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Original Article

Aesthetics in Biodiversity Conservation

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ABSTRACT

Biodiversity loss is an immense ecological crisis of our time. But while "biodiversity" has become a buzzword in media and policy, conservationists have found it difficult to build a common understanding on the nature and severity of biodiversity loss and the means to tackle it. Perhaps surprisingly, many biologists and philosophers have proposed that biodiversity might be best defended with reference to its aesthetic value. This article explores whether aesthetic values could provide strong support for biodiversity conservation. By exploring the question from the viewpoints of species diversity, ecosystem diversity, and genetic diversity, we argue that there is a mismatch between apparent and real biodiversity and that aesthetics can, at best, give only limited support for biodiversity conservation.

I. INTRODUCTION

Ongoing biodiversity loss is a severe crisis and poses a threat to life on Earth. Anthropogenic degradation of biodiversity has many forms, from declining local populations and loss of their genetic diversity, which can lead to extirpation of local populations, to extinction of species everywhere, and from disruption and fragmentation of ecosystems, to their wholesale extermination. These changes are happening everywhere at an overwhelming speed. The causes are many and vary between places.[1]

Although "biodiversity" has become a buzzword in media and policymaking, conservationists consider biodiversity loss an environmental problem that is more difficult for laypeople to understand than climate change. Whereas the central concepts of, and processes related to, global climate change, such as "global mean temperature" and "the greenhouse effect," are relatively comprehensible, and many of its effects, such as droughts, directly observable, it has proven more difficult to build a shared understanding of the nature and severity of biodiversity loss and the means to tackle it.[2] Quantification of biodiversity—most of which has not been described, identified, or mapped—and the estimation of the probabilities of known species becoming extinct appear as endeavors that are unconnected from people's everyday lives. The gradual and silent disappearance of species may seem implausible when nature, after all, supports human societies and continues to fulfill people's needs. Indeed, one of the major questions in conservation today is how to increase public awareness of biodiversity loss and the value of biodiversity.[3] This concern is even shared by investment and finance companies that seek new business opportunities that would support environmentally sustainable development.[4]

Somewhat surprisingly, many biologists and philosophers have advanced the claim that biodiversity might be best defended with reference to its *aesthetic* value, as beauty and related values allegedly have an immense appeal for humans.[5] The philosopher Bryan G. Norton, for one, submits that "nobody can deny the aesthetic benefits of a diverse and multi-textured environment" and that "[t]he human spirit seems to crave diversity and natural settings" (1986, 128–29), while the biologist Edward O. Wilson writes that "[w]e sense but do not fully understand what the highly diverse natural world means to our aesthetic pleasure and mental well-being" (1996, 197).

The biologists Reed Noss and Allen Cooperrider, for their part, assume that "[p]robably most people who care about the environment are motivated primarily by their personal appreciation of

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nature's beauty" (1994, 21). In like manner, the ecologist David L. Stokes states that "aesthetic appeal is one of the strongest potential motivations for conserving biodiversity" (2007, 368). Even more, in his pioneering essay "What is Conservation Biology?", the biologist Michael E. Soulé suggests that one of his normative principles for conservation biology—that "Diversity of organisms is good"—might be of aesthetic origin: "In general, humans enjoy variety. We can never know with certainty whether this is based on avoiding tedium and boredom or something else, but it may be as close to a universal norm as we can come" (1985, 730).[6]

In turn, the philosopher Alan Carter asserts that "regardless of what other justifications there might be for avoiding further depletion of biodiversity, there *are* aesthetic reasons for the preservation of species" (Carter 2010, 74–75, emphasis in original). According to another philosopher, Jennifer Welchman, "[t]o substantially diminish the array of aesthetically distinctive species and eco-systems current and future citizens have available to them would thus diminish their opportunities to lead fully flourishing lives" (2020, 8).[7]

In philosophical aesthetics, the beauty of an ecosystem is often linked with its diversity. Holmes Rolston III, for one, proposes that "[b]iodiversity enriches the landscapes on which humans reside; people enjoy variety in wildlife and wildflowers" (2001, 404). Correspondingly, Emily Brady maintains that "[b]iodiversity is considered desirable for healthy ecosystems and more diverse species [communities] often contribute to the aesthetic appeal of an environment" (2006, 284–85). Brady even claims that aesthetics "forms the basis of all other environmental values, such as valuing biodiversity or respecting the life of a species" (2003, 224–25). Further, many environmental philosophers think that finding something aesthetically valuable leads to a moral obligation to preserve it (for a comprehensive view of the topic, see Carlson and Lintott 2008).

Looks matter, and environmental organizations tend to capitalize on cuteness and charisma. But while aesthetic attractiveness might predict the survival of a species, it may also be a threat, as in wildlife trade (see, e.g., Stokes 2007; Frynta et al. 2010; Brambilla et al. 2013; Tribot et al. 2018; Senior et al. 2022; van Tongeren et al. 2023). For this reason, conservation scientists are eager to learn about humans' aesthetic preferences and how speciesist tendencies, for instance, might set challenges for environmental conservation. Aesthetic preferences affect scientific research as well: colorful tropical frogs, for example, have been extensively studied when compared to species groups that are perceived less attractive, such as tropical insects, and there has recently been interest in biology to acknowledge and study those biases (see, e.g., Lišková and Frynta 2013; Graves et al. 2017; Troudet et al. 2017; Bellwood et al. 2020; Adamo et al. 2021).

This article explores whether aesthetic values could provide support for biodiversity conservation.[8] By juxtaposing philosophical views on the aesthetic appreciation of nature with basic notions and principles of conservation science, we aim to show difficulties with the aesthetic appreciation of biological diversity as we are able to conceive it. Specifically, we attempt to demonstrate that there is a mismatch between *apparent* and *real* biodiversity; that people's direct observation and perception of biological variation—as in their aesthetic experiences of nature—is different from actual existing biodiversity, which is evaluated in scientific terms. Furthermore, we will show that such evaluation is arduous and, further, that biodiversity is a very complex concept that comprises many different aspects. Although we argue that aesthetics can only give limited support for biodiversity conservation—and in some cases, it may even hamper conservationist practices—we conclude that the aesthetic and spiritual values of nature are important and need to be acknowledged in protecting broader biocultural or socioecological diversity.

II. THE AESTHETIC APPRECIATION OF BIODIVERSITY

II.A. Object, Theory, Evaluation

What would be the object of aesthetic appreciation of biodiversity? In the classic ecological definition, biodiversity "refers to all aspects of variety in the living world" and "may be used to describe the number of species, the amount of genetic variation or the number of community types present in an area" (Begon et al. 2021, G-2). In this article, we will rely on this standard triadic conception of biodiversity and explore its aesthetic value from the viewpoints of *species*, *ecosystems*, and *genes*.

Assuming that we consider biodiversity in ecological terms, as *biological* diversity, it is expected that its appreciation requires some knowledge about nature, including capabilities to differentiate between species and observe them and their habitats. While there are no explicit philosophical theories of the aesthetic appreciation of biodiversity, there are philosophical positions which hold that the aesthetic appreciation of nature ought to be scientifically informed. Nevertheless, there are differences among these "cognitivist" views as to how they consider the relation between sense perception and scientific knowledge in aesthetic appreciation, as will be shown.

For Allen Carlson (2000, 11–12, 49–51, 63–68), aesthetic appreciation of nature *requires* scientific understanding to deepen what is presented to the senses. According to Carlson, the core of cognitivist accounts consists of "knowledge of why the object of our aesthetic appreciation, which is presented to our senses directly, presents itself to our senses as it does" (2018, 404). In Carlson's (2000, 61–62, 64, 90) view, natural objects and environments ought to be aesthetically judged in correct, namely, biological and geological, categories. Thus, he argues that the aesthetic evaluation of an object such as a wildflower or a basking gator "may involve explaining it and judging it in terms of what it is, placing it within its natural category, its species, genus, etc., locating it in its natural history and in its environmental milieu" (79). Similarly, Glenn Parsons (2006, 166–69) holds that appropriate aesthetic appreciation is appreciation of the—theoretically laden—sensuous.[9]

A further matter is whether aesthetic values may provide a strong rationale for conservation: not only would they need to guide conservation decision-making, but aesthetic conservation ought to also be competitive with other forms of land use. Now, the environmentalist Norman Myers, for one, has argued that all organisms are "complex and interesting" and exhibit equal beauty (1979, 45), whereas the biologists Paul R. Ehrlich and Anne H. Ehrlich have asserted that all organisms "exhibit the beauty of design," so that each species of insects, for instance, "dwarfs in interest and intricacy works like the *Mona Lisa*" (1992, 220). Parsons also states that one will grasp "the essential and universal beauty of nature" when one perceives natural objects "using those scientific categories that maximize their aesthetic merit" (2002, 294–95).

The view that all or at least the vast majority of untrammeled nature is beautiful—the idea known as positive aesthetics—is appealing, and we sympathize with it. Actually, we believe that all species are valuable in themselves and that people ought to defend their wellbeing without demanding a further payoff, such as aesthetic enjoyment or some other hedonistic pleasure, for it. But we are too familiar with the murky world of environmental administration and know the limits of conservation practices. It is estimated that *roughly hundreds of species go extinct every week, most of which remain unknown to us.*[10] From a practical conservationist viewpoint, not all species or ecosystems can be saved; conservation needs priorities. If aesthetics does not discriminate between more and less valuable objects and places, it cannot contribute to setting conservation priorities (see Sarkar 2005, 180; Hettinger 2010, 118n9; Parsons 2023, Chap. 9.4). Thus, in order for scientific cognitivism to connect "aesthetic appreciation, ecological science, and preservation," as Sheila Lintott and Allen Carlson (2014, 133) propose, it must provide criteria for selecting what will be saved and what will not. In what follows, we will examine the prospects of aesthetics in the conservation of species, ecosystems, and genetic variety.

II.B. The Diversity of Species

The most recognizable and most commonly understood element of biodiversity is the variety of species, often termed as "species richness" in ecology. Nonetheless, even at the level of species, sensory perception gives people a very limited view of the natural world. Moreover, perception is biased and culturally laden: people tend to pay most attention to charismatic animals, such as mammals and birds, or to species they see commonly, such as certain trees. In social conservation sciences, the alleged Western ignorance of the vegetal world has been approached in terms of "plant blindness" and "plant awareness disparity," for example.

In general, laypeople do not recognize species or distinguish between them. One could think of the blues (*Polyommatinae*), a subfamily of gossamer-winged butterflies (*Lycaenidae*); or eyebright (*Euphrasia*) flowering plants; or hawkweed (*Hieracium*), a genus of *Asteraceae* family. All these taxonomic groups include many species that are indistinguishable to the untrained eye. In fact, there are groups in which even taxonomists struggle to differentiate species from each other, and new molecular

methods have revealed that the actual genetic lineages may contradict traditional trait-based species identification. For instance, there are lots of morphologically indistinguishable species in the order of beetles (*Coleoptera*), which contain nearly 400,000 known species.

Beetles represent species diversity well, since they are the most species-rich insect group, and most of the species known to science are insects. For humans, these species are mostly invisible or unnoticeable. For example, in tropical rainforests, the biodiversity hotspots, significant amounts of insects live in the tree canopy where they are difficult for scientists to reach—the entomologist Terry Erwin discovered them in the 1980s by fogging insecticide on a tree canopy and collecting the fallen insects from sheets on the ground. When encountered, insects are commonly considered unattractive, or even as an obvious harm, as with mosquitos (butterflies constitute an exception within insects regarding both their perception and valuation). The vast majority of species—a mathematically derived rough estimation being over 80 percent of 8.7 million (±1.3 million SE)—are yet unknown to science (Mora et al. 2011), and many of them will go extinct without people knowing them.

At the same time, it seems indisputable that humans appreciate diversity and variety in their environment. For instance, empirical approaches have attempted to demonstrate that humans favor biologically diverse environments (typically conceived as species-rich environments in the studies). Empirical studies suggest that (plant) species diversity and (some) structural diversity correlate with aesthetic attractiveness—if there is not *too much* complexity (see, e.g., Lindemann-Matthies, Junge, and Matthies 2010; Hedblom et al. 2014; Tribot et al. 2016; Southon et al. 2017; Hoyle, Hitchmough, and Jorgensen 2017; Tribot et al. 2019; cf. Dallimer et al. 2012).[11] The biologist Gordon H. Orians contends that aesthetically valuable environments manifest "intermediate levels of biological complexity," for "[s]cenes of environments that contain a jumble of plants of many species receive low scores in psychological tests [on landscape preferences]" (2013, 43). People cannot distinguish all visible or audible species; perception is limited and oriented. Too many stimuli make an environment chaotic and disturbing.[12]

Empirical studies on biodiversity perception and appreciation suggest that people tend to pay attention to visual diversity (color, form, structure) over nuanced differences in species diversity (Graves, Pearson, and Turner 2017; Hoyle et al. 2018; Tribot, Deter, and Mouquet 2018; Santangeli et al. 2023). The studies also indicate that laypeople fare better in perceiving species richness (so-called α-diversity) accurately than other species-level biodiversity measures, such as species evenness and species turnover (so-called β-diversity) (see Breitschopf and Bråthen 2023). Whereas species richness can be directly observed as the number of species in a given location, evenness and turnover require deeper analysis of such observations. These characteristics are important ecologically, as evenness draws from the relative abundances of species in a location, describing whether there are a few species that dominate over others, and turnover describes how the species composition changes over time. Moreover, studies demonstrate that people's ability to perceive species richness varies across taxonomic groups (see Fuller et al. 2007).[13]

From a conservationist point of view, species richness is often used as an indicator for an ecologically valuable or "healthy" environment based on the premise of protecting biodiversity. The reasoning behind equating species diversity with ecosystem "vitality" or "health" often relies on a misunderstanding of resilience thinking, which postulates that biodiversity is crucial for the long-term capacity of ecosystems to adapt to environmental change while continuing their normal functions (Oliver et al. 2015).[14] In the simplest form, the interpretation is that the more species an ecosystem hosts, the more reserve there is against detrimental changes.

However, both practice and ecological theory challenge this assumption, since the *kind* of species present in an ecosystem matters more than their number. Maximizing the number of species present in a given locality will not necessarily promote the aim of biodiversity conservation. Nor can it be assumed that the species present are always the desirable ones (e.g., native vs. invasive species). A clear-cutting of an old-growth forest certainly increases the number of pioneering open-land species, while the old forest species disappear, and sometimes the highest species richness is observed in the transitional phase from forest to open land, when the species composition is turning over in between two different habitats.[15]

Further, as the climate changes, many species are on the move. When local endemic species decline and eventually become replaced by newcomers (that generally are common elsewhere), often

the number of species increases in that place, but the change is not the kind a conservationist could salute. Confusingly, local *gains* in species richness are observed in many places, while globally biodiversity is decreasing: climate change has increased butterfly species richness in southern regions of Fennoscandia, for instance.

Biodiversity conservation has long been focused on preserving rare and threatened species that are considered at risk of extinction; conservationism is about protecting species from human-induced extinction and maintaining natural habitats, and understandably, it prioritizes taxa at the highest extinction risk. Again, both biologists and philosophers have proposed that rare species could be defended aesthetically. For instance, in *The Diversity of Life*, Edward O. Wilson writes: "No one looks twice at a sparrow or squirrel, or even once at a dandelion, but a peregrine falcon or mountain lion is a lifetime experience. And not just because of their size (think of a cow) or ferocity (think of a house cat), but because they are rare" (1993, 36). Similarly, Orians assumes that people are aesthetically fascinated by "rare species, individuals outside the normal range of the species, or individuals present at unusual times of the year or in unusual habitats" (2013, 43).

Some philosophers have drawn analogues from the art world (see, e.g., Sagoff 1974; Russow 1981; for criticism of the analogues and the rarity argument, see Gunn 1980; Godlovitch 1989; Newman, Varner, and Linquist 2017; see also Loftis 2003). The philosopher Elliott Sober, for one, claims that "[a] work of art may have enhanced value simply because there are very few other works by the same artist, or from the same historical period, or in the same style" (1986, 190). Sober proposes that as aesthetic objects, "rare organisms may be valuable because they are rare" (190). As he sees it, the conservationists' concern in species preservation is best understood as aesthetic in nature.

There are several problems with this line of thought, however. To begin with, it might be reasonable to make a distinction between rarity in terms of population size and rarity in terms of perception, as in rare sights. Some relatively common species—or nocturnal animals in general—might not be perceived often, while some populations of a rare species might be a tourist attraction and visited by millions yearly. Overall, people's encounters with a species do not reliably reflect the state of its global population. The level of endangerment, or threat status, is estimated in terms of the probability of a species going extinct within a specific time frame, usually ten years or three generations (IUCN 2022). Estimating a species' extinction risk requires scientific mapping and monitoring of the species' abundance: data that is reliable, comparable, and up-to-date.

Accordingly, the decline in biodiversity is grasped by analyzing long-term monitoring and statistical data over multiple taxa. Unfortunately, there is only enough data available to assess the extinction risk for as little as about 7% of all known species. Within this group, most of the threatened species are flowering plants (over 25,300 species threatened out of 64,200 assessed species). The highest-ranking animals are fishes (nearly 3,800 threatened species out of 27,000 assessed species). These numbers do not represent global biodiversity well, though, since data availability is strongly biased towards certain taxonomic groups. For instance, considering that there are over a million known insect species on Earth, only 1.2% of them have been assessed, with less than 2,400 insect species considered as threatened (IUCN 2023).[16] A problem is that if conservationists would begin to give attention to species only when they are *known* to be globally endangered, the prospects of the survival of the species might be poor. For this reason, conservation aims to act in advance and prevent species endangerment.

Notwithstanding, from the viewpoint of an ecosystem, it is common species that typically matter the most, since they form the biotic backbone of the species community. Due to a small number of individuals, a rare species might play a minor ecological role (unless they are predators located at the top of the food chain). Here, we enter the realm of "functional diversity," which denotes "those components of biodiversity that influence how an ecosystem operates or functions" (Tilman 2001). Not all organisms have equal impact on their biotic companions and abiotic living environments; some of them drive the basic ecosystem functions such as primary production and decomposition, while others enjoy the ride from the backseat. Ecosystems are dynamic, and as long as the basic functions that keep the nutrients cycling and energy flowing continue, the structural organization of an ecosystem can be flexible, that is, the relative abundance of species—and to some extent even the species composition—conducting such functions can fluctuate. Within an ecosystem, some species have greater influence, while other species are irrelevant or replaceable in terms of the functioning of the system. If a species does not form interdependent interactions with others or otherwise significantly

influence the shared living environment, its extinction would not much affect the ecosystem in its current state.[17]

In some cases, aesthetic attractiveness goes hand in hand with ecological value, as with the mentioned predators or, say, coast redwood (*Sequoia sempervirens*) in the West Coast of the United States.[18] In such cases, these keystone species (species that have a large effect on the ecosystem) may make great flagships for conservation. As umbrella species, their protection indirectly protects many other species that share the same habitat. But iconic cases aside, it seems that human evaluation of the aesthetic attractiveness of a species and its importance for the broader ecosystem are only weakly connected (see Stokes 2007; Graves, Pearson, and Turner 2017).[19] It is also open to debate whether it is worth using scarce conservation resources to protect a species whose population is so small that it is unlikely for it to survive.

Moreover, public attention might not always be helpful. The ecologist Franck Courchamp and his colleagues (2018) note that many *charismatic animals* are at high risk of extinction in the wild. Researchers draw attention to rare charismatic animals' omnipresence in Western culture—from toys to books and screens—and the gap between virtual and real populations, hypothesizing that the profusion of tigers, lions, elephants, giraffes, and the like in the collective mental landscape might impair conservation efforts. Conversely, in the age of social media and mass tourism, people's desire to see a species in its habitat is potentially harmful, as in amateur photographers disturbing bird nesting. For this reason, out of conservationist concern, sometimes local populations of critically endangered species are not disclosed to the public.[20]

While the rare fascinates, and knowledge of the rarity of a species (or an event) might influence one's aesthetic experience, it is not quite clear in what sense rarity is an aesthetic value and how extensively it explains people's aesthetic interests in the animal and plant kingdoms (see Godlovitch 1989, 176). It is disputable how knowledge of the rarity of an insect species, for instance, would affect its aesthetic value (see Rolston 2001, 412). Besides rarity perhaps, people's aesthetic interest is often focused on the unusual and extraordinary. The aesthetic admiration of the plant and animal kingdoms is typically directed at particulars, distinctiveness, and uniqueness.[21] The empirical studies cited earlier suggest that in scenic appreciation, for instance, laypeople tend to pay attention to individual, eye-catching species and clearly distinctive features of an environment, whereas people trained in ecology notice structural matters, such as transition areas between two ecosystems (e.g., forest and grassland).

That people conceive species in terms of individuals and not as populations is a major obstacle for the common understanding of biodiversity. An observation of a species—its representative—in a certain locale is not yet telling of the condition of the population (nor the habitat). At the level of species, aesthetic appreciation and conservation overlap only partially, and in many cases, pull in opposite directions. Moreover, biodiversity conservation is not limited to species preservation, but is also about securing ecosystem integrity, connections between ecosystems, ecosystem sizes, and their resilience. As Sahotra Sarkar (2002, 134–35) puts it, biodiversity is rooted in *places* and biodiversity conservation should target places; yet, while all places contain biodiversity, not all places can be conserved. Nevertheless, prioritizations must again be made.

II.C. Ecosystem Diversity

In ecology, "gamma diversity" (γ-diversity) is used to denote the overall biodiversity within a given region or geographic area. Typically, gamma diversity is defined through examining the variation in species distributions and community structures across a landscape consisting of multiple ecosystems, and therefore, it is also termed as "ecosystem diversity." Looking at the landscape forces one to see beyond individual species; to observe the interrelatedness of the ecological components and note the web of life they form as a whole. In terms of gamma diversity, species richness is not a value per se, but the variation among ecosystems is what matters.

At this level, many philosophers and scholars in other disciplines have noted discrepancies between aesthetic preferences and ecological values. To give some examples: Paul Gobster and his colleagues hold that "ecologically healthy landscapes" might not be considered aesthetically attractive; for example, people deem wetlands and prairies unattractive and do not grasp their biological diversity (2007, 962). Orians points out that European and Japanese garden traditions "are based on just a few species of woody

plants" and that the garden preferences of landscape designers and botanists diverge, the former considering the latters' ideal "cluttered" (2013, 43). Yuriko Saito has studied instances of beauty in "unscenic nature" and perspicuously illustrated the mismatch between sense perception and knowledge, suggesting, however, that knowledge and/or physical distancing might help us to overcome some of the seeming ugliness in nature (1998b, 104–6). Arnold Berleant, for his part, thinks that aesthetic delight and knowledge of ecosystem health contradict each other in "the effluvium of a festering bog" (2016, 133). Conversely, traditional rural landscapes evolved in areas with long-term agroecological practices are often praised for their cultural values, not acknowledging that many of them represent rare ecosystems with immense biological diversity that often surpasses that of a "wild" place.[22]

As for ecosystems, some of the cognitivist theories suggest that the appreciator transcend the realm of perception. Rolston proposes that one ought to "appreciate what is not evident," for the beauty of an ecosystem is a matter of insight rather than sight (Rolston 1988, 239, 241). He asserts that "[i]n many of life's richest aesthetic experiences there is nothing to put on canvas, nothing to take snapshots of" (241). Elsewhere, he writes that "[w]e must enter into an appreciation of what the marsh ecosystem is in itself, when we are not there" (2000, 593). Likewise, J. Baird Callicott states that ecological aesthetic pleasure is ultimately based on an understanding of the scientific functioning of an ecosystem (Callicott 1994), which allows one to see beauty in things that "are not literally pleasurable or sensuously delightful" (Callicott 2003, 42). Such beauty lies in grasping the connections between the living components of the ecosystem and the functioning of the overarching whole. Callicott goes so far as to claim that the "experience of a marsh, bog, or swamp is aesthetically satisfying less for what is literally sensed than for what is known or schematically imagined of their ecologies" (2003, 44).

These views have been criticized for making sensory experience irrelevant in aesthetics and for rendering the beauty of an ecosystem in a highly conceptual way, beyond the reach of an ordinary experience (see, e.g., Saito 1998b, 104) and for confusing the aesthetic and scientific stances and reducing aesthetic experiences of nature to a conceptual understanding (see, e.g., Berleant 2016, 134). We sympathize with the idea of seeing value in all ecosystems; yet, we are not sure to what extent this fascination is principally *aesthetic*, instead of intellectual, spiritual, or moral. And to repeat: it has been noted that if all nature is beautiful in the eyes of a scientifically informed person, as in positive aesthetics, beauty can no longer function as a criterion in conservation decisions (see, e.g., Linquist 2020, 5–6).

In our view, ecology and aesthetics impose different spatial and temporal scales on the assessment of an environment. Biodiversity, for example, is not an object but a characteristic of nature, and understanding it requires knowledge of natural entities and processes together with scientific assessment, which, we argue, does not fit well in aesthetic experience. Certainly, the appreciation of biodiversity must acknowledge destructive instances like forest fires, which are required for ecosystem regeneration and which produce the sort of temporary ugliness as recognized by the ecological aestheticians mentioned above (see also Eaton 2007; for a recent look at the matter, see Prior and Brady 2017).

Further, an understanding of biodiversity decrease or loss requires *comparison* that takes the natural dynamism of ecosystems into account. For this purpose, The International Union for the Conservation of Nature (IUCN) uses different time frames for assessing changes in ecosystems; one of them defines the historical reference year (1750), which approximately corresponds to the earliest onset of industrial exploitation of ecosystems (Bland et al. 2017). In addition, the present state of an ecosystem is compared to future forecasts and the observed and predicted development around the present. This is required because ecosystem change is difficult to quantify, and slow incremental changes are hard to perceive. As for the human lifeworld and aesthetic engagement with nature, research on *shifting baseline* addresses the difficulty in the perception of environmental change and the generational redefinition of the "normal" and the "natural" (for the shifting baseline syndrome in the aesthetic appreciation of natural environments, see Mikkonen 2022).

The decline of ecosystems is tied to increasing risk of species extinction. Yet, extinctions, too, may be approached with different timescales. From the ecological perspective, extinctions are inevitable. As Soulé puts it, in conservation biology "[n]atural extinction is thought to be either value free or good because it is part of the process of replacing less well-adapted gene pools with better adapted ones" (1985, 730). Nevertheless, he adds that natural extinctions occur at a slow pace on a human timescale, whereas the rate of anthropogenic extinctions seems to be growing exponentially. Current estimates of global extinction rate are about 1,000 times higher than would be expected if only natural

extinctions took place (Pimm et al. 2014). The magnitude of human impact is immense and incomprehensible. In contrast, everyday human perspective supposedly typically extends maximally to three generations, and it is in this time frame that humans preserve things they value to please themselves and those who follow them.[23] Such a short temporal focus is highly problematic when aiming to preserve evolutionary lineages.

Carlson has consistently argued that ecology and aesthetics must go hand in hand in appreciating natural environments. He maintains that in the aesthetic appreciation of natural environments, common-sensical and scientific knowledge "yields appropriate boundaries of appreciation, particular foci of aesthetic significance, and relevant acts of aspection" (Carlson 2008, 127; see also Carlson 2000, 49). This way, he thinks, scientific cognitivism may provide aesthetic appreciation a degree of objectivity that is required in environmental conservation, for instance (see Carlson 2018, 405; Carlson 2000, 12, 51). As we see it, however, the idea of the natural sciences objectively carving nature at its joints is not credible either from the viewpoint of philosophy of science or the biological sciences. In this, we join those who argue that natural sciences provide neither the what nor the how of aesthetic appreciation of nature (for recent critiques, see Newman, Varner, and Linquist 2017, chap. 11 and Welchman 2018, 423).

It is important to note that there is no universal metric or methodology for assessing biodiversity. Instead, conceptions of biodiversity are grounded in several theories, and once a suitable index or indicator is chosen, its application is inevitably context- and place-specific. The classic conception of biodiversity that operates at the levels of species, ecosystems, and genes has laid the ground for newer, quantifiable approaches to biodiversity that measure "taxonomic diversity" (the richness and abundance of species present at a site), "phylogenetic diversity" (evolutionary uniqueness within a species group), or "functional diversity" (the range of species' ecological roles in a given ecosystem). As might be expected, each approach has its pros and cons, with mathematically elaborated indices being increasingly apt in a narrow ecological sense, yet less intuitive for laypeople.

Biodiversity is also place-bound. Species communities, food webs, topography, regional flows of energy, and cycles of matter are always linked to a location.[24] Adaptation to the local conditions is what drives evolution and increases the variation in between ecosystems, and the dynamism of the ecosystems is always a result of its components, biotic and abiotic structures and functions, all of which are more or less spatial. Biodiversity assessment requires an understanding of this uniqueness that grows from ecosystemic complexity and spatio-temporal dynamism.

Biodiversity is approached differently in research, administration, and conservation, and even ecologists have various—sometimes conflicting—conceptions of biodiversity when studying it. The notion of *species*, for instance, is extensively disputed among biologists (for a philosophical overview of the matter, see Ereshefsky 2022). The evolutionary biologists Sean Stankowski and Mark Ravinet empirically studied researchers' species concepts and found out that "two randomly chosen respondents will most likely disagree on the nature of species" (2021, 428). They propose that "concept diversity can instead be viewed as a strength because it allows us to see biodiversity from different perspectives"—and recount the parable of the blind men and an elephant (429).

Within biological sciences, there are numerous aspects that may be included or excluded in defining biodiversity, depending on the matter at hand (for an overview, see Koricheva and Siipi 2004; for the complex notion of "diversity" in ecology, see also Sarkar 2010, 129).[25] Each biodiversity measure, however, captures only some element of biodiversity, and in committing to some theory and measure of biodiversity, one has already made an implicit decision as to what to conserve (see Koricheva and Siipi 2004, 37). Even if a certain level of agreement is achieved regarding the conservation status of species—as is done when the priorities are based on the extinction risk assessments—there is the problem of micro-organisms that defy people's attempts to neatly categorize sexually reproducing, multicellular eucaryotic life forms. Do other kinds of beings deserve to be conserved? Malarial *Plasmodium* species or the Ebola virus, for instance? And what about species people have tampered with: should domesticated animals or genetically engineered organisms be protected?

As Wilson sees it, a notion of biodiversity that biologists could all agree on would include "everything" (1997, 1). Or, as Bryan G. Norton remarks, the right definition of biodiversity ought to be "rich enough to capture all that we mean by, and value in, nature" (2006, 57). Some have argued

that the vagueness of "biodiversity" might conceal serious disagreement about conservation matters and might impair biodiversity conservation planning and policy-making (Meinard, Coq, and Schmid 2019; Sarkar 2002). Norton claims that the features of biodiversity "are so diverse that they cannot be made precise and measurable" (2006, 57), whereas the philosopher Carlos Santana (2014, 2019) goes further, maintaining that the concept of biodiversity ought to be eliminated from conservation science.

Finally, although biodiversity loss is a global issue—ecosystems are destroyed, populations diminish, genetic variation is lost—it is essentially not one overarching phenomenon like global climate change: there is one global climate system but an endless number of different ecosystems. Respectively, there is a plethora of causes behind biodiversity loss. As a societal, political, historical, and economic problem, biodiversity loss appears different in different places; accordingly, the potential impact of aesthetic valuations of biodiversity is context-specific and different from, say, Germany to Brazil. With regard to ecosystem diversity too, it seems that aesthetics cannot plausibly back environmentalism.

II.D. Genetic Diversity

Genetic diversity, or the variation in the inherited genomic basis of a species, is where all biological diversity originates. Intercellular genetic differences (that is, genotypes) together with the living environment determine the appearance (that is, phenotype) and fitness (the ability to survive and reproduce) of an individual. It is these individual-level differences that fuel evolution through the need to adapt, and eventually lead to diversification of life in the form of species and ecosystems. Despite the key role of genetics in biology, it seems that there is not much to be said of aesthetics-based biodiversity conservation from the viewpoint of genetic diversity.

In fact, the matter was briefly touched in the United Nations Environment Programme's influential compendium *Global Biodiversity: Status of the Earth's Living Resources*, in which the authors asserted that "because genetic diversity is not susceptible to aesthetic appreciation, aesthetic criteria can be applied only to species and ecosystem aspects of biodiversity" (1992, xviii). Likewise, Sarkar questions the aesthetic value of genetic diversity in a very telling manner:

> "What, for instance, is the property of the cryptic genetic (allelic) diversity of a population that makes it *aesthetically* valuable? Simply noting that it has transformative value is not a sufficient answer; having transformative value does not, by itself, determine whether an entity should be regarded as having ethical or aesthetic value." (Sarkar 2005, 94; emphasis in original)

At the genetic level, the difference between apparent and real biodiversity is most striking. Following James Maclaurin and Kim Sterelny, we could speak of "phenomenological species" and "evolutionary species," human beings perceiving the former: "recognizable, reidentifiable clusters of organisms" (2008, 40). What people see are phenotypes, physical and behavioral traits of an organism, whereas the genotypes consist of DNA molecules that can be made visible only through special microbiological equipment. While the genotype of an individual is unique, phenotypes can be similar to each other, since different genes can result in the same phenotypic trait. As a result, hereditary diversity is the highest when measured in terms of genetic differences, and although evolutionary selection targets the phenotypes of the individuals, it is the genes within the reproductive cells that are carried on to the next generation. It is this overall gene pool of the living population of a species that genetic diversity is measured from, and as population numbers can change rapidly, so can the variation in the gene pool. However, genetic change typically leads only towards decreasing diversity, as new forms of genes (alleles) emerge only through slow and random process of mutation and they rarely bring forth adaptive benefit in terms of increased fitness; thus, the selective forces of evolution wipe the mutated alternatives out, leaving only the old and well-tested traits in existence.

In practice, important trade-offs are found when the impacts of conservation are compared across the different levels of biodiversity: genetic, species, and ecosystems. For example, think about the cheetah (*Acinonyx jubatus;* classified vulnerable in 2022), one of the most charismatic species of African savannahs. Due to rapid population decline, the genetic diversity of the remaining cheetah is extremely low. The level of inbreeding is so severe that it affects the health of individual cheetahs and

makes their populations prone to suffer from environmental changes, as the lack of genetic diversity equals poor ability to adapt.

If cheetah conservation were to be pursued to preserve genetic diversity, it would be built on systematic captive breeding, rearing and translocation of individuals, and artificial insemination. Yet people do not want to see cheetahs in captivity. They instead want to see them running wild and free in their natural habitat, and indeed they are conserved as part of savannah ecosystems, playing their part as a top predator. Setting conservation priorities based on ecosystem or species diversity appears more reasonable when compared to genetic diversity. After all, each species, and each individual of a species, is genetically unique: are they not of equal value?[26]

III. PLURALITY OF DIVERSITIES

III.A. Beyond the Biotic

Biodiversity has proved a good rallying cry. Supposedly, the reason for the term's success is its inclusiveness and flexibility. As the philosophers Nicolae Morar, Ted Toadvine, and Brendan Bohannan (2015) see it, "biodiversity" evokes and echoes earlier conservationist conceptions that had proven stimulating but are no longer in fashion. In turn, David Takacs, in his history of the term, aptly remarks: "Biodiversity has entered the dictionary, people respond to it, it works, because each of us can find in it what we cherish... What is it you most prize in the natural world? Yes, biodiversity is that, too. In biodiversity each of us finds a mirror for our most treasured natural images, our most fervent environmental concerns" (1996, 81). In addition, it has been noted that the concepts of social diversity and biodiversity were born in the same cultural context (Heyd 2010). Georg Toepfer, a philosopher of biology, writes:

> 'Biodiversity' fits very well into our pluralistic present because the concept renounces an overarching, universally valid (world) order and expresses a de-hierarchization and pluralization of perspectives. It refers to the heterogeneous interests and intrinsic worth of every single individual. With respect to human and non-human living beings the concept of diversity is successful, because it conveys respect and responsibility, tolerance and pleasure of heterogeneity. Since the 1980s, 'diversity' has become a central concept in social emancipation movements. It emphasizes cultural difference and includes a critical reflection of one's own cultural-relative standpoint. (Toepfer 2019, 343)

Walter G. Rosen, who is thought of as the originator of "biodiversity," said that the term was easy to invent, namely, just by taking the "logical" out of "biological." The neologism, Rosen said, allowed room for "emotion" and "spirit" (see Takacs 1996, 37). Now, there are many plausible ways of characterizing and classifying diversity in nature, and the framing of "biodiversity" partly depends on these. Further, different classifications may lead to cases in which global scientific values conflict with local values (see Sarkar 2019, 381–87; see also Guha 1989). Scientific taxonomies are—not only but *also*—cultural constructions. What value is to be assigned to other ways of classifying natures? What to think of diverse knowledge systems, indigenous taxonomies, and local ecological knowledge in biodiversity conservation, for instance? These classifications and knowledges *are* indeed many, as regions with high biodiversity often contain considerable cultural (linguistic) diversity (see Gorenflo et al. 2012). Cultural and social diversity also implies diversity in aesthetic values and ideals, which makes aesthetics-based conservation even trickier. Who should dictate i) what counts as nature, and ii) what nature is worth protecting?

Some have argued that biodiversity ought not to be defined solely in biotic terms, humans excluded, but it should also include socio-ecological aspects (see, e.g., Martin, McGuire, and Sullivan 2013, 125). There have been suggestions made to replace the prefix "bio" with other attributes, such as "ecological," "natural," or "biocultural" diversity, that would include human–nature interactions and abiotic nature to a varying degree. For example, the ecologist Ivan Jarić and his colleagues (2022) remark that the global biodiversity crisis is not only about biological but *societal* extinctions: it also involves the loss of experiences, collective memory, and cultural knowledge.[27] Local biodiversity is also a cultural value.

In turn, some others have advanced a notion of natural diversity that would allow room for the non-living parts of the environment and ecosystems. Shortly after the United Nations Convention on

Biodiversity (the Rio Summit) in 1992, geologists like Chris Sharples and F. W. Wiedenbein began talking about the abiotic counterpart of biodiversity, namely, geodiversity. Seeing diversity in nature as consisting of both biotic and abiotic components corresponds to a broadened definition of ecosystem diversity; one that acknowledges how bedrock and soil belong to organisms' environments, storing water and nutrients and creating microclimates, for instance, but also forming an integral part of the landscape by providing the physical foundation upon which life can flourish.[28]

III.B. Aesthetics of Diversities

As we noted in the beginning, many biologists consider the value of diversity characteristically or ultimately aesthetic. Brady has insightfully suggested that the very scientific concept of biodiversity "entails the aesthetic concepts of diversity and variety" (2006, 283). As Brady sees it, "diversity (and variety) in itself has an aesthetic meaning, and... this meaning is carried into the biological use of the term" (2006, 285). She claims that "[a]esthetic concepts and values underpin or play a role in the development of some scientific theories, as well as shaping some key scientific concepts and values, such as biodiversity and conservation" (2006, 286). The idea is intriguing and interestingly in line with Soulé's assumption, for instance.

Nevertheless, scientists' aesthetic interests in the objects of their study and their models of natural processes, for example, seem subjective and contingent; and again, it may be difficult to distinguish aesthetic interest from intellectual, spiritual, and moral domains.[29] Moreover, so many—mutually incompatible—properties may be seen as aesthetically valuable (e.g., simplicity vs. complexity, equilibrium vs. flux, harmony vs. dynamicity), and no matter what the properties of an object of scientific study, the meaning of a scientific term, or the ideals of scientific explanation are, those properties, meanings, and ideals may be rendered "aesthetic." Compared to the perception of nature as planned, organized, and unchanged that dominated in the Middle Ages, modern science has stripped away any ideals of a harmonious Garden of Eden by evidencing that nature is unbalanced and evolves mindlessly; it is raw and full of mishaps. As a matter of fact, in interviewing biologists about their aesthetic interest in biodiversity, David Takacs found out the following:

> [T]here is an aesthetic in diversity qua diversity, in the variety of stimuli diversity offers in a landscape. People are drawn to tropical rain forests, not only because we can glimpse an occasional spectacularly beautiful organism there, but also because we can see so many different kinds of beautiful organisms; and we can be overwhelmed by aesthetic appreciation of the terrifying complexity of it all. With astounding individual variety, however, comes chaos. Donald Worster warns that as ecologists have replaced a portrait of a balanced world at equilibrium with an ecology of chaos, the natural world grows harder to love. Daniel Botkin takes up this theme, noting, 'Nature that is inherently risky may seem less beautiful than nature that is completely deterministic.' He suggests we must change our ideas and aesthetics of nature to match our newly required view of nature as constant flux. But this complexity, this variety, this indeterminacy is a key part of biodiversity's aesthetic value for some biologists; they find the infinitely complex infinitely beautiful and infinitely challenging. (Takacs 1996, 274)

The natural world is certainly overwhelming; even so, humans perceive only a narrow part of it. In this article we have focused on humans' natural perceptual abilities to directly observe the biological world, arguing that such a view is very limited and biased and thus cannot guide biodiversity conservation choices reliably. However, technological equipment may help one to overcome some perceptual limitations and allow one to perceive and appreciate species that are minuscule, rare, or nocturnal, for instance. Furthermore, nature books, television documentaries, and photography exhibitions, for example, may represent parts of the natural world that many people would not otherwise know of.

But with mediation and representations come more problems—which we can only mention here. For example, whether photographic representations, for instance, actually make public attitudes favorable to neglected or disliked species and genuinely affect people's values, thought, and behavior, is an empirical question and requires empirical study. Moreover, representations such as photomicroscopic images are often aestheticized—colored or color-corrected—and appear more appealing than the unmodified images. Conversely, a photomicroscopic image of an insect might not look attractive at all;

the face of an ant, for instance, may look repulsive and the photograph could rather strengthen one's dislike for the species. Representation is also selective: who chooses which species are represented and how they are represented? And if the selection is based on biological knowledge, then it seems that science does all the hard work and aesthetics is a mere sugar-coating for the pill.

In this article, we have followed the assumption of some philosophers and biologists that diversity is an aesthetic value. But is this assumption always and necessarily correct, and if it is, how should it be understood? Do tropical rainforests, the biodiversity hotspots, provide aesthetic experiences of nature that are greater than those afforded by Siberian tundra? Such a comparison is ludicrous. First, diversity and variety in nature are related to the frame and perspective one adopts towards them. As Godlovitch puts it: "[t]here is much out there and a lot of it is simply unexceptional from whatever aesthetic perspective one would care to assume—Blake's grain of sand notwithstanding" (1989, 176). This is greatly expressed in *The Forest Unseen: A Year's Watch in Nature* (2012), in which the biologist David Haskell describes his one-year study of a one-square-meter patch of a Tennesseean old-growth forest, admiring nature through that microcosmic square. Or in the biologist Daniel Janzen's brief anecdote: "Now the thing about biodiversity is it's very complex.... I've been working in Santa Rosa [Costa Rica] for twenty years... and I can walk down the same trail I've worked down *thousands* of times and there's something new every single time" (in Takacs 1996, 274–75; emphasis in original).

Moreover, while diversity and variety surely are sources of inspiration and delight, there is aesthetic value in other, less diverse kinds of environment too, such as endless glaciers or, perhaps, an infinite landscape filled with a sole, blooming plant species. Historically, protected areas have been primarily vast metaphysical landscapes and refugia of imagination and spirituality—as well as places where human inhabitation has been excluded. Noss and Cooperrider assert that "[m]any national parks, wilderness areas, and other large reserves selected on the basis of esthetic criteria are relatively depauperate biologically.... most wilderness areas are rock and ice, or other such scenic but not particularly diverse lands" (1994, 22). Correspondingly, the ecologist Ilkka Hanski notes that

> "protected areas have been established mostly in areas where there is little competition from other forms of land use. This means that a large fraction of the current protected areas is marginal land in marginal areas, at high latitudes, at high altitudes, and on unproductive land that is not fit for anything else. Protecting these areas, and the species living in them, is valuable, but only a small part of global or national biodiversity is thereby protected" (2016, 33).

In the end, what is valuable is the diversity of species, ecosystems, landscapes as a whole—and the incredible number of perspectives humans can take on these, the room for imagination, and the possibility for one to feel connected with the web of life.

IV. CONCLUSION

In this article, we have explored the possibility of grounding biodiversity conservation on aesthetics. We have only looked at so-called cognitivist positions, ignoring the various non-cognitivist approaches that highlight the role of emotion and imagination, wonder and incomprehension, in people's aesthetic engagements with nature. On the face of it, non-cognitivist approaches seem ill-suited to the aesthetic appreciation of *biological* diversity whose assessment is, by definition, part of the cognitive domain. Further, as Carlson (2018, 404) reminds us, non-cognitive accounts allow room for subjectivity, which might be best excluded from evidence-based conservation decision-making.

Nonetheless, while the conservation of biological diversity is increasingly a scientific enterprise, it ought to better acknowledge aesthetic values that are central in humans' encounters with the natural world, and non-cognitivist approaches undeniably also contribute to conservation. For instance, while we are critical of the notion of wilderness and its status as a conservation ideal, we believe that the Edenic notion of the wild is central in the collective Western imagination and it does inspire conservation (see Stokes 2018). We think that imagination and wonder are central in people's aesthetic encounters with nature and ought to be incorporated in comprehensive socio-ecological approaches to conservation, as in the exploration and conservation of unknown biodiversity, also known as the

"dark matter of life." Hence, we side with Brady (2006, 286), who argues for the role of wonder in connecting scientific and aesthetic approaches.[30]

The collapse of biodiversity is very real, and words such as "crisis," "disaster," or "catastrophe" are simply too meek to describe it. In addition to other sorts of value, nature has aesthetic value, and biodiversity conservation would undeniably benefit from better acknowledgement of this value. In this article, we have examined aesthetics-based biodiversity conservation from the viewpoints of species diversity, ecosystem diversity, and genetic diversity. We challenge the common call in biology and philosophy to use aesthetics to increase the value of biodiversity in people's eyes as simplistic and present a counterargument that from a biological point of view, aesthetic defenses for biodiversity—as we are able to conceive them—are insufficient, sometimes misleading, and potentially harmful. The aesthetic appreciation of nature is biased according to human perception, and as such violates the premise of biodiversity as consisting of all life on Earth. However, we do not suggest abandoning the idea in totality. There are various reasons to conserve species and ecosystems and many ways to defend biodiversity from a broader aesthetic perspective.

The contemporary crises of climate change and biodiversity loss complicate the long cultural tradition of nature conservation and pose problems for environmental aesthetics. Further, the intertwining of global climate change and the biodiversity crisis makes these problems even more wicked. Although global climate change and the biodiversity crisis share the same root causes, namely human population growth and excessive use of natural resources, not all connections between them are synergistic: some actions taken to restrain climate change may reduce biodiversity, whereas some actions taken to enhance biodiversity may speed up climate change. We find no enjoyment in the skeptical conclusions we have arrived at; rather, this article is best read as a cry for help.[31]

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END NOTES

1 According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (henceforth IPBES), the leading causes of anthropogenic species loss today are "changes in land and sea use; direct exploitation of organisms; climate change; pollution; and invasion of alien species" (IPBES 2019, xvi).
2 Interestingly, modern environmental concern originated from the disappearance of visible and audible species and their threat of extinction; such change was comprehensible and mobilized people.
3 See, for instance, the Aichi Biodiversity target number one in *Global Biodiversity Outlook 5* report compiled by the Convention on Biological Diversity.
4 See, for example, the interview of Jennifer Wu at JP Morgan, https://www.esginvestor.net/the-esg-interview-a-marathon-and-a-sprint/
5 For recent expressions of this view in biology, see, for example, Tribot et al. 2016; Tribot, Deter, and Mouquet 2018; Langlois et al. 2021; Langlois et al. 2022. The aesthetic value of biological diversity is recognized in scientific reports such as *Global Biodiversity:*

Status of the Earth's Living Resources. A Report compiled by the World Conservation Monitoring Centre (1992), xviii; United Nations Environment Programme's *Global Biodiversity Assessment* report (1995); and the IPBES 2019 report. For Leopold's, Elton's, Lovejoy's, and Soulé's views of the aesthetic value of biological diversity, see Takacs (1996, 13–17, 23, 77, 97–98). For early aesthetic defenses of the protection of species and biological diversity, see Farnham (2007, 31–40, 68–71). Farnham remarks that in early 20th century conservation, "[t]o talk of protecting the aesthetic value of the plant and animal world, as Leopold and Roosevelt had attempted to do, served to link diverse interests. While no one could offer a strict definition of *aesthetic* that would cover all usages, many writers employed it to describe a kind of intangible value other than economic or scientific value, or to capture a characteristic of the human experience in nature that could not otherwise be expressed" (2007, 67–68; emphasis in original).

6 For studies of the diversity of values of today's conservation professionals, see Sandbrook et al. (2011) and (2019).

7 In an early defense of the value of biodiversity, the theologian John B. Cobb proposes that "[m]uch of our negative reaction to the destruction of species seems to stem from this sense that there are possibilities of experience forever lost" (1988, 483).

8 We will focus on people's aesthetic experiences of nature, putting aside matters such as the potential of environmental art and art–science collaborations in conservation.

9 Yuriko Saito, who defends a cognitive account other than scientific cognitivism, maintains that aesthetic experience "*begins and ends* with the sensuous surface—although... our initial reaction is subject to modifications and revisions with additional information" (Saito 1998a, 146; emphasis in original). Nevertheless, Saito thinks that some scientific information, such as that of a molecular structure of a rock, leads one away from aesthetic appreciation—"the immediate sensuous experience of nature" or "the actual experience of nature" and that such knowledge "seems too removed from our immediate perceptual arena to be realizable on the sensuous surface" (1998a, 144).

10 Given the observed biogeographical distributions and population trends of known species, patterns in global biodiversity consisting of known and unknown species can be estimated, and the extinction rates of all species can be modeled based on the assumption that species unknown to science share similar characteristics with the known species (Pimm et al. 2014).

11 We think that aesthetic valuation of nature is largely cultural and the values may change over time (as with mountains and wetlands, for example); further, we believe that one's capacity to aesthetically appreciate nature may be cultivated.

12 One should note however that species richness does not equal a profusion of noisy animals and colorful plants; a species-rich old forest, for instance, may look relatively "sparse."

13 Nevertheless, these kinds of studies often employ online surveys and (modified) still photographs. Arguably, the assessment of a visual representation of a natural environment is different from a physical experience of it: a photograph from the Amazon rainforest lacks features, such as high temperature, moisture, smells, and emotions like excitement, fear or even claustrophobia which are characteristic to the physical experience of the place, all affecting the sense-mediated perception and evaluation (see Sarkar 2005, 97). One might also expect that local communities experience these places differently than, say, Western nature tourists.

14 For problems in the concept of "ecosystem health," see Lu et al. 2015.

15 In his classic essay, Soulé remarks that many modern cities "have a greater diversity of plant families and tree species than did the original habitat destroyed to make way for the city"; nonetheless, he adds that the price for these "aesthetic benefits" are "low geographic diversity and ecological complexity" (1985, 731).

16 The least known taxonomic groups in terms of their extinction risk are green algae, brown algae, and fungi; most of them are microorganisms whose characteristics do not comply with the threat assessment methodology.

17 The interactions of a given species and the impact of its extinction on the ecosystem may be difficult to evaluate, however. Under changing conditions, such as considering climate change, the roles (and abundances) of the constituent species in an ecosystem can change, and species that previously were not key for ecosystem functioning may become important in adaptation to change.

18 For factors that increase a species' aesthetic attractivity, see Kellert (1986).

19 Unfortunately, we are not able to explore in this article the many problems related to the flagship species approach in conservation, on the one hand, and difficulties in assessing the impact of umbrella species on an ecosystem, on the other hand.

20 See Glenn Parsons's (2015) examination of what he calls "the hidden gems problems," namely, the aesthetic conservation of fragile environments which only a few could experience.

21 Whether normative philosophical theories consider such an individualistic approach an appropriate aesthetic response is another matter.

22 Why stop at these "natural" cases? Janna Thompson (1995, 298) remarks that industrial agricultural land likely has aesthetically valuable qualities (color, design); in similar fashion, Benjamin J. Richardson (2019, 33) notes that industrial and urbanized landscapes, even polluted ones, might attract many.

23 Yet another problem in aesthetic environmentalism is that aesthetic preferences are partly cultural and historical and there is little knowledge about human future preferences (see Maclaurin and Sterelny 2008, 156).

24 Rolston acknowledges this and asserts that "[t]here is a wildness in ecosystems that resists being completely specified in geology, botany, zoology, and ecology textbooks, even when principles set forth in theories are coupled with initial conditions. Scientific laws never catch in individual detail all that goes on in a particular place... and each new lake and canyon will have some differences" (1988, 183).

25 These aspects include local vs. global; present vs. past, present, and future; species diversity vs. genetic, taxonomic, and ecological diversity; composition vs. composition, structure, and function; biotic vs. biotic and abiotic; and native diversity vs. native and human-generated diversity (see Koricheva and Siipi 2004, 30).

26 When it comes to genes, there are also number of temptations. There are, for instance, more or less realistic species reconstruction—or recreation—projects that are based on genetic engineering and certainly have aesthetic appeal. To take a popular example, a project attempting to revive woolly mammoth (*Mammuthus primigenius*), practically perhaps producing an elephant-mammoth hybrid with around 1% mammoth genes, has be defended by an argument that such an animal could stop soil erosion and melting in Siberian Tundra (see the Colossal Laboratories & Biosciences webpage at https://colossal.com/can-bringing-back-mammoths-help-stop-climate-change/). Such projections are fascinating in their own way, but whether the revived organisms would actually balance the environment in the planned way, fitting in a system that has changed since, and whether it is reasonable to use incredible amounts of money and resources in such an enterprise at the expense of other species, including the cheetah, is disputable.

27 The cultural values of biodiversity have been acknowledged in United Nations Environment Programme's (1999) and IPBES's (2019) reports, for instance.

28 As Farnham puts it, from the viewpoint of biodiversity, "[a]ny interest in geologic, chemical, and physical attributes of the natural world is placed in the context of their impact upon or connection to biological life" (2007, 2). Nevertheless, any sharp divide between *biotic* and *abiotic* is problematic. Sedimentary formations, for instance, may be products of microbial activity, or fossilized remains of organisms; they are devoid of life albeit of living origin.

29 See Takacs (1996, 270–76) for biologists' explanations of the aesthetic value they see in biodiversity. See also Farnham (2007, 2, 18) for a history of scientific interest in biological diversity.

30 Here, see also Johnson (1995).

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