (2016), 60% of the world's population is expected to live in urban areas by the year 2030, with much of the growth occurring in the Global South. This rapid pace of urbanization will have considerable environmental challenges associated with it (e.g., energy use, land use change, water consumption, and air and water pollution), so much so that leading environmental studies texts consider urbanization to be one of the world's grand sustainability challenges, especially in the context of anthropogenic climate change (e.g., Lee et al., 2013). And with this, recent analyses observe positive associations between urbanization and carbon dioxide (CO_2) emissions for nations across different regional and structural contexts (Givens, 2015; Jorgenson et al., 2014)—that is, that CO_2 emission rates increase as urbanization intensifies, structured by social forces operating beyond any one nation-state—but further research is needed to better understand the processes and mechanisms through which urbanization affects greenhouse gas emissions.

In this preliminary study, we aim to modestly advance this area of research by investigating the specific influence of manufacturing on urbanization's association with CO_2 emissions. We examine this moderating relationship—that is, how manufacturing affects the urbanization–CO_2 emissions relationship—by using interactions between standard measures of urbanization and manufacturing, and we estimate longitudinal models of national-level anthropogenic carbon emissions for an overall global sample as well as various reduced samples of nations defined by income level and by region.

We find that for our entire sample, national CO_2 emissions are positively associated with the interaction between urbanization and manufacturing, and that this association is statistically significant for samples restricted to (1) high-income nations and (2) nations in Asia, suggesting that manufacturing often acts as a moderator for the relationship between national-level urbanization and emissions. In other words, these results suggest that manufacturing can exacerbate the impact of urbanization on emissions.

Urbanization and CO_2 emissions

According to the United Nations (2019), 68% of the global population will live in urban areas by 2050, up from 55% today. Further population shifts to urban areas will have substantial environmental impacts. Urban areas constitute approximately 70% of global carbon emissions today, and are expected to grow over time (International Energy Agency, 2008). However, as the world's population continues

to grow, urban areas could offer opportunities for more sustainable organizations of living due to available efficiencies (Dodman, 2009). For example, urban residents often live in denser areas comprising smaller dwellings that have a smaller energy footprint (Glaeser, 2012; York & Rosa, 2012), and they can also take advantage of public goods like public transportation that are less energy and carbon intensive than driving individual vehicles (Figueroa et al., 2014).

Yet, urban processes and conditions are also heterogeneous across disparate scales, times, regions, and nations (Smith, 1996). Recent research finds that regional differences are important to consider when studying relationships between human and natural systems (Marcotullio et al., 2014; Rudel, 2005). Of particular relevance for the current study, Jorgenson et al. (2014) find that the national-level association between urbanization and CO_2 emissions changes over time and differs by region. They observe a relative decoupling (the association decreases over time—CO_2 emission rates begin to slow relative to continuing growth in urbanization) between urbanization and CO_2 emissions per capita for nations in the combined regions of North America, Europe, and Oceania (NAEO), whereas the association between emissions and urbanization remains steady or increases in magnitude through time for nations in other regions. In addition, Jorgenson et al. (2014) observe a decreasing association between urbanization and emissions per unit of GDP (gross domestic product) within nations in the NAEO region and in Latin America (i.e., urbanization in these regions has become more carbon efficient), whereas the associations between emissions per unit of GDP and urbanization for nations in other regions in the analysis have remained relatively constant over time (i.e., urbanization in other regions did not become more carbon efficient). Others, like Poumanyvong and Kaneko (2010), have demonstrated that the magnitude of the relationship between CO_2 emissions and urbanization can also depend on the income level of a country. They observe that urbanization has its largest positive effect on CO_2 emissions in middle-income countries, and its smallest positive effect on emissions in high-income countries.

The regionally specific and income group–specific findings of cross-national research considering the impact of urbanization on CO_2 emissions are similar to analyses of other human drivers of emissions, such as income inequality, economic growth, and population growth. This has driven environmental and social scientists across various disciplines to underscore the importance of conducting such nuanced analyses of the drivers of anthropogenic CO_2 emissions and other environmental outcomes (Jorgenson et al., 2019), which speaks to a fundamental principle articulated by leading structural human ecologists—context matters (Dietz, 2013).

Urban political economists also highlight that regions and income groups differ tremendously in urban trajectory and form (Smith, 1996), which we suggest can influence the effect that urbanization has on CO_2 emissions. For example, rapid urbanization has given rise to urban mega-slums in developing nations (Davis, 2006). Even though the percentage of people living in urban slums has decreased over time, the total number of people living in slums has increased in developing nations from 792 million in the year 2000 to 881 million in 2014 (UN-HABITAT, 2016). Currently, nations in sub-Saharan Africa and southern Asia have the highest rates of urban slum prevalence (55.9% and 31.3% respectively) (UN-HABITAT, 2016). Slum dwellers often live in unsafe conditions with little access to suitable water, sewerage, and energy infrastructure (Rice & Rice, 2012). Their lack of basic access to resources, such as forms of fossil fuel energy, can have a suppressing effect on CO_2 emissions even though overall growth in urban populations can contribute to increases in CO_2 emissions (Givens, 2015; Jorgenson et al., 2010). Thus, the urbanization–CO_2 emissions relationship is likely moderated through various structural forces and social inequities (Clement, 2010).

Manufacturing as a moderator of the urbanization–CO_2 emissions relationship

Historically, the growth of manufacturing coincides with urbanization. By connecting labor and capital together in space, industrialists can take advantage of an ample and competitive labor supply that helps fuel further industrial production. Urbanization also encourages economic agglomeration by clustering firms within cities, metropolitan areas, and regions, allowing them to benefit from economies of scale and specialization. These processes often result in the introduction of capital-intensive technologies that can potentially improve production efficiency by lowering costs and reducing material inputs per unit of production, while leading to the overall expansion of output (Gould et al., 2004). This phenomenon, known as the "Jevons paradox," can lead to greater efficiency at micro levels but expand the total amount of pollution or resource use at macro levels (York & McGee, 2016). Urbanization plays a key role in facilitating the Jevons paradox by concentrating resources and labor in dense spaces, which can lower marginal costs, but also fuel demand and facilitate additional production by taking advantage of large consumer markets, utilizing the built infrastructure of urban areas to move goods across the world, and having access to a large labor pool.

However, how these processes operate is context-specific. Like urbanization, there is significant heterogeneity in industrial manufacturing processes across the global economy (Brady et al., 2011). Over the latter part of the twentieth century, the global organization of production shifted from a predominately US-dominated, Fordist economy to one defined as flexible accumulation, characterized by dispersed global supply chains, product differentiation, and intensified spatial competition (Harvey, 1990). These structural changes have played a key role in shifting carbon-intensive industries and manufacturing processes to developing countries (Mahutga, 2006; Thombs, 2018).

Foreign direct investment, international trade, and global governance institutions have facilitated the expansion of carbon-intensive manufacturing into developing nations and regions (Jorgenson & Clark, 2012; Jorgenson et al., 2007; Thombs, 2018). Many of these industries locate to urban areas with ample labor resources and supply chain linkages, leading to increases in fossil fuel energy consumption within these regions. Therefore, we might expect to observe a moderating effect of manufacturing on the relationship between urbanization and CO_2 emissions.

In the preliminary analysis below, we build on the bodies of literature and research on urbanization and manufacturing/industrialization to test how they potentially interact to affect CO_2 emissions. In other words, we assess whether manufacturing is a moderator for the association between urbanization and emissions for nations in different economic and regional contexts.

Data and methods

Sample

We analyze an unbalanced data set consisting of annual observations for 116 countries during the period 2000 to 2013. Manufacturing data are relatively limited for many countries prior to 2000, particularly for former Soviet nations and for a number of high-income countries. Consistent with methods employed in past research in environmental sociology and related disciplines (Jorgenson et al., 2019; Rudel, 2005), we also estimate models for reduced samples of nations defined by national income level (high income, middle income, low income), and region (Africa; Asia; South and Central America and the Caribbean (SCA); and North America, Europe, and Oceania (NAEO)) (Jorgenson, 2014; Jorgenson et al., 2014). The countries included in the overall sample are listed in Table 1.

Table 1. Countries included in the analysis

Africa	Asia	SCA	NAEO
HIGH INCOME Equatorial Guinea **MIDDLE INCOME** Cameroon Cote d'Ivoire Egypt Gabon Ghana Mauritania Mauritius Morocco Nigeria Republic of the Congo Senegal South Africa Tunisia Zambia **LOW INCOME** Benin Burkina Faso Burundi Central African Republic Chad Democratic Republic of the Congo Ethiopia The Gambia Guinea Kenya Liberia Malawi Mozambique Rwanda Sierra Leone Tanzania Togo Uganda Zimbabwe	**HIGH INCOME** Bahrain Japan Republic of Korea Russia Saudi Arabia Singapore **MIDDLE INCOME** Armenia Azerbaijan China Georgia India Indonesia Iran Jordan Kazakhstan Kyrgyz Republic Laos Lebanon Malaysia Mongolia Myanmar Pakistan Philippines Sri Lanka Thailand Turkey Vietnam Yemen **LOW INCOME** Bangladesh Nepal Tajikistan	**HIGH INCOME** Chile Trinidad & Tobago Uruguay **MIDDLE INCOME** Argentina Bolivia Brazil Colombia Costa Rica Cuba Dominican Republic Ecuador El Salvador Guatemala Honduras Jamaica Nicaragua Panama Paraguay Peru Venezuela **LOW INCOME** [none]	**HIGH INCOME** Australia Austria Belgium Canada Cyprus Czech Republic Denmark Finland France Germany Greece Ireland Italy Netherlands New Zealand Norway Poland Portugal Slovak Republic Spain Sweden Switzerland United Kingdom United States **MIDDLE INCOME** Albania Belarus Bulgaria Macedonia Mexico* Romania Ukraine **LOW INCOME** [none]

SCA = South and Central America and the Caribbean; NAEO = North America, Europe and Oceania.

* Mexico is included with North America due to it being a part of the North American Free Trade Agreement.

Dependent variable

Our dependent variable is total CO_2 emissions, measured in million metric tons. These data, which include emissions from the burning of fossil fuels and the manufacture of cement, were obtained from the World Resource Institute's Climate Analysis Indicator Tool, which provides public national-level climate data for the majority of the world's nations (WRI & CAIT, 2018). Total emissions is a widely used and substantively important dependent variable across disciplines, since the accumulation of overall CO_2 emissions in the atmosphere is a primary cause of anthropogenic climate change.

Independent variables

We include annual observations for six predictors in the analysis, all of which are commonly used in research on the human drivers of emissions: urbanization, GDP per capita, total population, trade openness, manufacturing as a percentage of GDP, and services as a percentage of GDP (Dietz, 2017; Jorgenson et al., 2019; Rosa & Dietz, 2012). Urbanization is measured as the percentage of the nation's population living in urban areas (World Bank, 2018). GDP per capita controls for a country's level of economic development, measured in constant 2010 US dollars. Total population counts all residents regardless of legal status or citizenship, except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. To control for integration into the global economy, we include trade (exports plus imports) as a percentage of GDP. Manufacturing as a percentage of GDP and services as a percentage of GDP are included to control for the general structure of a country's economy. All independent variables were obtained from the World Bank (2018). To test whether the effect of urbanization is moderated by manufacturing (and vice versa), we include a continuous interaction variable in the analysis (i.e., Urbanization × Manufacturing).

Estimation technique and models

We use 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. We use PCSE because the feasible generalized least-squares estimator that is often used to analyze panel data produces standard errors that can lead to extreme overconfidence with data sets that do not have very many more time periods than panels. We correct for AR(1) disturbances (first-order autocorrelation) within panels, and since we have no theoretical basis for assuming the process is panel-specific, we treat the AR(1) process as common

to all panels (Beck & Katz, 1995).[2] We include country-specific and year-specific intercepts to control for both case-specific and period-specific effects, the equivalent of a two-way fixed effects model. This modeling technique controls out between-country variation in favor of estimating within-country effects, a relatively conservative approach commonly used in panel analyses (Allison, 2009). Combined, these intercepts alone explain most of the variation in our outcome, which leads to relatively conservative hypothesis testing.

Consistent with much past research on anthropogenic emissions (as summarized in Rosa & Dietz, 2012) all non-binary variables are transformed into logarithmic form. Thus, the regression models estimate elasticity coefficients where the coefficient for the independent variable is the estimated net percentage change in the dependent variable associated with a 1% increase in the independent variable.

Two models are estimated for the overall sample as well as the reduced samples defined by national income and by region. The first model provides baseline results, whereas the second model includes the continuous interaction term, Urbanization × Manufacturing. The models are:

Model 1: $\text{Total Carbon Emissions}_{it} = \beta_1 \text{ GDP per capita}_{it} + \beta_2 \text{ Population}_{it} + \beta_3 \text{ Urbanization}_{it} + \beta_4 \text{ Trade}_{it} + \beta_5 \text{ Manufacturing}_{it} + \beta_6 \text{ Services}_{it} + \beta_7 \text{ year 2001}_t + \ldots + \beta_{19} \text{ year 2013}_t + u_i + e_{it}$

Model 2: $\text{Total Carbon Emissions}_{it} = \beta_1 \text{ GDP per capita}_{it} + \beta_2 \text{ Population}_{it} + \beta_3 \text{ Urbanization}_{it} + \beta_4 \text{ Trade}_{it} + \beta_5 \text{ Manufacturing}_{it} + \beta_6 \text{ Services}_{it} + \beta_7 \text{ Urbanization}_{it} * \text{Manufacturing}_{it} + \beta_8 \text{ year 2001}_t + \ldots + \beta_{20} \text{ year 2013}_t + u_i + e_{it}$

Subscript i represents the nation-state as the unit of analysis, t represents each year, u_i is the country-specific disturbance term, and e_{it} is the disturbance term for each country in each year. As a reminder, the dependent variable and the independent variables are logged.

Results

Table 2 presents the estimates for Model 1 and Model 2 for the full sample as well as the samples restricted to high-income, middle-income, and low-income nations. For Model 1, we find that the effect of the predictors on national CO_2 emissions depends to some extent on the income category of a country. Two predictors, GDP per capita and total population, have statistically significant effects on emissions for all analyzed samples. Other predictors like urbanization and trade have significant effects on CO_2 emissions for the entire sample, for the sample restricted to middle-

2 We found autocorrelation to be present using the Wooldridge test and heteroskedasticity to be present using the xttest3 command in Stata Software, Version 15.

income nations, and for the sample restricted to low-income nations, but not for the sample restricted to high-income nations. The effect of services on emissions is statistically significant for the sample of low-income nations, and the main effect of manufacturing on emissions is not statistically significant for any analyzed sample.

Turning to Model 2, with the incorporation of the continuous interaction term for Urbanization × Manufacturing, the linear coefficients for the two variables are to be interpreted as conditional relationships (Jaccard et al., 1990).[3] In other words, the linear coefficient for urbanization or manufacturing is the estimated effect on CO_2 emissions when the other variable equals zero. Similar to Model 1, in Model 2 the estimated effects of GDP per capita and total population on national emissions are statistically significant for all the analyzed samples. The estimated effect of urbanization on emissions is only statistically significant for the entire sample, and the effect of trade is significant for all analyzed samples except the sample restricted to high-income nations. The estimated effect of manufacturing on emissions is negative and statistically significant for the entire sample and for the sample restricted to high-income nations, and the estimated effect of services on emissions is positive and statistically significant in the sample restricted to low-income nations. In other words, the effect of manufacturing and services on emissions varies across income groups.

The estimated coefficient of interest—the interaction for Urbanization × Manufacturing—is positive and statistically significant for the entire sample and for the sample restricted to high-income nations. This coefficient has two general interpretations. First, it suggests that the association between CO_2 emissions and urbanization intensifies as manufacturing levels increase. Second, it suggests that the association between manufacturing and CO_2 emissions intensifies as urbanization increases. This general finding is likely due to several factors. First, in an unreported sensitivity analysis where we remove the nations located in Asia from the high-income sample, the estimated coefficient for the interaction between urbanization and manufacturing becomes only marginally statistically significant. The magnitude of the coefficient also decreases from 0.151 to 0.099, indicating that the high-income nations in Asia are largely influencing this estimated coefficient.

However, it is not too surprising that the estimated coefficient for the interaction between urbanization and manufacturing remains marginally significant when high-income nations located in Asia are excluded. Increases in urbanization in the non-Asian high-income countries often involve the further expansion of built infrastructure, such as transportation systems and buildings, and even though most high-income countries have gone through periods of relative deindustrialization,

3 In a sensitivity analysis available upon request, we also estimate the models with CO_2 per capita as the dependent variable. The findings are similar. The one exception is for the NAEO region where the interaction is significant at the 0.05 level. However, the magnitude of the coefficient is substantively the same.

many of these countries remain global leaders in a range of energy-intensive industry, much of which is located in or near urban areas. For example, the United States and Germany are global leaders in iron and steel production; the United States, Germany, and Italy are among the world's largest producers of cement; and Australia, Canada, Germany, Norway, and the United States produce substantial amounts of nonferrous metals, including aluminium, copper, tin, and zinc (US Geological Survey, 2014).

Table 2. Unstandardized coefficients for the regression of total carbon dioxide emissions by income level, 2000–2013: PW regression model estimates with PCSE and an AR(1) correction

	All nations		High-income nations		Middle-income nations		Low-income nations	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
GDP per capita	0.532^ (0.046)	0.521^ (0.045)	0.705^ (0.125)	0.710^ (0.129)	0.327^ (0.086)	0.345^ (0.092)	0.524^ (0.075)	0.562^ (0.075)
Population	1.602^ (0.280)	1.593^ (0.283)	1.270^ (0.174)	1.312^ (0.174)	0.975** (0.358)	1.024** (0.353)	1.160^ (0.208)	1.308^ (0.282)
Urbanization	0.642^ (0.057)	0.382** (0.130)	–0.005 (0.353)	–0.217 (0.377)	0.440^ (0.111)	0.013 (0.400)	0.521# (0.273)	0.072 (0.501)
Trade	0.069^ (0.016)	0.065^ (0.016)	0.046 (0.073)	0.020 (0.071)	0.062^ (0.009)	0.061^ (0.008)	0.083* (0.039)	0.069# (0.041)
Manufacturing	–0.007 (0.025)	–0.345* (0.164)	0.057 (0.065)	–0.527* (0.265)	–0.046 (0.033)	–0.692 (0.466)	0.003 (0.018)	–0.547 (0.387)
Services	0.101 (0.065)	0.097 (0.065)	–0.133 (0.175)	–0.069 (0.173)	0.098 (0.126)	0.109 (0.134)	0.118** (0.045)	0.128** (0.041)
Urbanization × Manufacturing		0.098# (0.050)		0.151* (0.062)		0.192 (0.134)		0.175 (0.127)
Number of countries	116	116	34	34	60	60	22	22
N	1543	1543	451	451	808	808	284	284
Min/max number of observations	1/14	1/14	4/14	4/14	1/14	1/14	3/14	3/14
R^2	0.991	0.991	0.996	0.997	0.988	0.988	0.968	0.968
Number of coefficients	135	136	53	54	79	80	41	42

Note. Panel-corrected standard errors are in parentheses; unit-specific and period-specific intercepts are unreported.

# p <.10. * p <.05. ** p <.01. ^ p <.001 (two-tailed tests).

Table 3 presents the estimated models of carbon emissions for the reduced samples of nations defined by region (Africa, Asia, SCA, and NAEO). Similar to Model 1 in Table 2, we find that the effects of the predictors on national-level emissions vary across regions. The estimated effects of GDP per capita, total population, and

urbanization on emissions are all statistically significant for every regional sample. However, there is a considerable amount of difference in the estimated urbanization coefficient across the models. The coefficient is largest in the NAEO sample (0.911), whereas the coefficient in the SCA sample is negative (–0.492).

Unlike urbanization, the estimated coefficient for trade is consistent across regions and is positive and statistically significant for all regionally defined samples except the sample of nations in NAEO. The results for manufacturing and services are slightly more nuanced. The sample of nations in Africa is the only region with a statistically significant coefficient for the main effect of manufacturing (–0.042). The samples of nations in Asia and NAEO have a statistically significant coefficient for services, but the estimated effect is positive for the sample of nations in Asia (0.187) and negative for the sample of nations in NAEO (–0.324).

We find that the estimated effect of the interaction between urbanization and manufacturing on CO_2 emissions is positive and statistically significant for the sample of nations in Asia, whereas it is nonsignificant in the models for the other regionally defined samples. The positive effect of the interaction on emissions for the sample of nations in Asia is consistent with the well-established observation that manufacturing has played a notable role in the development trajectories of most countries in the region, coinciding with rapid urbanization in recent decades. This finding is also likely due to the types of manufacturing that are concentrated within urban areas in these nations. For example, multiple nations in Asia are among the leading global producers in energy-intensive industries, including cement, iron, and steel production. China and India were by far the largest cement-producing countries in the world in 2013, while China, Japan, and India were the largest iron and steel producers (US Geological Survey, 2014). These industries tend to be concentrated in or near urban areas, and are largely powered by fossil fuels. For example, industrial-based coal consumption for nations in Asia, most notably China and India, increased substantially during the first decade of the twentieth century (International Energy Agency, 2017).

The null findings for the interaction between urbanization and manufacturing in the models for the other regional samples of nations could be due to several reasons. First, numerous NAEO and SCA countries have experienced deindustrialization and shifts away from labor-intensive manufacturing with a trend toward service and finance-based economies (Brady et al., 2011). Much of this is tied to shifts in the global organization of production, which has resulted in a 'tilt' of carbon-intensive processes from developed countries to developing countries over time (Thombs, 2018).

Second, the null findings for the samples of nations in Africa and SCA could be due to the large urban slum populations in these regions (Davis, 2006). The prevalence of urban slums is known to have a suppressing effect on carbon-intensive processes

and overall energy consumption (Jorgenson et al., 2010). Many nations in Asia also have a relatively large urban slum prevalence, but the extensive industrialization of most nations in this region could be offsetting the potential suppressing effect of urban slums on fossil fuel energy consumption and carbon emissions.

A third possible reason for the interaction's null effect on emissions for the sample of nations in Africa is simply that most nations in the region are less urbanized and industrialized than nations in other regions. However, as nations in Africa continue to urbanize, combined with the impetus for industrialists to seek out new geographical and structural spaces for cheap labor and less regulation, the urbanization–manufacturing relationship and its impacts on carbon emissions for nations in this region could become more pronounced in the future.

Table 3. Unstandardized coefficients for the regression of total carbon dioxide emissions by region, 2000–2013: PW regression model estimates with PCSE and an AR(1) correction

	Africa		Asia		SCA		NAEO	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
GDP per capita	0.419^ (0.080)	0.419^ (0.081)	0.149* (0.069)	0.156* (0.066)	0.828^ (0.158)	0.837^ (0.156)	0.584^ (0.052)	0.589^ (0.051)
Population	1.248** (0.443)	1.247** (0.440)	0.355# (0.196)	0.388* (0.197)	2.237^ (0.359)	2.258^ (0.360)	1.459^ (0.184)	1.429^ (0.185)
Urbanization	0.198** (0.068)	0.188 (0.216)	0.870^ (0.218)	0.367 (0.311)	–0.492# (0.259)	–0.607* (0.289)	0.911^ (0.144)	1.361^ (0.412)
Trade	0.109* (0.046)	0.109* (0.048)	0.048^ (0.015)	0.049^ (0.014)	0.212^ (0.060)	0.215^ (0.061)	0.032 (0.044)	0.037 (0.045)
Manufacturing	–0.042# (0.023)	–0.056 (0.253)	–0.015 (0.041)	–0.681** (0.235)	–0.090 (0.068)	–0.310 (0.261)	0.030 (0.053)	0.812 (0.659)
Services	0.038 (0.080)	0.037 (0.081)	0.187* (0.095)	0.175# (0.092)	0.078 (0.121)	0.123 (0.140)	–0.324* (0.138)	–0.307* (0.138)
Urbanization × Manufacturing		0.004 (0.081)		0.180** (0.064)		0.059 (0.069)		–0.188 (0.157)
Number of countries	34	34	31	31	20	20	31	31
N	432	432	412	412	272	272	427	427
Min/Max number of observations	1/14	1/14	4/14	4/14	9/14	9/14	7/14	7/14
R^2	0.985	0.985	0.992	0.992	0.992	0.992	0.998	0.998
Number of coefficients	53	54	50	51	39	40	50	51

Note. Panel-corrected standard errors are in parentheses; unit-specific and period-specific intercepts are unreported. SCA = South and Central America and the Caribbean; NAEO = North America, Europe, and Oceania.

# p <.10. * p <.05. ** p <.01. ^ p <.001 (two-tailed tests).

Because the interpretation of continuous interaction terms can be relatively complicated, we report the urbanization and manufacturing slope coefficients at various levels of the moderator variable (the 1st, 25th, 50th, 75th, and 99th percentiles) (Thombs, 2017; UCLA Institute for Digital Research and Education, 2019). This approach allows for the slope coefficients of urbanization and manufacturing to be derived while the moderator is held constant. In other words, it illustrates how the effect of each variable changes at various levels of the moderator variable. These slope coefficients are derived by using the margins command in Stata Software, Version 15. We report the urbanization and manufacturing slope coefficients for the three samples with a statistically significant interaction (All Nations, High-Income Nations, and Nations in Asia) in Table 4. As in Models 1 and 2, the coefficients should be interpreted as elasticity models. In other words, a 1% increase in urbanization or manufacturing is associated with a percentage increase in CO_2 emissions at a specific level of the moderating variable.

For the entire sample, the urbanization slope coefficient increases from 0.465 at the 1st percentile of manufacturing (2.3%) to 0.720 at the 99th percentile of manufacturing (31.4%). However, urbanization appears to have a much smaller moderating effect on manufacturing. At the lowest level of urbanization (9.9%), the manufacturing slope coefficient is negative (–0.120). It is statistically equivalent to zero at the 25th percentile (38.8%) and remains so through the 99th percentile (97.7%).

The opposite is true for the sample restricted to high-income countries. The urbanization slope coefficient is zero at all levels of manufacturing. However, the manufacturing slope coefficient increases as urbanization increases. At the 1st percentile of urbanization, the association between manufacturing and CO_2 emissions is zero. The slope coefficient becomes positive and statistically significant (0.127) at the 75th percentile (75.5%) and increases to 0.166 at the 99th percentile of urbanization.

Turning to the sample of countries in Asia, the coefficient for urbanization increases as manufacturing level increases. The coefficient increases from 0.520 at the 1st percentile of manufacturing to 0.986 at the 99th percentile of manufacturing. Similarly, for the sample of nations in Asia the manufacturing slope coefficient increases as urbanization increases. At the 1st percentile of urbanization, the manufacturing coefficient is negative (–0.269). At the 25th percentile, the manufacturing coefficient is zero, and then at the 75th percentile, the coefficient increases to 0.096. At the highest level of urbanization, the manufacturing coefficient is positive and statistically significant, with a value of 0.142.

Table 4. Slope coefficients for urbanization and manufacturing for All Nations, High-Income Nations and Nations in Asia

	Urbanization slope coefficients				Manufacturing slope coefficients		
Manufacturing percentiles	All nations	High-income nations	Nations in Asia	Urbanization percentiles	All nations	High-income nations	Nations in Asia
1st (2.3%)	0.465^	–0.089	0.520#	1st (9.9%)	–0.120*	–0.180	–0.269**
	(0.092)	(0.374)	(0.273)		(0.052)	(0.132)	(0.095)
25th (9.7%)	0.604^	0.126	0.774^	25th (38.8%)	0.014	0.026	–0.024
	(0.049)	(0.386)	(0.225)		(0.032)	(0.070)	(0.039)
50th (14.7%)	0.645^	0.189	0.849^	50th (58.2%)	0.053	0.088	0.049
	(0.051)	(0.393)	(0.216)		(0.048)	(0.063)	(0.047)
75th (18.9%)	0.670^	0.227	0.894^	75th (75.5%)	0.079	0.127*	0.096#
	(0.056)	(0.398)	(0.212)		(0.060)	(0.063)	(0.058)
99th (31.4%)	0.720^	0.304	0.986^	99th (97.7%)	0.104	0.166**	0.142*
	(0.072)	(0.410)	(0.208)		(0.072)	(0.067)	(0.071)

Note. Panel-corrected standard errors are in parentheses; unit-specific and period-specific intercepts are unreported. The coefficients in each sample are statistically different from one another. The pairwise comparisons of the estimates are available upon request.

* p <.05. ** p <.01. ^ p <.001 (two-tailed tests).

Conclusion

In this preliminary study we engaged the growing body of research that highlights the various socioecological dynamics that influence the urbanization–CO_2 emissions relationship. We contribute to this scholarly literature by examining how level of manufacturing moderates urbanization's effect on national-level CO_2 emissions.

We find that, while the interaction between urbanization and manufacturing has a positive effect on emissions for our global sample, this effect is primarily driven by the reduced samples of high-income nations and nations in Asia.

These findings highlight the importance of examining urbanization from a regional and structural perspective and underscore the role that the global organization of manufacturing and production plays in moderating urbanization's effect on CO_2 emissions.

However, this study has limitations. First, both the urbanization and manufacturing measures used in the analysis are unable to capture the full scope of both conditions. The urbanization measure is defined by a single indicator of the percentage of nations' populations residing in urban areas, making it unable to capture the multiple and oftentimes unequal dimensions of urbanization. Likewise, the

manufacturing measure consists of industries defined as such by the International Standard Industrial Classification. This includes an array of industries from recycling to the manufacturing of steel and does not take into account the heterogeneous composition of the manufacturing sector, especially across income groups and regions. Second, the time period covered in the analysis (14 years) limits the temporal generalizability of the results. The dearth of available longitudinal data that are suitable for reliable and valid comparisons, especially for manufacturing, may explain why the interaction between urbanization and manufacturing for some of the reduced samples was found to be nonsignificant.

As the world continues to urbanize, future research should investigate more closely the various mechanisms by which urbanization affects CO_2 emissions across disparate economic, structural, and regional contexts. By examining in more nuanced ways how these various socioecological processes interact with one another, and especially how other factors and conditions act as a moderator for the effect of urbanization on emissions, additional research can better identify and explain the ways in which urbanization can further contribute to, or help mitigate, anthropogenic climate change.

In a related vein, the findings for this study have implications for the Sustainable Development Goals (SDGs) (United Nations, 2019). This study suggests that some of these goals may be in contention with one another. For example, SDG #9 calls for the promotion of sustainable industrialization and a significant increase in manufacturing in developing nations, whereas SDG #11 calls for sustainable cities and communities, and SDG# 13 calls for urgent action to combat climate change and its impacts. However, as we illustrate, these goals are likely in contention with one another as greater industrialization is likely to come at the cost of greater emissions as urban areas continue to grow. Given the current structure of the global organization of production and manufacturing, the further promotion of industrialization in rapidly developing nations within regions such as Asia may come at the cost of less-sustainable cities. Thus, "significantly raising industry's share of gross domestic product," as called for in the SDGs, could increase the carbon intensity of cities within this and other regions, which is antithetical to a holistic sustainable development agenda and climate change mitigation in particular (United Nations, 2018).

Along similar lines, this study, in tandem with other recent analyses (Givens, 2015; Jorgenson et al., 2014), suggests that policymakers would benefit from incorporating a structural approach to addressing urban–ecological issues. As the findings for this study indicate, urbanization and global economic processes such as manufacturing are to some extent tied together in ways unique to region and structural location, which should be given further consideration in developing sustainability indicators and constructing policy measures (Wachsmuth et al., 2016). This is particularly relevant as many cities have taken a leading role in creating policy to mitigate and

adapt to climate change (e.g., C40 Cities).[4] However, local levels of government are often more restricted in scope and less powerful than national governing bodies (Thombs, 2019). Additional policymaking at the national and international levels is needed to address urban–ecological issues tied to inequities within the global organization of manufacturing and production.

In conclusion, the complex urbanization–CO_2 emissions relationship is one of the most paramount socioecological problems of the twenty-first century. Analyzing its underlying mechanisms and relationships to other socioeconomic factors, such as how manufacturing moderates the effect of urbanization on emissions, are crucial to increasing our understanding of this grand sustainability challenge.

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Book Review

The Politics of the Anthropocene

By John S. Dryzek and Jonathan Pickering

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John S. Dryzek and Jonathan Pickering's book, *The Politics of the Anthropocene*, takes upon itself the challenge of exposing and disrupting the politics and governance that brought humanity into the age of the Anthropocene. It combines Dryzek's expertise in environmental politics and deliberative democracy with Pickering's work in international negotiating regimes and governance of climate change and biodiversity. It also provides a strong narrative of the authors' concerns not only of Holocene institutions and their associated path dependencies, but also of the discourses and dominant concepts that are used to guide action in a time of change, despite having been created under the exceptionally stable (ecological) conditions of the Holocene.

The Anthropocene is the unofficial term for a new geological epoch of human activities becoming the main driving force behind the changes in the Earth system. While natural scientists debate over when the current official age of the Holocene ends, social scientists have engaged with the political and social implications of the Anthropocene. Others find scientific value in the Anthropocene concept for rethinking and reimagining our political and social orders (e.g., Burke et al., 2016), while some believe that it has become an ideology justifying human exceptionalism and more intervention into nature (e.g., Baskin, 2015). Critical scholars blame the anthropocentric and modernist worldviews for the dawn of the Anthropocene. Eco-modernists, on the other hand, profess faith in the power of human knowledge and technology to save the planet. *The Politics of the Anthropocene* straddles these two viewpoints by moving beyond critique and by recognizing the active, unstable character of the Earth system while encouraging human agency and responsibility. In addition to identifying the flaws of Holocene institutions, practices, and ideas, the authors propose several practical recommendations on how societies should deal with the Anthropocene. In doing so, they further the concept of *ecological reflexivity*, which they define by combining a more generic understanding of reflexivity (i.e., "the capacity of structures, systems, and sets of ideas to question their own core commitments, and if necessary, change themselves") with a specifically ecological

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form of reflexivity (i.e., "one that listens and responds to signals from the Earth system, and has the foresight to anticipate potentially catastrophic changes in the system") (p. 18).

Chapter 1, "Anthropocene: The good, the bad, and the inescapable," lays out the various discourses contemporary scholars use to conceptualize the depth of the challenges the Anthropocene poses to humanity and the solutions that these discourses—the good, the bad, and the inescapable—propose. It presents the limitations of all three (though gives greater validity to the inescapable) and thus encourages us to start considering the alternatives the authors are offering: ecological reflexivity and deliberative democracy. Chapter 2 takes a step back and describes "Governance in the Holocene." Here, the authors highlight how many of our current institutions follow a "pathological path dependency." Path-dependent institutions are problematic in the Anthropocene because they embody "feedback mechanisms that systematically repress information about the condition of the Earth system" (p. 23). This leads to institutions producing and accepting more of the same ineffective ideas, processes, and rules. Even the popular concepts of sustainability, resilience, and adaptation all fall short of facilitating the innovation and transformation needed in the Anthropocene because their promoters often take institutional structures and goals as given, and thus help secure a type of pathological path dependency in concepts created to respond to change.

In Chapter 3, titled "Governance in the Anthropocene," the authors describe what "ecological reflexivity" entails—processes over models, and continuous foresight and anticipation instead of a mere reaction to ecological crises—and how it could assist in breaking away from this dependency through an iterative process of recognition, reflection, and response to ecological conditions. In contrast to the preservation goal of resilience, ecological reflexivity embraces dynamism even if it necessitates changing, or even transforming, the system and the values preserving such a system. Ecological reflexivity does not rest on traditions and assumptions; it listens to all voices and reflects on them before pursuing an action. Having established the foundations of ecological reflexivity the authors then invite us to exercise the concept in rethinking and reimagining the established values of justice and sustainability.

Chapter 4 takes on the concept of justice and introduces the idea of "Planetary Justice." Like other environmental governance scholars, the authors consider the concept of justice as fundamental to the way one should conceive of problems and solutions. Indeed, they interpret any response to environmental challenges ignorant of justice as likely to generate greater vulnerability to risk and perpetuate further inequalities and, thus, promote maladaptive responses at best. However, the authors also argue that existing conceptualizations of justice, having been formed by Holocene experiences and ideas, can no longer provide adequate guidance. Not only might Holocene ideas of justice be incapable of fully comprehending future Anthropocene conditions, but such ideas may also be "complicit in accelerating

the ecological risks" humans may face in the Anthropocene (p. 65). For example, and as the authors point out, while the second half of the twentieth century has seen significant progress in attempts to address numerous social injustices, such as those associated with gender, race, and sexuality, such movements have taken place alongside the Great Acceleration[3] in material consumption and production. A reflexive justice apt for the Anthropocene must, therefore, be able to represent not only multiple social groupings and generations, but also the perspectives and needs of nonhumans. More than this, a reflexive justice is dynamic, in that its core elements are amendable, open to continual rethinking—rethinking through deliberation—and capable of absorbing non-Western notions of morality.

Chapter 5 focuses on the concept, or even discourse, of "sustainability" and, to a lesser extent, its close ally, sustainable development. While the two terms are often used interchangeably in the literature, the authors differentiate how the former is far broader than the latter and has the conceptual capacity to consider long-time horizons by emphasizing the relationship between the present and the future. However, despite sustainability "being a hugely popular way of thinking about environmental governance," the authors are quick to remind us that "the popularity of the idea has been matched by persistent shortfall in practice" (p. 82). This shortfall is discussed in terms of the various critiques of sustainability in the literature, that it is too static, too co-opted, and perhaps impossible. Like justice, the idea of sustainability also needs to be rethought for the Anthropocene. Ideally, sustainability would reconfigure to become reflexive and, in doing so, portray five core characteristics: open (e.g., open to public debate), ecologically grounded, dynamic, far-sighted, and integrated with other values such as justice. In this way, a reflexive conception of sustainability would be able to develop the capacities to rethink the idea of sustainability in the light of Earth system shifts as well as changes in new technologies and societal values.

The authors then make a case in Chapters 6 and 7 for advancing the effectiveness of democratic sensibilities and principles in scrutinizing pathological path dependency and invoking and exercising reflexive governance in the Anthropocene. Chapter 6 poses an important question: "Who will form the Anthropocene?" Working with the idea of "formative agency," Dryzek and Pickering suggest that formative agents will be the discourse and norm entrepreneurs—scientists and other experts; the most vulnerable; city and subnational governments; as well as nonhumans—as "they give form to what justice, sustainability, and related concepts should mean in practice" (p. 105). Warning their readers about the harmful kinds of agency, the authors also highlight who *should not* form the Anthropocene, namely, states,

3 The term "Great Acceleration" (Hibbard et al., 2006; Steffen et al., 2015), although linked with proposals of the Anthropocene (Crutzen, 2002), refers to a much more contained and distinct period of time, from the 1950s onwards; a period of time that has seen the most dramatic change in the magnitude and rate of human imprint in the earth system.

international organizations, and corporations—that is, those who have contributed most to pathological path dependency in Holocene institutions. There are several ways to exercise formative agency, but the authors focus on how formative agents can mobilize using language (reason, rhetoric, and deliberation) and act as the engines of reflexivity.

Building on the notion of formative agency, Chapter 7, "Democratic Anthropocene," expounds the concept of a formative sphere, described as "the sum of activity encompassing the creation, questioning, and development of principles for collective action" (p. 128). On top of this, the formative sphere is also (or ought to be) democratic, but democratic in a particular way—a deliberative way. It is at this point that the authors are able to demonstrate their scholarly strengths in deliberative democracy. It is only through deliberation, they contend, that (1) experts and scientists will be able to interact beneficially, (2) experts and citizens will be able to engage, and (3) the most vulnerable will be able to keep their advocates accountable such that the discourses emphasized by their entrepreneurs and advocates can be made legitimate and kept in check. By advocating a more deliberative democracy—and deliberative democracy within a formative sphere as opposed to more democracy as traditionally conceived (e.g., aggregative and vote-centric)—calls for more democracy become valid and capable of attending to skeptics.

The book concludes with a practical framing of politics in the Anthropocene. First, the notion of living frameworks for the Anthropocene is introduced, described by the authors as frameworks "flexible enough to respond to feedback from public deliberation and changing environmental conditions, while stable enough to provide a framework for collective, large-scale responses to risks to the Earth system" (p. 152). Unlike a fixed and institutionalized target, such as a rigidly interpreted view of planetary boundaries, a living framework evolves alongside changes in values, risks, and technologies. For instance, although the Paris Agreement has a more flexible approach than the Kyoto Protocol by conducting a periodic review of national targets, the global target to reduce emissions still competes with national priorities of economic growth, priorities that are encouraged and supported by other international institutions. International organizations and domestic political institutions need to abandon their unsustainable practices in order to allow existing sustainability efforts and mechanisms to internalize reflexivity and transform into living frameworks.

What sets the book apart from hubristic or apocalyptic framing of the Anthropocene is its humble take on the political landscape of human civilization. It celebrates the independent agency of nature and decenters human exceptionalism by encouraging ecologically aligned values, practices, and structures. *The Politics of the Anthropocene* unpacks the reasons why, despite the plethora of frameworks and institutions advanced to mitigate the symptoms of the Anthropocene, human societies remain at the brink of ecological destruction. It offers a theoretically grounded diagnosis of the Holocene

as well as a realistically informed antidote for the Anthropocene. This antidote is not another checklist of static and perfunctory action items embedded within the existing technocratic and state-centric approaches to the causes and consequences of the Anthropocene. In fact, Dryzek and Pickering shy away from proposing a new model of governance as *the* solution. They believe that our society's obsession with fixed models, and their preservation despite being ecologically destructive, is what brought about the Anthropocene. Instead, the authors propose a way of responding to the Anthropocene by challenging us to identify our pathological path dependencies and overcome the institutions and practices that feed them through ecologically reflexive thinking and action. Fulfilling this challenge, however, does not guarantee an ecologically just and sustainable future, rather, it promotes diligent reflection and transformation. As the authors state in the final paragraph of the book, "we may not escape the Anthropocene, but we can escape the path dependencies that threaten the pursuit of reflexive sustainability, planetary justice, and ecological democracy" (p. 161).

The book is a refreshing perspective, distancing itself from the tendency to preach critical postmodern and posthumanist perspectives, which advance human–nature entanglement but are failing to navigate the political contours of the challenges of the Anthropocene. The authors interrogate the dominance of Holocene institutions, but they also outline specific and practical suggestions for developing the capacities for ecological reflexivity: "It has to start from where we are now" (p. 155). However, "where we are now"—the starting line for deliberation and transformation—varies greatly. Although the authors acknowledge the differentiated vulnerability and diverse agency of human societies, there is an implicit assumption in the book of a significant level of uniformity across institutions of different societies, and that these institutions are already equipped with the capacity to listen, reflect, and respond to ecological shifts. This assumption is understandable since the book deals mainly with political and economic institutions at the international setting. However, at national and subnational levels, armed conflict, political violence, and economic downturns could disrupt or diminish the capacity for deliberation and transformation of these institutions. So, the question remains: How can the formative agents of unstable institutions, such as in politically unstable societies where short-term self-preservation is prioritized, start the path of transformation, especially when they do not have the capacity or willingness for self-scrutiny?

The global character of the Anthropocene ultimately requires a totalizing response, which is advantageous for inspiring a unified global action. On the other hand, a universalizing logic also tends to sideline the diversity of experiences in the Anthropocene, especially of those who will be hit the earliest and the hardest. This universal narrative is echoed, for example, in the dominance of Western paradigms and marginalization of the Global South in the Anthropocene scholarship (Marquardt, 2018). A universalist approach could reinforce historical injustice and existing socioeconomic inequalities by silencing the differentiated agencies

and vulnerabilities within human societies. It could also jeopardize the provision of context-specific requirements of vulnerable populations, considering that some of the implications of the Anthropocene are invisible from international and state levels, as demonstrated in the community-level analyses that regularly appear in this journal. This necessitates a critical inquiry into contemporary systems of governance since, according to Dryzek and Pickering, the development of capacities for ecological reflexivity starts with the examination of the current state of governance institutions, and such examination reveals that these institutions are not monoliths. The authors' consideration of indigenous knowledge and of the formative agency of the most vulnerable in their discussion contributes to this inquiry. However, it could have been furthered by articulating how diverse narratives, including those of postcolonial, indigenous, and marginalized societies, could inform global action and how multi-level perspectives could bridge the implementation gap between global agreements and regional, national, or local contexts.

The book is a timely and important contribution to academic and policy research on socioecological issues and responses to planetary changes. Readers will find themselves immersed in the clear and engaging prose of the book, and challenged or inspired by, if not agreeing with, the authors' vision of an ecologically reflexive governance system in the age of the Anthropocene.

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