Justifying Nature-based Solutions

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Abstract: Nature-based solutions (NbS) have in recent years occupied a central position in conservation and climate discussions among both scientists and policy makers. NbS generally refer to a set of strategies which use nature, or natural objects, to address societal (human) issues while simultaneously supporting the broader environment. This paper examines the concept of NbS to determine whether it is a useful and well-motivated category to guide future climate and conservation efforts. I argue that NbS may in fact be a valuable contribution to environmental thought and policy, but not for the reasons that they are typically thought to be. Specifically: while we have reason to doubt that NbS should be prioritized over other environmental strategies on the grounds that they are uniquely environmentally-friendly or supportive of biodiversity, they may nevertheless have an advantage insofar as they play a vital aesthetic role in developing a healthier relationship between humans and the nonhuman world.

At the most recent Conference of the Parties (COP27), an annual international climate convention hosted by the United Nations, "nature-based solutions" (NbS) played a central role in conversations surrounding climate change and resilience building. Since the term was first coined in 2008, NbS have been growing in popularity. Conceived of as a set of solutions aimed at addressing both the causes and effects of climate change, they were included in the mitigation and adaptation plans of almost two-thirds of the Paris Agreement parties and have been called "key" to achieving net-zero carbon emissions (Chandrasekhar and Viglione 2021, 1, 11; Seddon et al. 2020, 2). In addition to their climate potential, NbS provide an integrated approach which promises to simultaneously offer benefits to both humans and broader ecosystems, including enhancing biodiversity and supporting healthy ecosystem functioning (Chandrasekhar and Viglione 2021, Xing et al. 2017, Cohen-Shacham et al. 2016). Depending on the particular NbS employed, the diverse benefits to humans might include increased food and water security,

reduced disaster risk, enhanced human health and well-being, social and economic development, mitigation of the urban heat island effect, improved air quality, reduced urban noise, energy saving, and creation of recreational areas (Kabisch et al. 2016, Chandrasekhar and Viglione 2021, Cohen-Shacham et al. 2016, Seddon et al. 2020, Xing et al. 2017, Nesshöver et al. 2017). NbS receive $133 billion in funding each year (Chandrasekhar and Viglione 2021, 18).

Although official definitions vary, the general idea behind NbS identifies a set of strategies which use nature, or natural objects, to address societal (human) issues while simultaneously supporting the broader environment. These strategies are contrasted with methods of confronting climate change that do not explicitly rely on natural objects, such as building a concrete wall to address coastal flooding, employing carbon-capture technology to aid in mitigation, or installing air-conditioning units in at-risk areas to prevent heat-related injury. For many policy makers and activists, NbS have emerged as a refreshing and particularly environmentally-friendly alternative to these more common-place approaches. This paper examines the concept of NbS to determine whether it really is a useful and well-motivated category to guide future environmental and conservation efforts.

The most common critique of NbS, where there is such a critique, is that the term is too vague to be truly action-guiding (Chandrasekhar and Viglione 2021, 7; Nesshöver et al. 2017). My strategy will be to circumvent this worry by motivating a plausible way of thinking about NbS based on how the term is defined and illustrated in the literature. I then investigate whether NbS, conceived of in this way, can be justified as a category worthy of our serious consideration. My argument will be that the concept of NbS may in fact be a valuable contribution to environmental thought and policy, but not for the reasons that it is typically thought to be. Specifically: while we have reason to doubt that NbS should be prioritized over other

environmental strategies on the grounds that they are uniquely environmentally-friendly or supportive of biodiversity, they may nevertheless have an advantage insofar as they play a vital aesthetic role in developing a healthier relationship between humans and the nonhuman world.

The paper proceeds as follows. After describing the state of the current debate regarding NbS, in the first section I address the vagueness concern by arguing that the most common understanding of NbS is synonymous with the protection and implementation of "blue/green" areas and infrastructure. In the second section, I present evidence from artificial analogues, human-made constructions that share certain relevant features with "natural" (non-human-made) structures, to undermine the popular claim that NbS, understood as the implementation of blue/green infrastructure, are especially supportive of native biodiversity. Finally, in the third section I suggest that there may still be a way to justify and prefer NbS by considering the effect that the "natural aesthetic" of NbS has on humans' relationship with the nonhuman world.

1. Defining Nature-based Solutions (NbS)

Typical examples of NbS give us a sense of the general approach: sustainably managing wetlands, conserving forests, restoring drylands, using mangroves to protect shorelines, and developing green infrastructure in urban areas (Cohen-Shacham et al. 2016, 9) which might include building foliage-covered walls and roofs, designing urban parks, and planting street trees (Kabisch et al. 2016, 2). In certain cases, even avoiding deforestation can be considered a NbS (Chandrasekhar and Viglione 2021, 19). Generally, NbS encompass any approach that uses nature or natural ecosystems to simultaneously address environmental and societal issues (Cohen-Shacham et al. 2016, 12).

No doubt the general idea is attractive. But despite its initial appeal, NbS have faced

substantial criticism from those who doubt that the concept can truly guide environmental

decision and action. According to one climate policy coordinator, "The term is so vague I could

probably cut down a tree, whittle it down to a stick, wave it at the moon and call it a nature-based

solution" (Chandrasekhar and Viglione 2021, 8). Consider two popular definitions of NbS from

the International Union for the Conservation of Nature (IUCN) and the European Commission[1]:

IUCN definition: NbS are "actions to protect, sustainably manage, and restore natural or

modified ecosystems, that address societal challenges effectively and adaptively,

simultaneously providing human well-being and biodiversity benefits" (WCC-2016-Res-

069).

European Commission definition: NbS are "actions that aim to help societies address a

variety of environmental, social, and economic challenges in sustainable ways. They are

actions which are inspired by, supported by, or copied from nature" (European

Commission 2015, 74).

Even putting aside the fact that these two commonly used definitions are not at all identical, the

worry is that, without a clear set of principles, these definitions are so broad that nearly any

action plausibly taken to have been "inspired by" nature could be justified as a NbS. Even the

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[1] The International Union for the Conservation of Nature (IUCN) is an international organization made up of both governmental and non-governmental parties whose mission is to assist in the conservation of nature and the equitable and sustainable use of natural resources. The European Commission is part of the executive of the European Union which, among other things, funds research and projects in areas like agriculture, health, and the environment.

IUCN admits that "NbS still remains, for many, a general metaphor without sufficiently clear guidelines to enable effective operationalism" (Cohen-Shacham et al. 2016, 27). Because NbS are rarely translated into strategies which are both measurable and evidence-based, the term has been accused of being a mere tool "to help powerful people 'green their image'" (Chandrasekhar and Viglione 2021, 9, 11).

In response to these criticisms, policy makers have attempted to better demarcate what constitutes a NbS. The IUCN's revised characterization of NbS grounds the concept in the more widely known "ecosystem approach," emphasizing that NbS must work *in conjunction* with existing ecosystems to protect both natural environments and human well-being (Cohen-Shacham et al. 2016, 28). Because the Convention on Biological Diversity[2] has already developed a set of operational guidelines for the ecosystem approach, the hope is that NbS can benefit from its connection with more specific principles. On the IUCN's account, NbS are a *kind* of ecosystem approach: namely, they are ecosystem-based strategies which are aimed at addressing *societal issues* in particular (Cohen-Shacham et al. 2016, 29).

Besides attempting to address the ambiguity critique, the IUCN, like many supporters of NbS, also tries to distance the concept from the classic "natural" vs. "artificial" debate. Traditional conceptions of naturalness rely on a distinction between humans and nature; only entities which are independent from human interference can properly be called "natural," while those entities which have been created, modified, or maintained by humans are "artificial." But this way of conceptualizing the natural vs. artificial has been heavily criticized (e.g., Cole and Young 2012; Marris 2013; Sober 2007). For one, the reach of human impact is so extensive that

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[2] The Convention on Biological Diversity is an environmental treaty aimed at the protection of biological diversity and the sustainable use and development of resources. A Conference of the Parties (COP) is held every other year; the ecosystem approach was adopted by the Parties as "the primary framework for action under the Convention" in 1995 (Secretariat of the Convention on Biological Diversity, 2004).

nearly every place has already been modified by humans, rendering the distinction largely inapplicable, or, if not inapplicable, at least ambiguous. Further, insisting on a division between those things which are "touched by humans" and those which are not implies that humans are not fully part of nature, an idea which seems to counter the sentiments of many contemporary environmentalists. The IUCN's updated characterization of NbS makes sure to clarify that solutions can be "nature-based" even if they involve human interference into ecosystems; in fact, even direct human intervention in the form of ecological engineering could constitute a NbS so long as the strategy supports the ecosystem as a whole.

But despite the IUCN's explicit rejection of the traditional natural/artificial distinction, the terms "natural" and "artificial" continue to make frequent appearances in descriptions of NbS. An exemplar of NbS, often used in the literature to illustrate the general NbS strategy, is using *natural* coastal infrastructure to prevent flooding (Cohen-Shacham et al. 2016, 2, 9). A recent article from the Secretariat to the United Nations Framework Convention on Climate Change (UNFCCC) characterizes NbS in terms of examples like "building a *natural* retaining wall using no concrete," "restoring *natural* drainage canals and ponds," and supporting "*natural* systems" by restoring degraded mangroves ("Increasing Resilience" 2022). According to the European Commission, NbS must not "*artificially* alter nature" (European Commission 2015, 26).

The frequent use of the terms "natural" and "artificial" might appear to be objectionable, given the problems articulated above. Yet in the context of NbS, these terms take on a very specific meaning. NbS use barrier islands, mangrove forests, and/or oyster reefs to prevent flooding *instead of* the more conventional concrete sea walls (Cohen-Shacham et al. 2016, 2, 9). Examples of acceptable ecological engineering include large-scale tree planting and the creation

of green walls and roofs, which is contrasted with "technology-based solutions" and "engineering solutions" (WCC-2016-Res-069, Kabisch et al. 2016, 8). NbS are "explicitly considered as alternatives to and choices against human-made infrastructure" (Nesshöver et al. 2019, 1217). Most important, they promote "green and blue" areas *as opposed to* "grey" (Kabisch 2016, 37, Seddon et al. 2020, 7).[3]

In other words: in the context of NbS, whereas artificial things are human-made, grey, and possibly involve certain kinds of modern technology, natural things tend to be blue or green and are not constructed out of human-made materials. Although there is still room for ambiguity (how "human-made" must something be to count as artificial?) we might think of the natural/artificial distinction here as tracking a kind of "natural aesthetic," where artificiality is determined not necessarily by the degree of human interference, but by the degree to which some structure can be considered "grey" rather than "blue/green". Often, references to "blue/green" (or sometimes just "green") infrastructure are taken to be *synonymous* with NbS (Kabisch et al. 2016, 38; Nesshöver et al. 2019, 1218-1219).

Conceived of in this way, the term "natural," when used in the context of NbS, is neither overly ambiguous nor in danger of prohibiting human interference in ecosystems (a tree would still count as "green" even if it were planted by human hands). But the question then becomes: is there good reason to prefer blue/green infrastructure over grey in our environmental policy? If so, then we have a general reason to endorse NbS over other kinds of potential solutions.[4]

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[3] The term "green" or "blue/green" in these cases refers to not only those places which are actually blue and green (oceans and forests) but to all places that possess the "natural aesthetic". A desert, for example, might be considered a blue/green area, despite being yellow.

[4] For a small sample of recent philosophical discussion on conservation, and in particular, what ought to be conserved, see Jones 2021; Casetta 2020; Santana 2019; Marris 2013; Cole and Yung 2010.

Before continuing, it will be useful to distinguish between two broad NbS strategies. The first strategy I will call "conservation-focused," which includes managing wetlands, restoring drylands, conserving forests, etc. These strategies are conservation-focused because they primarily concern the protection and restoration of blue/green places (forests, oceans, etc.) Conservation-focused activities count as NbS when they aim to not only support the environment, but also address some societal issue (for example, restoring a forest in order to create local job opportunities, improve air quality, support climate mitigation, etc.). The second broad NbS strategy, "infrastructure-focused," includes using mangroves as sea walls, planting street trees, building green walls, designing non-grey drainage canals, etc. Whereas conservation-focused NbS tend to replicate the kinds of large-scale projects that conservationists are already involved with, infrastructure-focused NbS involve the smaller-scale implementation of blue/green infrastructure *as a substitute for* grey infrastructure. Mangroves are used as sea walls *instead of* the more conventional concrete; urban shade is created using street trees *instead of* other kinds of human-made structures. Here, the blue/green vs. grey distinction is used not to identify places that ought to be protected, but to determine which kinds of infrastructure ought to be prioritized when attempting to address some specific societal need.

Infrastructure-focused NbS seem particularly important to characterizing the broader NbS vision. The NbS label could be attached to any conservation-focused project which plausibly provides some kind of benefit to humans, even if the main motivation behind the project is not aimed at addressing specific societal concerns. Infrastructure-focused NbS, on the other hand, are often employed to address specific societal needs, making them more obvious cases of *solutions* rather than mere extensions of more general conservation efforts. Further, whereas many conservation-focused projects would still be warranted even were it to be determined that

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they did not address any societal issue, the same may not be true of many infrastructure-focused efforts. In other words, whereas the NbS label may play some role in justifying certain conservation-focused projects, it plays a crucial role in the justification of infrastructure-focused efforts.

For these reasons, the rest of this paper deals primarily with the justification for infrastructure-focused NbS. My question going forward will be: should we prefer blue/green forms of infrastructure over grey forms, as the push for the implementation of infrastructure-focused NbS implies? The next section will begin to answer this question through an analysis of the connection between the cultivation of biodiversity, one of the supposed key merits of blue/green infrastructure, and artificial analogues, grey forms of infrastructure which nevertheless play a surprising and important ecological role in the lives of many nonhuman species.

2. Biodiversity and Artificial Analogues

The selling point of infrastructure-based NbS is that the implementation of blue/green infrastructure is better suited than more conventional solutions to provide benefits to both humans *and* broader ecosystems. Using concrete to hold back rising sea levels from flooding a coastal town solves a particular societal problem, but it may do so at the expense of the environment (or, at least, it does not take the environment into account at all). Even if we have reason to doubt that blue/green infrastructure solutions are always or even usually best suited to solve particular societal problems (Chandrasekhar and Viglione 2021, 4-8; Seddon et al. 2019, 7), an argument might be made that, given our contemporary environmental situation, seeking out solutions that go beyond human interests is worth some amount of human sacrifice.

In fact, the idea that NbS are particularly well-suited to support and nourish the environment is a major emphasis in justifications for the implementation of these kinds of projects. A central benefit of NbS, or blue/green spaces and infrastructure, is that they "support biodiversity conservation" and "foster the functioning of ecosystems" (Kabisch et al. 2016, 37). The UN Climate Change's Standing Committee on Finance specifically notes that NbS "can help in addressing both the climate and the biodiversity crisis" (Chandrasekhar and Viglione 2021, 19). Although particular NbS will vary with regard to their ability to provide biodiversity benefits (Seddon et al. 2019, 2), some basic ability to support biodiversity and/or healthy ecosystem functioning is considered a necessary component of NbS, whether as an explicit goal or a prerequisite (Nesshöver et al. 2019, 1220). According to the IUCN definition, it is a prerequisite: an intervention *must* provide some kind of biodiversity benefit in order to be considered a NbS at all (WCC-2016-Res-069; Nesshöver et al. 2019, 1217).[5] Given the centrality of biodiversity and ecosystem functioning in definitions of and justifications for NbS, it is worth determining whether there really are reasons to think that, in general, "nature-based," blue/green infrastructure is better for the broader environment than grey.[6]

It is reasonable to associate blue/green areas and infrastructure with environmental health. Urbanization has destroyed and degraded a great many landscapes, such as when previously green areas are replaced with hard, grey surfaces like roads and buildings. The result

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[5] Although the term "biodiversity" has been recognized as problematically vague (Maclaurin and Sterelny, 2008; Santana 2014), a common understanding is provided by the 1992 Convention on Biological Diversity: "'Biological diversity' means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (Article 2).

[6] Note that my question here concerns *general reasons* for preferring NbS over other strategies. It is obviously true that the success of particular instances of NbS will depend on specific factors; in certain cases, a particular form of NbS will be capable of providing more benefits than a particular conventional solution, and vice-versa. But given the amount of attention and funding that the concept of NbS currently enjoys, there is value in attempting to understand the broader vision and justification for these kinds of strategies.

tends to be, among other things, a loss of biodiversity (Xing et. al 2017, 1). The problem with artificial, human-made objects is that they do not always "fit in" with previously existing natural ecosystems; biodiversity is lost in large part because native species cannot thrive in ecosystems radically altered by humans. Lundholm and Richardson (2010) write: "The main view is that anthropogenic ecosystems are largely distinct in structure and function from the natural ecosystems they replaced because of alterations to resource availability, stress intensity, disturbance, and changes in the spatial arrangement of ecosystem components" (967). If blue/green forms of infrastructure can better match the conditions of previously existing natural ecosystems, then native species may have an easier time adapting to anthropogenic changes. The thought is that, by reducing the amount of grey space in our cities, and increasing blue/green space, we can support native biodiversity and increase healthy ecosystem functioning. If true, this would give us good reason to choose the natural, green plant over the artificial, grey concrete, even if both would serve as solutions to some societal need.

Yet evidence on the environmental impacts of artificial analogues gives us reason to be skeptical of this common view. Artificial analogues are human-made constructions that share certain relevant features with natural (non-human-made) structures. For example, hard surfaces like walls and quarries are artificial analogues of natural rock pavements and cliffs. They are analogous in the sense that they share certain material and structural features which allow them to play comparable roles in particular ecosystems. The result is that native species typically found on rock pavements and cliffs will spontaneously colonize walls and quarries (Lundholm and Richardson 2010). Similarly, native species accustomed to living in salt lakes and marshes are attracted to roadsides treated with salt (Reznicek 1980). Different materials attract different kinds of species: plants and animals accustomed to limestone bedrock can be found living in

limestone cement basements, while species who hail from volcanic habitats will be attracted to basalt rock walls (Crucitti, Malori and Rotella 1998). Crustaceans and fish have found an unlikely home in old New York subway cars, discarded and dumped into the Atlantic, the structures given new life as a thriving underwater reef for thousands of organisms (Parke 2015). Spanish moss lives on aerial cables, grape vines climb telephone poles, and rock doves nest in human-made rock structures (Lundholm and Richardson 2010, 969). Even waste sites can host a diversity of species typical of limestone grasslands (Ratcliffe, Dunham, and Poore 1974). Oftentimes, these artificial analogues host not only native species, but *rare* native species, such as a gravel pit in Germany which houses hundreds of red-listed plants, moss, lichen, and animal species (Schiel and Rademache 2008). Far from serving as a barrier to biodiversity, Lundholm and Richardson (2010) write in their literature review that in many human-affected areas "human activities have unwittingly *expanded* the habitat available for native species and decreased the rarity of particular species associations in the region" (969).

The argument here is not that grey infrastructure will always or even usually provide the conditions necessary for native biodiversity to prosper. The point is rather that, when it comes to those artificial analogues that *do* provide the proper conditions, these structures seem to serve the same functions as their natural analogues. From the human perspective, there is a considerable difference between a marsh and a salted roadside: the marsh is a natural, blue/green ecosystem, while the roadside is a clear example of grey, artificial infrastructure. But from the perspective of certain salt-tolerant plants, the two are equivalent: both provide the conditions necessary for acting as a suitable habitat. To generalize: from the human perspective, areas and objects which are blue and green, and which have the kind of aesthetic traditionally associated with natural things, are "nature," while areas and objects which are grey and human-made are "artificial."

From the perspective of nonhuman species seeking to colonize a particular area, this distinction is irrelevant. When determining what counts as "nature" and "natural," we must decide whether to take an aesthetically-oriented human perspective, or a more open, unbiased "species-eye view" (Lundholm and Richardson 2010, 973).

Given that the aesthetic division between "the natural" and "the artificial" belongs to humans alone, it would be unwise to rely on this distinction when making infrastructure decisions meant to be especially friendly to biodiversity. If the evidence on artificial analogues is any indication, there will be plenty of situations in which altering a particular grey space (in the more extreme cases, by adjusting its microhabitat) will be a more practical and effective solution for both humans and nonhumans than replacing it with something more aesthetically natural (Bulleri and Chapman, 2010; Herath et al. 2009; Lundholm and Richardson 2010, 970). In addition, human constructions often have the advantage of being more durable and predictable, qualities which might aid in long term conservation of species, especially in a rapidly changing climate. So although blue/green types of infrastructure may *appear* to be more environmentally-friendly, a more inclusive "species-eye" perspective reveals a human aesthetic preference where we once saw a marker of ecological suitability.[7]

In light of this, the supporter of NbS has at least two options. The first is to abandon the concept's reliance on the blue/green vs. grey distinction, holding that infrastructure-based NbS are *any* kind of societal solution which takes into account the broader environment, regardless of

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[7] One potential complication to consider is the possibility that certain NbS might increase local biodiversity by their very presence. For example, although constructing a sea wall made of mangroves instead of suitably adjusted grey material may not make much of a difference to already existing local wildlife, perhaps the very presence of the mangroves increases local biodiversity, thereby fulfilling a policy maker's mission of both implementing a climate solution and supporting biodiversity. Although this strikes me as certainly possible, unsettled ideas about what exactly counts as a relevant increase in biodiversity make the point difficult to consider (does planting 5 mangroves of a native species count as increased biodiversity? 100 mangroves? 5 or 100 mangroves of a rare species?) My inclination is that any NbS that can truly be said to increase local biodiversity would have to be quite large-scale – and in that case, the project may be moving into the realm of conservation-focused NbS.

the kind of material used. Constructing a seawall made from concrete can be just as much of a

NbS as constructing a seawall made from mangroves, so long as the concrete provides, or can be

adjusted to provide, the kind of conditions suitable for local biodiversity. The focus, in other

words, is shifted from aesthetic preoccupations to concern for the ability of a societal solution to

"fit in" and support the surrounding environment and biodiversity. This "opening up" of what

counts as nature, with its subsequent shift in the priorities of NbS, is crucially important for the

survival and coherence of the NbS concept. Particular solutions ought to be judged not based on

the degree to which they fit some human conception of the natural aesthetic, but on the degree to

which they truly serve as the best solution for both human and environmental concerns.

For the proponent of NbS, however, there is a strategic disadvantage: with the

abandonment of the aesthetic element of NbS, the concept of NbS as a unique strategy loses its

force. A NbS becomes any solution which takes into account both humans and the environment.

Although this has been the NbS proponent's claim all along, the accompaniment of particular

examples which reflect traditional ideas about naturalness has provided an understated but

nevertheless central dimension of the NbS category, a dimension which has helped to mitigate

worries about the category's inherent vagueness and potential lack of distinction from other

kinds of solutions. Without such an aesthetic dimension, a NbS strategy becomes synonymous

with whatever strategy is determined to be the "overall best." Although we can agree that we

must look for the all-things-considered best solution to a particular problem, taking into account

both human and nonhuman perspectives, it is unclear that a special label like "NbS" is needed to

complete the conceptual landscape.[8]

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[8] Other considerations that would need to be taken into account in order to make the best all-things-considered
judgement include a strategy's predicted cost, risk, possible co-benefits, maturity, ethical and political constraints,
etc. Although various advantages are commonly associated with NbS, evidence does not support a clear distinction

In order to preserve NbS as an interesting category for policy makers, a second option is to maintain the distinction between blue/green and grey infrastructure, arguing that, even if such a distinction cannot be justified in terms of biodiversity concerns, it can be justified on some other grounds. On this view, we still have reason to prefer infrastructure which adheres to the natural aesthetic over infrastructure which does not. The NbS category would then play the role of tracking those solutions which not only acknowledge the needs of both humans and broader ecosystems, but also have an added benefit which could only come from those places and objects traditionally understood as natural. In the next section I gesture towards what this benefit might be, and how infrastructure-based NbS might be justified as a general strategy.

3. The Natural Aesthetic and Nonhuman Connection

In the previous section I argued that the effects of artificial analogues on biodiversity put pressure on the common practice of associating NbS with blue/green, as opposed to grey, infrastructure. If NbS are truly concerned with finding solutions that work in conjunction with local ecosystems, and that serve both human and biodiversity needs, then strategies that focus on promoting "natural" as opposed to "artificial" materials are distractions.

In this final section, however, I explore the possibility that there is another way to justify, from the perspective of environmental ethics and policy, a general preference for blue/green infrastructure. Note that such a preference will not, in my view, override considerations favoring whichever potential solution will best satisfy both human and (especially) nonhuman needs. However, in cases where there are multiple satisfactory contenders, I will suggest that we may have reason to prefer the option which adheres to the natural aesthetic.

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between NbS and more "conventional" solutions in terms of oft-stated benefits like cost-effectiveness, maturity, co-benefits, and ethical governance (Osaka, Bellamy, and Castree 2021).

While NbS are most commonly defended in terms of biodiversity and environmental benefits, appeals to aesthetic and psychological benefits often serve as a secondary argument. The most effective NbS are described as promoting human health and psychological well-being, as when a green urban space provides city dwellers with a recreational area and respite from the city's more routine grey landscape (Kabisch et al. 2016, 39-40). There is an important connection between the aesthetics of a particular NbS (including the degree to which the space is perceived of as "natural") and the likelihood that local citizens will accept and appreciate its implementation (Hofmann et al. 2012, Frantzeskaki 2019, 102). These aesthetic considerations in favor of blue/green NbS are often minimized in attempts to provide more "scientific" justifications. The worry, perhaps, is that aesthetic considerations are too superficial to provide much support in favor of NbS, and certainly not enough to justify the concept's central place in environmental policy and discourse. In the spirit of taking a "species-eye view," one might even argue that, rather than allow our narrow aesthetic preferences to bias our environmental decisions, it would be better to attempt to expand our aesthetic appreciation to a broader, more "grey-inclusive" perspective of what counts as nature, in recognition of the fact that grey strategies can also benefit both humans and the environment.

Instead, I want to suggest that we may still have reason to prefer blue/green infrastructure, despite the implausibility of thinking that only blue/green areas and objects can properly be considered "nature." I will briefly argue on behalf of blue/green materials in light of evidence that the natural aesthetic may help to guide humans, especially those living in urban areas, into a deeper connection with the nonhuman world. A healthier relationship between humans and the rest of nature is crucial in this time of environmental crisis, the alleviation of which will require wholesale changes in our institutional and value systems. If living in places

filled with blue/green entities can help to facilitate this new relationship, then the importance of

NbS takes on a new dimension.

It is clear that the presence of blue/green entities has a variety of measurable effects on

the human psyche.[9] More specifically, there is mounting evidence that time spent in blue/green

areas and with blue/green objects has the potential to change attitudes towards nature, referred to

in the literature as increasing one's "nature connectedness." A strong nature connectedness

"means feeling a close relationship or an emotional attachment to our natural surroundings"

(Mental Health Foundation 2021, 4), and has been measured using a variety of scales, including

a 14-item questionnaire which asks participants to report the degree to which they agree with

statements like "I think of the natural world as a community to which I belong" (Mackay and

Schmitt 2019, 1-2). High degrees of nature connectedness are associated with increased pro-

environmental and conservation behaviors (Mental Health Foundation 2021, 4; Richardson et al.

2020; Mackay and Schmitt 2019). Mackay and Schmitt 2019 found substantial evidence that

this relationship is causal: increased nature connectedness *causes* increased pro-environmental

and conservation behaviors. If the natural aesthetic is found to be particularly successful in

facilitating nature connectedness, and therefore behaviors which promote a healthier planet, then

there is good reason to prefer blue/green kinds of infrastructure when making design decisions.

And indeed, most activities described as promoting nature connectedness involve the natural

aesthetic in one way or another. Citizens are encouraged to foster connectedness by engaging in

"natural beauty," noticing wildlife, and appreciating local trees, with the central lesson being to

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[9] Spending time in blue/green areas has been shown to improve mental health; even the presence of indoor plants can improve concentration and productivity (Xing et al. 2017, 4-5). Compared with urban grey environments, interactions with blue/green areas more successfully restore cognitive functioning, including directed attention and memory (Berman et al. 2008, 1207). Studies on the psychological effects of green urban areas report that such spaces have the power to create a renewed sense of place and community belonging (Frantzeskaki 2019, 102-104), and "set the stage for meaningful social relationships, identity development, and ecological awareness" (Grimwood 2016, 513).

"stop, look, listen and enjoy nature every day" (Richardson et al. 2020, 833-834). According to Mackay and Schmitt, it is important that we let nature engage all of our senses, since "truly engaging and connecting with nature through intimate, yet simple, activities involving one's physical senses of sight, sound, smell, and touch appears to be a key pathway to moving people towards greater engagement in conservation-friendly behaviors" (2019, 832).

Areas and objects possessing the natural aesthetic do seem to capture our senses and inspire reflection of the more-than-human world in a way that grey infrastructure typically does not. The problem with purely human-made constructions and technologies, writes David Abrams, is that they "only reflect us back to ourselves" (1996, 22). Although concrete may be capable of playing the same ecological role as a mangrove, it is hard to look at concrete and see anything but the usual brand of human design. A tree, even if planted by human hands, has the ability to surprise us, in form, in color, in smell; it seems to exist for itself in a way that concrete simply does not. In the words of William Cronon:

> When we visit a wilderness area, we find ourselves surrounded by plants and animals and physical landscapes whose otherness compels our attention. In forcing us to acknowledge that they are not of our making, that they have little or no need of our continued existence, they recall for us a creation far greater than our own (1995, 23).[10]

The presence of a tree reminds us of the existence and persistence of the nonhuman world. In a study on youth perceptions of urban "nature" (conceived of as blue/green objects and

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[10] According to Cronon, this point applies not just to wilderness areas, but also to the plants, animals, and landscapes closer to home: "The tree in the garden is in reality no less other, no less worthy of our wonder and respect, then the tree in an ancient forest…Both trees stand apart from us; both share our common world" (1995, 24).

spaces) in the UK, participants described nature as offering "a new perspective of oneself within the world" (Birch et al. 2020, 5), with one participant stating that nature helped them to think "about the rest of the universe rather than your little social bubble" and another describing nature as giving "life another dimension" (Birch et al. 2020, 6-7). Because of this, urban trees and green spaces have been described as promoting connection and care between city dwellers and the nonhuman world (Mental Health Foundation 2021, 41; Birch et al. 2020).

My suggestion is that this psychological aspect of blue/green entities, their ability to prompt us to reflect on things which are not human or human-made, is especially important in a world suffering from the effects of human selfishness and ambivalence. Choosing to implement blue/green forms of infrastructure, in urban areas especially, might help city dwellers to feel more deeply connected to the world outside of human control and design. If such a feeling can lead to changing attitudes about humans' place in the natural world, and perhaps even an increase in behaviors that support the rehabilitation of the planet, then we have a strong reason to endorse the implementation of blue/green infrastructure whenever the opportunity arises.

4. Conclusion

This paper has examined whether we have good reason to prioritize NbS over other potential solutions in our environmental and conservation efforts. Although the term NbS is ambiguous, I argued that most articulations of NbS rely on an intuitive appeal to a certain "natural" blue/green aesthetic. If proponents of NbS want to hold on to the concept's association with the natural aesthetic, then NbS cannot be justified in terms of being especially environmentally/biodiversity friendly. Artificial analogues show us that, from the perspective of native biodiversity, there is no clear distinction to be made between "natural" and "artificial" forms of infrastructure. The

first lesson, then, is that we must make sure that our aesthetic preferences do not bias our search

for the solutions that will actually best support both human and nonhuman needs. I suggest,

however, that we may nevertheless have some reason to prefer blue/green forms of infrastructure

insofar as the natural aesthetic may help to facilitate a healthier relationship between humans and

the nonhuman world. In a time when we are struggling to redefine a relationship between

humans and nature, there may be something powerful about knowing that the sea is being held

back by mangroves rather than concrete.

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