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In Defense of Wild Night

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Abstract

In this piece, I extend Sarkar's (2011) conception of transformative power to the conservation of dark (and starry) night skies. More specifically, I argue that the transformative power that dark nights bear warrants their conservation and is best understood in terms of the important intellectual, cultural, aesthetic, and (psycho-physiologically) restorative effects that they afford. This gives us a pressing set of reasons to combat the growing, global phenomenon of light pollution. To do so, I argue, we ought to preserve the few remaining dark refuges that we have left (what I term *wildness* regions) and *synergistically re-wild* (i.e., re-darken) urban and suburban environments. Synergistic re-darkening, I propose, can be achieved by (i) establishing interpretive (educational) "dark zones", (ii) implementing bioluminescent lighting technologies, and (iii) strategically employing lighting design. Finally, and in order to enact a degree of epistemic justice, I argue that we ought to implement multi-cultural "co-learning" initiatives, which promote education pertaining to both Western, scientific and indigenous, North American astronomies.

Keywords: Environmental philosophy | environmental ethics | light pollution | transformative power | re-wilding

Disclaimer

I. Introduction

1.1 Introduction

Broadly, I endorse a transformative power account (Sarkar 2011), which justifies biodiversity conservation (partially) by reference to its capacity to induce and to play an important role in the facilitation of intellectual insights, discoveries, psychophysiological restoration, and the formation of cultural relationships. For our present purposes, I will assume that this account of biodiversity conservation has been well-defended. My task in this piece is to extend this conception of transformative power to the conservation of a non-biotic feature of our planet Earth: our dark and starry night skies. The transformative power of dark night skies —like that of biodiversity—can be understood by assessing the important intellectual, cultural, and restorative roles that they play for subjects who perceive and are affected by them. We have, in addition, another, indirect reason to conserve dark nights, which appeals to the important role that their preservation plays in the conservation of biodiversity. More specifically, as the artificial brightening of dark nights prevents nocturnal flora and fauna from flourishing, artificially bright nights contribute to the declination of biodiverse populations globally.

With this in mind, my project in this piece is the philosophical articulation of an account that justifies the conservation of dark, unpolluted nights. To achieve this end, I proceed as follows. I begin by introducing the concept of light pollution, then examine its deleterious effect on the psychological and physiological integrity of human and more-than-human species. I then clearly examine the important intellectual and cultural transformations that dark nights afford and, by extension,

that which their brightening eliminates. Altogether, this investigation, I argue, demonstrates that we have a pressing obligation to combat light pollution. Indeed, the topic requires far more practical and theoretical attention than it has so far garnered, both philosophically and legislatively.

Having done so, I will then argue that we have a pressing obligation to conserve the few remaining dark spaces that we have left: that which I term *wildness* regions, which I define in terms of biodiverse, dynamic, ecological regions that exemplify a low degree of toxic anthropogenic influence (below a vague threshold). As I understand toxicity in terms of *pollution*, I focus (given the current context) on wildness as explicated by reference to light pollution. Wild nights are by necessity dark nights; conversely, naturally dark nights are to some degree wild.[1] I conclude this piece by evaluating a natural upshot of this view: I suggest, more specifically, that we ought to facilitate the (what I term) synergistic re-wilding (i.e., re-darkening) of urban, suburban, and rural landscapes. Within this particular context, synergistic re-darkening can be enacted via (i) the establishment of interpretive (educational) "dark zones," (ii) the implementation of biomimetic, luminescent technologies, and (iii) the strategic use of lighting design, which minimizes skyglow, emphasizes astronomical aesthetics, and draws the human eye toward direct, empirical observations of the starry heavens. I also encourage the implementation of multi-disciplinary, "co-learning" initiatives (Marshall 2018), which promote public education pertaining to both Western, scientific and indigenous, North American astronomies and world views. When enacted successfully, synergistic re-wilding of this particular stripe therefore contributes to the flourishing of human and more-than-human species alike.

II. The Dwindling Dark

2.1 What is a Dark Night?

Before we proceed, it will be helpful to do a bit of conceptual book-keeping. I am committed to the astronomical view that 'the sky' is not a sharply distinguishable ontological entity; it is not a process, an event, or an object. Instead, 'the sky' is a cluster concept that refers to the celestial sphere—a useful heuristic device that consists of an abstract, spherical mapping with a concentric radius to Earth, onto the interior of which celestial objects (e.g., the stars) are projected. For perceivers like us, the celestial sphere appears to contain an array of astronomical objects, which are perceptible relative to one's geographical position on a planet's surface (in our case, the planet Earth). Employing this definition, the sky during day then refers to the celestial sphere when it includes the Sun, cloud cover, etc.[2] The 'night sky', by contrast, refers to the celestial sphere at night, which (from our planet's surface) appears to contain the Moon, stars, meteors, cloud cover, etc. Over the course of a year, the lengths of nights and days vary in accordance with the seasons, which are determined by the tilt of the Earth as it rotates on its axis.

All things considered, the presence or absence of the Sun is the primary feature which distinguishes day from night, for the Sun's presence produces a brightness which occludes the celestial objects that would otherwise be perceptible, if not for its shining rays. Note that nights are not, however, defined by reference to an absence of light altogether. Natural nights (those that have not been polluted by anthropogenic influences) still contain "[n]atural lighting levels," which "are governed by natural celestial sources, mainly the Moon, natural atmospheric emission (airglow), the stars and the Milky Way, and zodiacal light" (Falchi et al. 2016: 1). The distinction between unpolluted and polluted nights is thereby not defined by reference to an absence of light, but by reference to "[alterations] of night natural lighting levels caused by anthropogenic sources of light" (Falchi et al. 2016: 1).

As insightfully observed by Rich and Longcore (2004), there is, furthermore, an important distinction between *astronomical* and *ecological* light pollution. Astronomical light pollution is indexed to the perceptual experiences of members of our species, *Homo sapiens*. It refers, more precisely, to the visual obfuscation of dark, starry night skies from the vantage of human beings. Astronomical light pollution is thereby measured in terms of lux—i.e., wavelengths of brightness that are perceptible to the human eye. Ecological light pollution, by contrast, affects and modifies light levels across a wide of variety of wavelengths (e.g., ultraviolet) and ecosystems (both terrestrial and aquatic). For example, the lights emitted from fishing and undersea research vessels, which negatively affect the daily cycles of undersea organisms (e.g., zooplankton) (Moore et al. 2000) qualify as instances of ecological—though not astronomical—light pollution.

2.2 Ecological Light Pollution as a Threat to Biodiversity

As Dominoni (2015) notes, "[t]he rhythms of life on Earth are regulated by sunlight" (5). More precisely, the sun's light serves as a physiological signal that synchronizes the daily activities of almost all biotic organisms (Foster and Kreitzmann 2004). The mechanism that enables this internal-external synchronization to occur is referred to as the circadian system—an endogenous mechanism that enables organisms to measure time and anticipate temporal changes. Circadian synchronization ensures that organisms have specified windows of time in a 24 hour period to secure sustenance and avoid predation. Unnaturally bright nights negatively impact molecular, circadian rhythms, for bright nights mimic well-lit days. As a result, the circadian systems of various organisms are unable to properly synchronize or track external light-dark cycles (Dominoni 2015). As well-functioning circadian rhythms contribute to metabolic functioning, healthy growth cycles, and behavioral regulation, poorly-functioning circadian rhythms produce the inverse, detrimental effects (Berson et al. 2002; Dunlap 1999; Schoech et al., 2013; Dominoni et al.

2013).[3]

To make this claim a bit more salient, it will be helpful to focus on the case of one particular, vulnerable species, which has been widely covered in the light pollution literature. Loggerhead sea turtles (*Caretta caretta*) and their descendants tend to choose the same beaches on which to lay their eggs, year after year. Over the course of decades, hatchlings are birthed; those that reach reproductive maturity then return to their original nesting site in order to lay eggs of their own. Unfortunately, artificial lighting systems installed on beaches that house turtle nests interrupt this important reproductive cycle (Salmon et al. 1995). Well-lit beaches appear threatening to nesting turtles and fail to provide them with the appropriate cover of darkness, which—under typical, unpolluted conditions—allows them to avoid predation. Furthermore, the blaring beams of artificial lighting systems confuse nesting turtles, many of whom meet an untimely end by wandering, disoriented, onto nearby car-strewn roads. Freshly hatched loggerheads also find it difficult to navigate to the sea after emerging from their eggs, as they mistake artificial lighting sources for reflective seas (and so chart courses toward them) (Salmon 1992; Chepesiuk 2009).

A similar set of concerns applies to an array of species. Loggerhead sea turtles therefore concretely illustrate how ecological light pollution interrupts and negatively affects the functioning and flourishing of biodiverse flora and fauna. As there is a pressing set of reasons to conserve biodiversity, we therefore have at least one, indirect reason to conserve dark nights: natural darkness is, after all, integral to the health and reproductive success of biodiverse ecosystems and their constituents—including the sea turtle.

2.3 Light Pollution Poses a Threat to Human Health

Light pollution also disrupts circadian rhythms in our own species (*Homo sapiens*).

Over-illumination correlates, more precisely, with an increase in cancer rates (Anisimov 2006), contributes to psychophysiological stress and strain, and occludes the opportunities for star-gazing that dark night skies afford. The three former effects of light pollution pose threats to our psychophysiological health, while the latter poses a threat to a set of important, aesthetic values that dark night skies contribute to our world—a point to which I will return shortly.

The threat that artificially brightened nights pose to human health and wellbeing is so pressing that the World Health Organization's International Agency for Research on Cancer (IARC) now classifies night-shift work as a carcinogen (Erren et al. 2010).[4] More specifically, night shift work—which has increased significantly in the post-Industrial, Information Age—is strongly correlated with a variety of psycho-physiological illnesses, including cancer, heart disease, obesity, insomnia, anxiety, and depression (Chepesiuk 2009). In addition, those of us who do not work nights are still at risk, for electrical lighting systems—which dot highways, light up vacant buildings, and illuminate our homes—are now ubiquitous in urban and suburban environments.

2.4 Astronomical Light Pollution and the Destruction of Aesthetic Values

Due to artificial lighting and the loss of natural darkness, two-thirds of the U.S. population and over one half of European populations are now unable to perceive the Milky Way. This entails that a majority of those living in the developed and developing world do not now have access to truly dark night skies (Cinzano, Falchi and Elvidge 2001; Gandy 2017). The loss of dark nights therefore carries with it a loss that extends beyond threats to biotic well-being. More specifically, as nightscapes brighten, opportunities to enjoy and to wonder at stars, meteors, comets, galaxies, planets, and the Milky way evanesce. This constitutes a

substantive harm, for the profound, transformative experiences associated with perceptions of starry night skies are also eradicated. These include the experiences of beauty that they induce, their capacity to facilitate intellectual or scientific discoveries, the recreational opportunities that they afford, and the spiritual experiences (e.g., experiences of the sublime) which they catalyze.

There are a range of emotions triggered by perceptions of clear, dark night skies, which are associated with discovery and creativity. Wonder, intrigue, fascination, and awe, for example, encourage curiosity, promote contemplation, and elicit feelings of humility in the face of our vast cosmic landscape. Furthermore, as keenly noted by Stone (2018), Dunnett (2015), and Kessler (2012), the sheer immensity of starry night skies inspires a sense of the "astronomical sublime" in subjects who view them. Utilizing an interdisciplinary, empirical framework, Arcangeli et al. describe the sublime (broadly construed) as a,

> "type of experience [that] arises when we are confronted with an overwhelming vastness or power," which "has an overall positive valence (Arcangeli et al. 2019), even though it also involves a negative affective evaluation of the world, something like terror (Burke, 1759), fear (Kant, 1790/2000) or a feeling of self-negation (Cochrane, 2012)" (2).

Within the current context, the astronomical sublime is induced in subjects who perceive an innumerable expanse of stars. Experiences of this sort trigger an abstract and incomplete awareness of the universe in its vast, never-fully-comprehensible, and exciting totality (Hepburn 2010; Stone 2018)—a sensation that is simultaneously pleasurable and existentially unsettling.

Additionally, when starry night skies are occluded by city and industrial lights, opportunities for individuals to enjoy the non-consumptive and integral value of natural beauty evanesce (Gallaway, 2010: 85). Experiences of natural beauty born

by perceptions of starry night skies are, I argue, important (even critical) for human psychological wellbeing. After all, empirical studies suggest that perceptions of natural beauty produce declinations in cortisol levels[5] , increase subjective wellbeing, and elicit feelings of connectedness between subjects and the broader, more-than-human and cosmic world. Zhang, Howell, and Iyer (2014) empirically justify this view by demonstrating that:

(i) Perceptions of natural beauty induce positive, phenomenological experiences in human subjects.

(ii) Subjects who experience more-than-human environments as beautiful tend to feel more deeply connected to them, and

(iii) The states of subjective wellbeing that subjects report increase substantially when they experience natural environments as beautiful *and* feel deeply connected to them (Zhang, Howell, and Iyer 2014).

Integrating claims (i)-(iii), Zhang et al. arrive at the hypothesis that "individuals who are more connected with nature [...] report more life satisfaction [,] self-esteem [and "psychological well-being"] only if they also engage with natural beauty" (Zhang et al. 2014).

It is, I hope, clear that starry night skies induce profound experiences of natural beauty in subjects who perceive them. Furthermore, these perceptions of *astronomical* beauty are likely to induce feelings of greater connection with the extraterrestrial cosmos. On the basis of the empirical evidence just outlined, it then follows that experiences of beauty induced by starry night skies will also produce greater life satisfaction, happiness, and other emotional or psychological states associated with subjective wellbeing. The loss of bright, starry nightscapes therefore constitutes a substantive loss, for (under optimal conditions) their natural beauty

serves as a source of psychological, emotional, and spiritual sustenance.

2.5 Astronomical Light Pollution and the Loss of Cultural and Intellectual Values

The first documented astronomical recordings are found in the Lascaux Caves of Southern France, which are approximately 17,300 years old. Archaeo-astronomers posit that these early astronomical paintings portray the Pleiades asterism (a smaller-than-constellation-sized grouping of stars) and the nearby Hyades star cluster (Rappenglück 1996). These astronomical observations were clearly of heavy cultural interest to the Paleolithic *Homo sapiens* who dwelled at Lascaux, for the artists among them were inspired to recreate their likenesses through pictorial representations.

Furthermore, each culture's taxonomy of celestial objects provides important information about their mythological, practical, cosmological, and scientific world-views. For example, each constellation, which is comprised of a set grouping of stars, is typically associated with a corresponding mythological tale. This allows for the cultural transmission of knowledge, including important information pertaining to seasonal changes, cultural norms, and theological commitments. To help guide astronomical observation and inquiry, the International Astronomical Union has compiled an official list of 88 constellations in total, over half of which are Greek in origin. Even the early Greek system of profiling constellations, however, has its roots in a variety of older cultures, including ancient Babylonian, Assyrian, and Egyptian mythology. The Diné (Navajo) People of North America, likewise, have a unique, cultural method of grouping stars via their own constellations, which correspond to Diné mythological tales and cosmological worldviews.[6] This and a multiplicity of other cases demonstrate that constellations, asterisms, and other celestial bodies are cross-culturally significant, partially serving to constitute a

people's self-conception and identity.[7]

Furthermore, the night sky is valuable partially insofar as it affords opportunities for intellectual, scientific, and mathematical progress. Historically, starry night skies have been used for navigational purposes (as when e.g., seafarers utilized constellation maps to chart their oceanic voyages), to measure the changing of seasons, and to mark the passage of time. Likewise, the rise of mathematics corresponded with a range of astronomical observations and theoretical developments. More specifically, mathematical models had to be refined in order to accurately predict eclipses and track celestial bodies in their parade across the night sky according to season (Aveni 2002).

2.6 Astronomical Light Pollution and the Loss of Recreation

The recreational value associated with dark, starry skies is also lost in the glare of astronomical light pollution's heavy glow. Leisurely, stargazing opportunities are rare (if not entirely absent) from the vantage of an urban landscape. In this brightened context, opportunities to enjoy dazzling meteor showers or the dancing, wondrous lights of the Aurora Borealis and Aurora Australis evaporate. Worryingly, as amateur astronomers can no longer perceive clear, starry skies from their homes, cars have become "the main observing instrument of the amateur astronomer, not the telescope" (Pierre Brunet in Bogard 2013: 227).[8] Altogether, this entails that amateur astronomy is now available only to those of a higher economic bracket who must contribute to the fossil fuels industry (and, by extension, climate change) in order to enjoy their hobby.

III. Why Are Dark Nights Wild Nights?

3.1 Our Few Remaining Dark Spaces

Electrical lighting is so prolific in the developed and developing world that its detrimental effects extend far beyond urban and suburban environments. More specifically, the light that emanates from nearby cities bleeds into rural regions, creating a sky glow that extends from 100 to 200 miles away.[9] Additionally, as light pollution is worsened by dust, air pollution, and cloud cover, it is therefore very difficult to find geographic regions that do not now suffer its effects (Cinzano, Falchi and Elvidge 2001b; Gallaway, Olsen, and Mitchell 2009).

Even the most uninhabited regions in the 48 mainland United States struggle to maintain their dark night skies. Bureau of Land Management parcels, National Forests, and National Parks in California, Utah, Arizona, and Nevada, for example, are now brightened by the blaring, electrical lights of nearby Las Vegas. As this phenomenon extends far beyond Las Vegas, truly dark regions are thus becoming far and few between. This is evidenced by Falchi et al.'s (2016, below)[10] *New World Atlas of Artificial Sky Brightness*, which visually portrays a sharp increase in light pollution over the course of the past 70 years.[11] Even the Great Basin National Park in eastern Nevada—arguably the darkest spot left in the United States—suffers from astronomical and ecological light pollution.

With these considerations in mind, we ought to avoid exacerbating the problem of both astronomical and ecological light pollution by *first* taking steps to preserve the few remaining dark refuges that we have left: what I will soon define as *wildness* regions. Dark nights, in other words, are wild nights; conversely, a distinctive feature of wildness regions are the dark night skies that they uniquely afford. By prioritizing the preservation of wild skyscapes, I posit that we will be better able to mobilize more wide-spread efforts *contra* light pollution and its various, detrimental effects (by, for example, revamping urban, electrical lighting systems). One interesting consequence of this view is that we can (to at least some degree) re-wild our cities by successfully re-darkening them.

V. From Wilderness to Wildness

5.1 A Matter of Degree

As briefly stated, the definition of wildness proposed here includes regions that have been anthropogenically modified under its purview.[12] This implies that we ought to conceive of the distinction that obtains between wildness areas and non-wildness areas as being a matter of degree, rather than of type or of kind. One way to measure degrees of wildness is by reference to the degree of anthropogenic influence that has impacted an area; intuitively, urban sprawl and inner city environments are stationed at one extreme (paradigmatic of the highest degree of anthropogenic influence), while deep Amazonia (which exhibits the least amount of anthropogenic influence) is stationed at the other. Painting first with broad, conceptual strokes, an adequate definition of wildness must then make sense of this set of starting intuitions: urban, suburban, and inner city environments are definitely not wild, regions that are traditionally occupied by many indigenous and residential populations (e.g, Matsés communal reserves on the Javary River in Peru) may be, and environments with an utter lack of anthropogenic influence (e.g., bentonite slopes or the barren surface of Mars) are definitely wild.

Refining this intuition, it makes good sense to posit that the terms ‘wild’ and ‘wildness’ mark the fact that differences obtain between varying anthropogenic influences. With this in mind, I posit that there are toxic anthropogenic influences, on the one hand, and non-toxic, regulative anthropogenic influences, on the other. Toxic anthropogenic influences include those technologies (e.g., gasoline-powered vehicles), feats of engineering (e.g., concrete high-rises), and features of modern living (e.g., urban sprawl) that produce (light, air, sound) *pollution* or result in the displacement, degradation, or eradication of more-than-human, dynamic,

biodiverse species and ecological systems. Non-toxic, regulative anthropogenic influences include those practices—e.g., fire ecological, foraging, permacultural, regulative hunting practices, etc.—that contribute toward the preservation and flourishing of over-arching biotic wholes and their constituents.

Therefore, the scale that I employ uses two variables to measure a region's wildness: the degree to which an area is anthropogenically modified and the toxicity (as defined above) of these modifications. Regions that are *definitely not-wild* are classed as such due to the extreme degree of toxic, anthropogenic modification that they exemplify; regions that lack any anthropogenic modifications are *definitely wild;* and regions that are occupied by indigenous (or other) populations who employ regulative, ecological practices count as wild if and only if their anthropogenic modifications contribute to the overall flourishing of their dynamic, biotic community.[13]

5.2 Nature and Culture

What, one might wonder, is the distinction that obtains between (for example) the elaborate structures built by male satin bowerbirds (*Ptilonorhynchus violaceus*) and the grand, gothic cathedrals yielded by human hands? Both are the products of building behaviors that were selected for via evolution; both require a degree of foresight, planning, and the selection of preferred, proper materials (e.g., limestone, in the latter case, and objects of a uniform color, in the former). Bowerbirds and human builders alike belong to the kingdom *Animalia*, and both species exhibit well-developed and complex cerebellums (Day et al., 2005). The best explanation for the parallels that obtain between these two cases is, I think, that the distinction between bowerbirds and cathedral builders is not at all sharp, but a matter of continuous, biological degree. The same, it makes sense to claim, holds true between our species and the more-than-human biotic community that extends

beyond bowerbirds. More specifically, the genetic and phenotypic features that distinguish between species are, ultimately, all variations on a common, primordial ancestor. We living organisms (on the planet Earth) are, in short, all branches that spring forth from and share the same phylogenetic tree.

There is therefore no sharp boundary that distinguishes humans and human culture from the more-than-human, natural world. We can, nevertheless, still draw a pragmatic distinction between human and the more-than-human world by employing an operational definition that is useful in practical contexts (Sarkar, 2011: 19). This operational distinction allows us to account for the ethical fact that we can be held responsible for anthropogenic features or effects (e.g., climate change), but cannot be held responsible for non-anthropogenic features or effects (e.g., asteroid impacts).

5.3 Wildness

The distinction that I employ between wildness and non-wildness is analogous to the continuous distinction that obtains between nature and culture. More specifically, we ought to conceive of the distinction between wildness areas and non-wildness areas as being a matter of degree, where degrees of wildness are determined by the level of toxic, anthropogenic influence that a region is subject to. Inner city environments (e.g., New York City) exemplify one extreme—definitely not wildness—and (relatively) untouched wild spaces exemplify the other (e.g., deep Amazonia)—definitely wildness. There are, in addition, many regions that serve as borderline cases—i.e., regions that are neither definitely classed as wildness nor definitely not classed as wildness—including, for example, Zion National Park (replete as it is with a continuous stream of Park visitors and a variety of paved trails and roads).

The proposed redefinition—from wilderness to wildness—avoids the worry posed

by Cronon (1995; 1996) that,

> "[in] its flight from history, in its siren song of escape, in its reproduction of the dangerous dualism that sets human beings outside of nature—in all of these ways, wilderness poses a serious threat to responsible environmentalism at the end of the twentieth century" (Cronon 1995: 81).

After all, the conception of wildness introduced here is *spectral*[14]. Spectral models differ from those which are dualistic, for they represent a world that is metaphysically vague; that is, theorists who endorse them also subscribe to the general view that the world is not categorizable by reference to sharp distinctions of kind. Within the context of environmental philosophy, spectral definitions and models commit theorists to the more specific claim that members of our species *Homo sapiens* are inherently integrated with (that is, inextricably part and parcel of) our more-than-human biotic (and abiotic) world (Cuomo 1994, 1998, 2005; Plumwood 1993).

Furthermore, the process of re-wilding urban spaces is inherently good (given the proposed definition) *if* one conceives of goodness in terms of that which contributes to the flourishing (i.e., physical and psychological wellbeing) of human and more-than-human entities and environments (Cuomo 1998). In order to track this feature, call the human behaviors that contribute to biotic flourishing *synergistic*. By contrast, and as previously noted, regions that are anthropogenically modified in a way that detracts from or suppresses biotic flourishing are not-wild insofar as they are *toxic*[15].

Distinguishing "wild" from "non-wild" spaces by reference to the presence or absence of anthropogenic toxicity creates a pragmatic opportunity for the revisionary development of healthful, synergistic urban environments. By utilizing the terms in this way, we avoid the claim that the property of anthropogenic

urbanity is, by definition and inevitably, harmful. Instead, wild spaces may very well (though to differing degrees) contain or be synergistic human settlements. More robustly, it is imperative that we collectively implement policies that facilitate the re-construction of urban, suburban, and otherwise developed spaces in a way that is minimally (or, substantively less) toxic.[16]

VI. Re-Wilding the Night

6.1 Darkness as a Distinguishing Feature of Truly Wild Places

Now that I have introduced the conception of wildness that I endorse and defend, I will focus on one particular anthropogenic modification that is toxic, and thus destructive, to dynamic, biodiverse systems: light pollution. More specifically, I posit that wild nights[17] are by necessity dark nights. This entails that, due to the ubiquity of light pollution globally, there are very few truly wild spaces left. Furthermore, as there is a pressing set of reasons to combat both ecological and astronomical light pollution (due to the transformative power that dark nights bear), we have good reason to preserve wild spaces. Indeed, as wildness is explicated in terms of an absence of anthropogenic toxicity, there is a positive correlation that obtains between it and the transformative power possessed by dark nights (and, more generally, biodiversity).

With these considerations fueling the discussion, my argument is twofold. First, we ought to conserve the few truly wild spaces that we have left, which house or exhibit features (in particular, natural darkness) that are positively transformative in nature. Second, we ought to *re-wild* cityscapes in order to combat light pollution's detrimental effects. Re-wilding can be accomplished, I propose[18] , by exchanging toxic anthropogenic practices (e.g., omnipresent, high pressure sodium bulbs that

illuminate human dwellings) for regulative, synergistic management practices (e.g., motion-activated outdoor lighting systems, wildlife corridors, and biomimetic luminescence).

6.2 The (Spectral) Ethics of Nighttime Lighting

Employing an operational distinction between human and more-than-human environments suggests that the "ethics of nighttime lighting" falls along a spectrum. That is, ethical prescriptions ought to be formulated in a (piecemeal) fashion that is relative to the degree of development and the needs of the occupants (human and more-than-human) who dwell within each space. Ultimately, the way that a region is lit ought to contribute to the flourishing of its occupants.

For instance, dark night sky preserves require (i) minimal anthropogenic lighting, and (ii) restrictions on the way that urban spaces in the surrounding region are lit. As many more-than-human species (particularly nocturnal and predatory species, including *Puma concolor*—cougars) cannot thrive within built cityscapes, "preservation" will therefore be a guiding value that tracks the needs of occupants in strongly wild regions. In addition, preservation recommends and requires the implementation of a value in neighboring urban environments: "containment," in order to prevent e.g., skyglow.

To accommodate the psychological and physiological needs of *Homo sapiens* and nocturnal species that occupy cityscapes, the value of "re-wilding" ought to be implemented. Synergistic re-wilding recommends the creation of a nighttime ecological climate that is conducive to human and more-than-human wellbeing while still meeting the functional needs of those who must navigate through a technologically complex world (Light 2001: 19–27; Stone 2018). By re-engineering urban spaces synergistically, they will be,

> “Certainly not as bright as our current city nights, and perhaps not featuring a pristine, completely unpolluted night sky, but a re-oriented urban nightscape nonetheless. [This] can offer a new relationship between the stars above and the lights below” (Stone 2018).

Dark sky preserves and urban spaces therefore constitute two extremes on either side of the lighting revision spectrum. In both cases, the preservation of dark nights is motivated by the flourishing of its occupants.

There are, of course, many borderline cases that require lighting solutions tailored to accommodate the varying (and sometimes conflicting) needs of its multiple inhabitants. Consider again the case of loggerhead sea turtles, whose successful nesting is threatened by the artificial lights that illuminate the urban beaches on which they deposit their eggs. Ideally, steady-stream illumination would be substituted for strategically-placed, motion-activated lighting systems in these spaces. If, however, this radical urban modification is not possible, then Salmon et al. (1995) have empirically demonstrated that the construction of low-light barriers which mimic natural features provides an adequate compromise. By blocking the illumination sprouting from buildings, low-light barriers create a more viable climate in which loggerhead hatchlings can flourish.

6.3 Our Few Remaining Dark Spaces

The darkest regions in the continental United States tend to be (but are not limited to) a variety of National Parks, including Natural Bridges National Monument, Capital Reef National Park, Bryce Canyon National Park, Canyonlands National Park, Big Bend National Park, Grand Canyon National Park, and Chaco Culture National Park (Bogard, 2013). This means that our few, remaining, paradigmatically wild spaces are, on the whole, land parcels and ecological regions that fall under the management of the National Park Service, the National Forest Service, and the

Bureau of Land Management. This is deeply tragic, as many of these parcels were created by forcibly removing sociopolitically oppressed, indigenous populations from their homes. More specifically, the creation of many National Parks—including Yellowstone, Mesa Verde, and Glacier—involved the unjust expulsion of Native American peoples from their ancestral lands (Kantor 2007).[19] I would like to clearly note that I by no means condone this history. Indeed, it is ethically imperative for immediate, reparative legislations to be enacted in order to restore indigenous land management and sovereignty to these regions (via e.g., the creation of Native-led "Tribal Parks" and "Protected Areas") (Murray & King 2012).

In the present piece, I aim merely to establish the (admittedly minimal) claim that, from within the context of both current (e.g., NPS) and ethically ideal (e.g., Tribal Park) structural frameworks, we ought to ensure that ecological spaces remain synergistically wild. This way, we can (at the very least) preserve remaining darkness and better mobilize wide-spread efforts to combat light pollution in rural, suburban, and inner city environments.

With this in mind, National Parks (as they currently stand) are well-equipped to preserve natural darkness due to the availability (relatively minimal though it may be) of monetary, technological, and staffing resources that they enjoy. National Parks are therefore able to address the problem of both astronomical and ecological light pollution by enforcing sustainable lighting practices (e.g., employing low-pressure sodium bulbs) and by encouraging surrounding cities, villages, and towns to employ sustainable lighting practices, too.

The sky glow that is emitted via light pollution extends beyond the bounds of highly lit cities. More specifically, sparse cloud cover creates an exaggerated scattering effect, wherein artificial light extends in an elongated fashion across a horizontal plane (Gaston *et al.*, 2012; Falchi *et al.*, 2011). As natural darkness is heavily affected by nearby, city skyglow[20] , the inhabited regions that surround wild spaces must

therefore do their part if dark night skies are to be preserved. National Parks in the United States are particularly well-situated to facilitate this change, for they serve as central hubs that encourage municipalities in the region to become buffer zones that preserve dark skyscapes on a wide geographic scale.

In addition, National Parks receive heavy visitation from a range of visitors annually, who are then given opportunities to receive education on the importance of dark night sky conservation and the practices that will effectively enact this goal. Furthermore, the NPS Sky Team—which monitors 30 parks—collects data on light pollution in order to document it and its effects. The NPS Night Sky team is also responsible for retrofitting outdoor lighting fixtures in order to provide parks with energy efficient and environmentally friendly alternatives. As a result, almost all National Parks in the United States are now "night sky friendly".[21]

Finally, National Parks are charismatic places that are approved of and loved by a large portion of the general public. Their appeal is akin to the appeal of charismatic megafauna (e.g., tigers, orcas, elephants, pandas, and bald eagles) that play a key role in acquiring popular support for conservationist goals. Charismatic species—and, in this case, National Parks—are therefore important insofar as they serve as the "faces of night sky conservation": they attract attention, aid in the distribution of integral information, and contribute to the widespread preservation of e.g., natural darkness (by, for example, impacting surrounding buffer zones and leveraging relevant votes). As they employ synergistic anthropogenic practices to ensure that their night skies remain dark, National Parks therefore meet the requisite criteria and count as genuine wildness spaces.

6.4 Re-Darkening Cityscapes: General Strategies

An additional consequence of the definition of wildness that I have so far proposed (defined by reference to a lack of toxic, anthropogenic influences) is that, by

prioritizing (and reinstating) darkness in cityscapes, we can, in effect, successfully *re-wild* them (to at least some degree).[22] This re-wilding, understood in terms of re-darkening, can be achieved by swapping out toxic for regulative anthropogenic management practices. It is imperative that stronger policies are implemented to achieve these ends, for as the "nocturnal commons" ever more rapidly diminishes, so too does "access to the visual wonders of the night sky" (Gandy 2017).

When re-conceiving how to light our cities and towns, it is imperative to remain mindful of the unique needs borne by suburban and urban populations. Safety and navigability are both pressing considerations and can be understood in a variety of ways. Too much darkness is, for example, associated with increases in a variety of health and safety risks (including robberies, assaults, and other injuries to the body associated with e.g., tripping hazards). Nevertheless, we can still work to minimize the glare emitted by light-polluting sources, which The Royal Commission on Environmental Pollution (2009) has defined as artificial "over-illumination".[23]

Street lighting is responsible for the bulk of light pollution and wasted energy, due to the dense way in which street lights are clustered together.[24] Furthermore, street lights are often outfitted with either LEDs or high-pressure sodium bulbs that emit white lighting. White lighting is particularly detrimental to human and broader ecological health, due to its broad "spectral composition, duration and spatial pattern," which interrupts circadian functioning and interferes with the reproductive and navigational patterns of nocturnal species (Gaston et al. 2012).

Finally, the International Energy Agency (2006) estimates that the devices employed to light streets waste approximately 114 terawatt hours (TWh) of energy, while the European Union spends an average of 1.7 euros per annum for outdoor lighting that, ultimately, goes to waste (Bogard 2013: 228). With this in mind, current electrical lighting systems not only contribute to an overabundance of astronomical and ecological light pollution, but are also economically wasteful and impractical.

In order to combat light pollution and its adverse effects, Gaston et al. propose, that we modify our existent lighting fixtures so as to:

> "(i) prevent areas from being artificially lit; (ii) limit the duration of lighting; (iii) reduce the 'trespass' of lighting into areas that are not intended to be lit (including the night sky); (iv) change the intensity of lighting; and (v) change the spectral composition of lighting" (2012: 1256).

Overall, astronomers tend to advocate for the use of warmly toned, low-pressure sodium bulbs, for they minimize skyglow, utilize the least energy, do not negatively impact human and more-than-human circadian rhythms, and have the fewest, detrimental effects on biodiverse species that flourish at night. This is partially due to the fact that low pressure sodium bulbs emit monochromatic, yellow—as opposed to white—light. As yellow light is situated along a narrow band on the color spectrum, low-pressure sodium bulbs do not negatively affect species that navigate by reference to e.g., moonlight. Perhaps ironically, one of the drawbacks of low-pressure sodium bulbs is a direct consequence of this ecological benefit: due to their narrow spectral composition, yellow lights restrict visibility (and thereby navigability) in human populations, for we are unable to perceive fine color distinctions under a yellow glow.[25]

We can nevertheless address the concerns posed by the problem of light pollution while simultaneously paying due heed to the needs of urban and suburban populations, who must successfully navigate (by foot, bicycle, car, or other means of transport) through darkened nights. The first proposed suggestion involves using strategically-placed LEDs in amber, green, and yellow tones. (Recall that lights emitting a spectral profile in the white or blue range have a detrimental effect on wildlife and human circadian rhythms.) Warmly-toned LEDs could illuminate streets, residences, schools, and businesses during a limited set of restricted hours. Similarly, it would be both conducive to dark night conservation and economically

practical to employ motion-activated lighting systems that are triggered only in the presence of e.g., foot traffic.

Finally, lighting engineer Francois Jousse has demonstrated through his mindful use of accent, splash lighting on a variety of Parisian monuments (including Notre-Dame) that there are a variety of ways to, "blend light with the surroundings [in a way that does not] annoy the birds, the insects, the neighbors of the astronomers."[26] In order to successfully facilitate these changes, it is important to regulate lighting at the legislative level by implementing building codes, which govern urban planning and development. It makes good sense to posit, for example, that legislation should dictate that lights shine "only on the premises to be illuminated—not into the sky, not onto your neighbor's property, not into the street. It doesn't seem like too much to ask" (Bogard, 2013: 229). By implementing combinations of these lighting management practices and technologies, we will be better able to provide human populations with (what I will term) 'light corridors'—lit channels through which we can efficiently navigate—while simultaneously partitioning off "dark refuges that mobile animals can exploit" (Gaston et al. 2012: 1256).

6.5 Re-darkening Cityscapes via Wildlife Corridors

It is important to re-emphasize that the preservation and re-wilding of dark, urban nights is an essential component of biodiversity conservation. The further development of interconnected wildlife corridors—designated ecosystem strips through which more-than-human animals migrate and escape e.g., fires[27] —will contribute to the synergistic revision of suburban and per-suburban spaces (Beier and Noss 2008). Indeed, conservation biologist Nick Haddad has empirically demonstrated that even relatively small wildlife corridors (around 25 yards wide) contribute to the flourishing of biodiversity in a region.[28]

The construction of wildlife corridors constitutes the development of interspersed, peri-urban spaces, which blend barriers between developed and more-than-human realms. Consider, for example, Utah's recently-built wildlife pass, which stalwartly hovers over Interstate 80. At 50 feet wide and 320 feet long, the I-80 wildlife pass is bordered by miles of fencing and peppered with ecologically-appropriate logs and boulders. Biodiverse species—including mule deer and elk—utilize it to circumvent highway traffic safely and unperturbedly (Cramer 2013). This interweaving of more-than-human ecologies with urban infrastructure creates a cross-hatched, tapestry landscape, which is comprised of distinct and varying degrees of wildness.

Problematic niche overlap—a phenomenon wherein e.g., bears who utilize these passages destructively encroach onto human settlements (through, for example, raiding bins)—can be avoided by ensuring that bordering development is strategically lit by motion-activated sensors placed near waste receptacles. As bears have a keen cognitive capacity for working and long-term memory (Kilham 2013), they are able to quickly learn to regulate their behavior near (i.e., avoid) spaces that are motion-activatedly lit. It is furthermore imperative that policies are implemented which ensure that urban and suburban developments surrounding dark wildlife corridors only (legally) utilize warmly-lit, low-pressure sodium bulbs. This policy will prevent the (problematic) spillover of harmful, white or blue LEDs.

6.5 Re-darkened Cityscapes and the Preservation of Aesthetic and Cultural Values

In addition, if we take seriously the consideration that the conservation of dark nights is partially justified by reference to the important experiential features that they afford (through e.g., facilitating access to starry night skies), then "we must [strive] for nightscapes that are both aesthetically powerful and morally engaged," (Stone 2018). By paying particular mind to the kinds of values that we build into

urban environments, the way that we light our urban landscapes will inevitably influence the way that we collectively perceive, interpret, and understand nighttime darkness (Verbeek 2011).

With this in mind, cityscapes and developments more generally can be built in a way that "[imagines and implements] an environmentally responsible world" (King 2000: 122). Within the current context, this project can be accomplished by highlighting and drawing public attention to the importance of natural darkness. The urban restoration of dark night skies is therefore,

> "an act of re-orienting the ecological and cosmological sense of place for cities and their inhabitants, of re-connecting the urban with the natural. It allows for the incorporation and fostering of the full spectrum of values associated with darkness, from efficiency and sustainability to a connection with nature" (Stone 2018, drawing on de-Shalit 2003).

Toward this end, lighting ought to be utilized in a way that is psychologically and aesthetically efficacious. More specifically, the way that cities are lit ought to actively promote an appreciation for dark, starry nights, an awareness of light pollution and its deleterious effects, and a broader sense of connectedness with our more-than-human world.

This can be accomplished by utilizing a range of "dark design" strategies, including those proposed by Edensor (2017) and French lighting firm Concepto (2012; Narboni 2017)[29]. To promote the aesthetic values emphasized earlier in this piece, I propose that lighting fixtures be built in a way that guides the human eye toward the heavens. This can be achieved by employing some of the practical techniques and strategies proposed by Chris Lowe and Philip Rafael via their "Dark Art Movement" (2011; 2014). As has been noted, sky glow is substantively reduced through selective splash lighting, the minimal use of harmful, white LEDs, the

utilization of bulbs that emit a warm (not cool) glow, and by restricting the use of high luminescence to (what Lowe and Rafael term) “task areas”. These recommendations create a more fruitful set of conditions through which the stars may more brightly shine. Combine these with the further suggestion that light should be gradated: brighter concentrations of warm-tone luminescence should be placed near the base of buildings, which become progressively darker, the farther into the sky they reach.[30] By drawing the human eye attentively upward, this design strategy promotes sky-gazing, framing distant stars in a perceptually salient way. Furthermore, this natural gradation between light and shadow promotes a visually immediate, cultural understanding of the spectral inseparability of *homo sapiens* from the broader, more-than-human world. As a result, feelings of connectedness are inevitably elicited.

I’d like to further extend these practical recommendations by proposing the construction of public park “dark zones” and “dark parks,” [31] which include educational, interpretive kiosks that are culturally-sensitive and specific. These interpretive kiosks could be lit by motion-activated, splash, and properly-shielded light fixtures. Within the context of the United States, this proposal presents an opportunity for the dissemination of information that encourages scientific (astronomical, environmental) and indigenous, cosmological literacy. The combination of Western astronomical and Traditional Ecological Knowledge promotes that which Mi’kmaw Elder Albert Marshall has termed *Etuaptmumk* or “Two-Eyed Seeing” (TES). As an epistemic framework, TES presents (in the current context) a diverse set of cultural orientations toward the heavens. Committees formed to develop these interpretive, dark sky kiosks ought to be governed by the principle of “co-learning”, which “[develops and nurtures] collective and collaborative understandings and capabilities” (Marshall 2018). This ensures that portrayals of Traditional Ecological and Astronomical Knowledge (TEAM) are testimonially accurate, while simultaneously avoiding the tokenization of

indigenous culture. Utilizing an environmental justice framework, kiosks that actively integrate this TES approach could serve as a small but important step toward reconciliation and the decolonization of public and conservation spaces.

The construction of these educational dark zones and parks will require a combined resource pool, drawing on the budgets of both state and local Infrastructure, in addition to that of Parks and Recreation. As suggested, their development furthermore requires the establishment of lighting conservation task-forces that actively facilitate interdisciplinary co-learning. These task forces ought to be comprised of diverse representatives hailing from across a range of fields (lighting engineers, urban development, indigenous knowledge-bearers, environmental ethicists, astronomers, etc.).[32] To quote indigenous star-story expert Wilfred Buck (of the Opaskwayak Cree Nation), "[we] arrive at knowledge from many different paths. And the more aware we are of other possibilities, the more sensitive we will be to understanding and difference" (Buck 2018 via Boutsalis 2020).

6.6 Envisioning New Technologies: Re-darkened Cityscapes and Synergistic Biomimicry

Finally, "synergistic biomimicry", I urge, ought to be employed as a design feature that governs the re-darkening of urban spaces. As a field, biomimetics engineers technologies that imitate biological processes (often, though not solely, via synthetic means). Cities could utilize biomimetic lighting fixtures, which are both aesthetically pleasing and (on the whole) substantively less harmful to human and more-than-human physiology.

One organic, biomimetic strategy involves the utilization and cultivation of bioluminescent fungi—including *Panels stipticus, Panels pusillus, Mycena chlorophos*, and *Omphalotus olearius* (amongst other species)—along footpaths in temperate and other wet climates. This approach could be particularly effective in

park-like spaces and along wildlife corridors, simultaneously stimulating the growth of more fungal diversity and contributing to a beautiful nighttime aesthetic. The utilization of bioluminescent fungi is not as far-fetched as it may at first seem. For though wonderfully mystical, its implementation is also highly practical. As Merlin Sheldrake (2020) notes,

In a guidebook to fungi published in 1875, Mordecai Cooke wrote that bioluminescent fungi were commonly found on the timber props used in timber mines. Miners "are well acquainted with phosphorescent fungi, and the men state that sufficient light is given 'to see their hands by.' The specimens of *Polyporus* were so luminous that they could be seen in the dark at a distance of twenty yards" (242).

There are, in addition, a range of creative potentials that involve the integration of organic and synthetic materials[33] in lighting design. For example, by mimicking or utilizing bioluminescent algae in fixtures, the way that cities are lit may aesthetically mirror (and thus complement) the gentle glow emanating from stars in the night sky. Indeed, technologies like these, though novel, are already in development. The glowing Ambio light, designed by biologist and engineer Teresa van Dongen, utilizes bioluminescent bacteria (*Photobacterium bacteria*), which, when oxygenated, effuse a gentle blue (Stinson 2017).[34] To ensure a fresh supply of oxygen, the Ambio light has been kinetically designed to promote interactive movement. Structures that grow and employ *Photobacterium* could illuminate footpaths, harnessing the footfalls of visitors in order to stimulate kinetic motion—ensuring, by extension, a fresh supply of oxygen at needed intervals.[35]

In regions that are relatively low in rainfall and humidity, alternatives can be envisioned that capture the same aesthetic, pragmatic, and energy-conserving benefits of bio-luminescence. Walkways painted with low VOC (Volatile Organic Compound), photo-luminescent pigments could helpfully direct foot traffic, while simultaneously increasing urban beauty and minimizing skyglow. The commercial

application of these glow-in-the-dark paints could be utilized “on a large scale in high rise buildings [...] as safety markings for corridors and stairwells,” all while meeting, “the necessary requirements in terms of brightness and afterglow” (Jolin Group).[36]

There are a range of potential trade-offs associated with the implementation of these proposed, bioluminescent lighting technologies. As insightfully observed by David Collingridge (1980), assessing and offsetting any concerns during the nascent stage of these technological developments is feasible.[37] By contrast, technologies (more generally) and their potential harms are far more difficult to regulate once they have become societally entrenched and ubiquitous. Within the current context, two specific, pressing worries associated with bioluminescent lighting strategies arise: they may be either invasive (as in the case of fungi) or toxic (as in the case of paint).[38]

The first worry states that introducing genetically modified or non-native species of bioluminescent fungi into urban regions could potentially threaten ecological health. This worry is not unreasonable. After all, fungal varietals, including the chytrid *Batrachochytrium dendrobatidis* (Bd) and *B. salamandrivorans* (Bsal), have substantially contributed to e.g., the global loss of amphibian biodiversity (Dillon et al., 2016). (Indeed, in this particularly tragic case, Chytridiomycosis outbreaks have spurred the decline of 501 amphibian species, with an observed 90 extinctions globally (Scheele et al. 2019).) One version of this worry runs: as fungal spores disperse widely, the construction of cordoned-off zones (by e.g., fruiting mushrooms within specified, street-side beds) could not fully ensure their containment. Therefore, the implementation of this particular bio-technology may exacerbate the already deeply-entrenched problems associated with invasive species more generally.

Importantly, the fungi that I have in mind as biomimetic, lighting alternatives are

(unlike *Batrachochytrium dendrobatidis*) non-invasive varietals with fruiting bodies. Furthermore, bioluminescent *Mycena chlorophos*, for example, are markedly niche-specific and non-virulent, requiring very particular conditions under which they successfully flourish. Endemic to forested ecosystems, *Mycena chlorophos* grow on woody detritus and fruit only on those rare, seasonal days following a rain, when the atmosphere lingers at around 27 °C relative humidity (Niitsu & Hanyuda 2000).

With this in mind, this particular, biomimetic lighting strategy would only be feasibly (and sustainably) implementable within certain regions. For example, it would be inappropriate to fruit *Mycena chlorophos* in dry Arizona (USA), though fitting throughout urban spaces in subtropical Asia. Other bioluminescent varietals would be more appropriately grown elsewhere; *Mycena haematopus*—endemic to North America and Europe—would do well in e.g., Portland, Oregon, though not in the hot desert climate of Dubai. Furthermore, even when ecologically well-situated, the flourishing of bioluminescent fungi may still require very particular, climatic containers, which mimic their ideal growing conditions year-round (Niitsu & Hanyuda 2000). Altogether, as *Mycena chlorophos* and related, bioluminescent fungal varietals are environmentally-specific and ecologically picky, they therefore pose little threat of becoming invasive.

It is relatively simple to address concerns pertaining to e.g., the potential toxicity associated with bioluminescent paints and lanterns. The toxicity associated with paints more generally is typically associated with their gaseous emission of Volatile Organic Compounds (or VOCs). However, the photo-luminescent paints developed by the Jolin Group contain no VOCs and are water-based, making them (relatively) environmentally friendly and non-toxic. Nevertheless, it is worth noting that the available photoluminescent paints available on the market are currently comprised of (plastic) acrylics. To avoid further contributing to the fossil fuels industry, research into e.g., silicone-based alternatives is thereby warranted and integral.[39]

Having addressed potential concerns, I conclude that we can partially re-wild cities by creatively, collaboratively, strategically, and aesthetically re-darkening them. Re-darkening reduces one feature of environmental toxicity—light pollution—and therefore contributes to the development of synergistic, healthy urban spaces. To achieve this important set of ends, we must implement "lighting strategies that minimize adverse ecological impacts while balancing the often conflicting requirements of light for human utility, comfort, and safety, aesthetic concerns, energy consumption and the carbon emission reduction" (Gaston et al. 2012). The extended, practical framework that I have outlined here does satisfy a range of these important, environmental values and goals, including:

(i) Energy conservation

(ii) Public education

(iii) The pragmatic illumination of pathways

(iv) Environmental justice, and

(iv) Biodiversity conservation

VII. Conclusions, Considerations, Potentials

In this piece, I have shown that we have a pressing set of reasons to conserve dark nights, for they bear a transformative power that is aesthetically, psycho-physiologically, and ecologically integral. I have also shown that we ought to conserve (what I have termed) synergistically wild spaces, for—due to the prevalence of astronomical and ecological light pollution—they are the only bearers of true darkness left. Through their conservation, we are furthermore able to

mobilize more wide-spread efforts to re-darken rural, suburban, and urban environments. This re-darkening can be achieved by swapping out toxic, anthropogenic lighting sources for regulative lighting (e.g., biomimetic) alternatives that contribute less to ecological degradation and astronomical skyglow. And, as I have defined wildness by reference to a low degree of toxic, anthropogenic impact, re-darkening cityscapes (and other populated environments) will effectively contribute to their healthful, synergistic re-wilding.

There are a variety of remaining worries that, going forward, must be addressed. For example, how should we accommodate the pressing worry that access to maximally wild regions in the United States is currently restricted to the wealthy (and is therefore, in practice, closed to the urban poor)? How do we avoid, as Pritchard (2017) warns, the over-romanticization of natural darkness at the expense of further entrenching lighting inequities?[40] As I have proposed that the threshold between wild and not-wild is spectral and vague, how then should we measure the successful implementation of these proposed, re-wilding strategies? Though I have not articulated a direct response to this particular set of concerns in this piece, I would like to re-emphasize their critical import within the context of advocating for dark-night restoration and conservation.

Finally, it is worth reiterating that the concept of synergistic re-wilding introduced here ought to be used as a vehicle through which a *degree* of de-colonial, reparative work is achieved. Formulating and funding "Two Eyed Seeing" task forces that actively engage in interpretive, dark night sky outreach could effectively draw the public's attention to—historical and contemporary—injustices affecting indigenous peoples. Initiatives of this sort would constitute a step (small though it may be) toward enacting epistemic reparations. More specifically, the wide-spread dissemination of information about and pertaining to locally-specific cosmologies would—in a perceptually salient and immediate way—centralize their import within

the American cultural landscape. As argued, the epistemic centering of Traditional Ecological Knowledge systems could be partially achieved through the wise utilization of combined physical ("Dark Zones") and conceptual (interpretive) space.

The beneficial upshots of interweaving U.S. governmental and indigenous land management practices are multiplicitous. In this context, by re-wilding urban nights, we collectively reap the fruits of their positive, psycho-physiological transformative power, promote the flourishing of biodiversity, encourage the development of interdisciplinary, multi-cultural relationships, and carry out the slow work of repairing epistemic injustice.

Notes

1 Here, I use the term 'natural' to mark the fact that e.g., a darkened room does not qualify as wild. Wildness spaces are, after all, dynamic, biodiverse ecological regions.

2 Though note that the moon does at times appear during the day!

3 For example, predation pressure increases as the predatory timeframes of daytime predators is extended by artificial light.

4 Shifts that run from 11:00pm to 7:00am.

5 The hormone associated with stress.

6 https://astrobiology.nasa.gov/education/nasa-and-the-navajo-nation/

7 http://multiverse.ssl.berkeley.edu/multicultural#One

8 Member of France's Association National pour la Protection du Ciel et

l'Environment Nocturnes.

9 Sky glow and its interference in rural environments is measured by astronomers using the formal model, Walker's Law (Walker 1977).

10 This photo tracks light pollution's growth in the 48 continental United States over the course of the last 75 years: https://cires.colorado.edu/Artificial-light.

11 As Pritchard (2017) has compelling argued when evaluating NASA's related photograph of the Earth from space—*City Lights of Africa, Europe, and the Middle East*—images portraying light pollution are by no means value- or culturally-neutral. More specifically, many of the regions that appear darkly lit in the New World Atlas struggle with lighting-poverty. Therefore, Pritchard argues, we need to mindfully avoid a romanticization of the dark and the reproduction of "(neo)colonial forms of conservation that place landscapes of tourism, leisure, and aesthetics for wealthy outsiders at odds with ensuring local livelihood and improving basic standards of living" (323). It is, however, worth noting that some eco-feminist authors, including Vandana Shiva (1988), have argued that increases in local livelihoods and flourishing need not always involve development in this Westernized sense.

12 Anthropogenic influences may be unintentional or may occur without permanent settlement. Consider, for example, a variety of invasive species in North America that were originally introduce by settler colonialists (to the degradation of local ecosystems).

13 As I note later, there are a plethora of borderline cases that are not obviously classed as either toxically anthropogenic or non-toxically anthropogenic. While it is inarguable that regulative burnings in oak groves contribute to ecosystem functioning, it is disputable as to whether e.g., maize agricultural practices hinder or harm ecosystems. It is clear that they are harmful in monocultural contexts, but less

obvious when maize is grown in polycultural agricultural contexts (e.g., as when it's grown alongside bean and squash varietals, as was common in Iroquois agricultural society) (Mohlenhoff and Codding, 2017).

14 I here use this term to refer to the idea that wildness falls along a continuous spectrum.

15 There are some very intriguing cases that are neither clearly toxic, nor synergistic. These include sulphuric environments that are only habitable by tardigrades ("water bears") and other extremophiles.

16 I have chosen to employ the word 'wild', as it implies the true claims that (i) humans are animals, and (ii) that animals fare best (that is, flourish) when they exist in cooperative ecological harmony with their broader environment (and the various species that dwell therein). One interesting upshot of this definition is that invasive species—including e.g., *Carpobrotus edulis*, the iceplant—do not qualify as genuinely wild, as their presence within an ecosystem is inherently problematic, disruptive, and fails to contribute to collective wellbeing. Invasive species are, by contrast, inherently *toxi*c.

17 That is, wildness regions at night.

18 By reference to the existent urban planning, engineering, and astronomical literature.

19 Focusing on a particular case—the creation of Yellowstone National Park in the United States—will go some way toward illuminating this claim. Yellowstone, established in 1872 by President Ulysses S. Grant, constitutes America's first National Park. Prior to its establishment, the geographic area that it currently comprises was occupied by Bannock, Crow, Shoshone, and Sheep Eater peoples. Each gained their sustenance by hunting game animals that occupied the region

and engaged in fire ecological practices that helped maintain the integrity of local ecosystems (by, for example, increasing overall ecosystem resilience and mitigating the destructive effects of wildfires) (Reinhardt et al., 2008). The interaction between indigenous populations and the lands that they occupied was thus dynamic, interwoven, and interdependent.

Contrary to this braided ecological picture, the American environmentalist worldview that gained prevalence in the late 1800s drew a sharp dichotomy between humankind, on the one hand, and the natural world, on the other. John Muir and his contemporaries, for example, (beautifully though dangerously) proposed that the conservation of truly wild spaces requires the absence of human interference. As Muir's influence in environmentalist circles was widespread (due, in part, to the popularity of his newly established Sierra Club), it therefore became commonplace to define wilderness as, "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain" (Wilderness Act, 1964; emphasis my own). In sum, wilderness areas were conceived of as being ecological regions that lack any anthropogenic (i.e., human) influences. This definition was later then utilized to (badly) justify the abhorrent displacement of the indigenous people from their ancestral homes.

20 Gaston et al. define sky glow as, "the increased night sky brightness that is produced by upwardly emitted and reflected electric light being scattered by water, dust and gas molecules in the atmosphere" (2012: 1257)

21 https://www.nps.gov/cany/learn/nature/nightskyteam.htm

22 At least, along this particular metric of anthropogenic toxicity—light pollution.

23 Over-illumination is yielded by light clutter, light trespass, high intensity bulbs, bright, white lighting, and (as previously mentioned) encroaching sky-glow. Light

clutter refers to the over-abundance of lighting that is emitted by sources that are closely grouped together, while trespass is defined as lighting that directly affects an area that was not originally intended as a target for illumination (for example, street lampposts that directly illuminate suburban homes). The primary sources of over-illumination in city and suburban environments include street lights, advertisements, vehicular lighting (e.g., high beams), domestic lighting fixtures, and architectural lighting accents.

24 the International Energy Agency (2006) estimates that the devices employed to light streets waste approximately 114 Twh of energy per annum.

25 http://www.flagstaffdarkskies.org/low-pressure-sodium-lighting/

26 https://www.nytimes.com/2006/12/23/world/europe/23jousse.html

27 https://conservationcorridor.org/2020/09/ten-percent-of-the-global-protected-area-network-is-connected/

28 https://e360.yale.edu/features/habitat-on-the-edges-making-room-for-wildlife-in-an-urbanized-world

https://conservationcorridor.org

https://conbio.onlinelibrary.wiley.com/doi/abs/10.1111/j.1523-1739.1998.98036.x?deniedAccessCustomisedMessage=&userIsAuthenticated=false

Haddad's Conservation Corridor Project is dedicated to research on and advocacy in favor of connected corridors as an effective means to preserve biodiversity.

29 Who instated dark zones in Rennes, France.

30 Buildings located within flight paths, of course, ought to be strategically illuminated. However, bright illumination at buildings's summits should be

restricted to those that fall within high-traffic aerial zones.

31 Note that these dark zones are importantly different from wildlife corridors, which—by contrast—do not promote human engagement.

32 The scaffolding for these coalitions can be built by referencing the work of Buck, Hilding Neilson, Robert Cockcroft, Annette Lee, and Andrew Judge (Boutsalis 2020). Buck—who serves as science facilitator at the Manitoba First Nations Education Center—has developed a set of educational curricula, which combine scientific, astronomical research with Opaskwayak, Anishinaabe, Inuit, and other indigenous astronomical understandings. Neilson (Mi'kmaq) has worked to assemble a set of resources for educators that center Indigenous Star Stories. Robert Cockcroft has created a Two-Eyed Seeing and Astronomy course, co-developed with Andrew Judge and astrophysicist and director of the Native Skywatchers research and programming initiative, Annette Lee (Ojibwe and Lakota). Furthermore, the first International Indigenous Star Conference (Canada) was slated to meet in 2020, though their first meeting was postponed due to due to COVID-19.

33 I am here using the term 'synthetic' in a bit of an anomalous way, to mark the distinction between human artifacts, on the one hand, and naturally-occurring biota (e.g., mushrooms and fungi), on the other.

34 Under ordinary conditions, these bioluminescent bacteria grow on the tentacles of octopi.

35 www.wired.com/2015/01/lamp-whose-light-comes-bioluminescent-bacteria/

http://teresavandongen.com/Ambio

36 http://jolingroup.com/environmentally-friendly-glow-in-the-dark-paints/

37 "When change is easy, the need for it cannot be foreseen; when the need for

change is apparent, change has become expensive, difficult and time consuming" (Collingridge 1980).

38 Admittedly, we are veiled by a bit of epistemic darkness. There may be other potential (negative) effects of implementing bioluminescent technologies, of which we cannot currently conceive. However, worries pertaining to epistemic blindness are applicable to technological innovations more generally; that is, this concern is not unique to the implementation of biomimetic luminescence per se.

39 Silicone can be utilized to produce high-quality and long-lasting paints.

40 As she notes when stating that, "too few in the light-pollution science and conservation communities have paid adequate attention to vital social justice issues including the benefits of artificial lighting and the ways in which darkness can index low standards of living, even dire poverty" (322-323).

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Further reading