Searching for Symbiosis: Exploring the Role of Deep Ecology in Probiotic Ecology

Name: Lyndsey Denton-Fray

Student Number: s1029798

Thesis Supervisor: Dr Martin Drenthen

Word Count: 15090 (without bibliography), 16092 (with bibliography)

Date: 30-06-2024

Master Thesis to obtain the degree of "Master of Arts" in Philosophy at Radboud University Nijmegen

Hereby I, ***Lyndsey Denton-Fray***, declare and assure that I have composed the present thesis with the title ***Searching for Symbiosis: Exploring the Role of Deep Ecology in Probiotic Ecology***, independently, that I did not use any other sources or tools other than indicated and that I marked those parts of the text derived from the literal content or meaning of other works – digital media included – by making them known as such by indicating their source(s).

30th June 2024

Acknowledgements

I just want to take the time to say thank you to the people who got me through my degree and have helped me through all the times I thought I wouldn't make it. Lizzie for all your love, support and reality checks, Matthijs for all your feedback, advice and support, Renske for all your care and understanding, and Georgia for being just a call away to let me vent. To Saar and Sophie, for keeping me sane and always letting me be right when I needed it. To Marc Davidson, for being such an inspiration for all of my work and always being there to cheer me on and help me through any problem. To Martin Drenthen, for giving me the confidence to bring my idea to life and the most motivating feedback. To my Grandad, for always being there and being the reason I am where I am today. And to my Bob, you are the most wonderful, supportive and loving partner; thank you for carrying me when I needed it most.

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ABSTRACT

The way humans have industrialised with such ferocity has led to a string of problems that have impacted our environment and nature from mass consumption, over-production and exploitation. It has become clear with such environmental implications that we cannot depend on nor carry on with our previous ways of ecological care and management. We not only need to change how we act but challenge the current way of viewing nature and develop a better understanding of our environment. This thesis looks at a prospective way of viewing ecological management and restoration through the lens of probiotic ecology: the science of studying and examining the relationships in probiotic management and using this knowledge to make changes in ecosystems and relationships with nature. Jamie Lorimer's concept of 'probiotic management' is discussed, analysing the potential problems and ethical implications of such a practice. The thesis explores environmental ethical frameworks that can be attached to probiotic management, contending deep ecology as the most applicable framework to help deal with the ethical concerns. I conclude that ecological management is not the core problem, as human intervention with nature is inevitable. What *is* the problem is the way in which we manage, treat and value nature. Probiotic management is a practice that looks to move away from current ecological management practices and make room for a more holistic approach to coexisting with and managing nature. What deep ecology can provide is an environmental framework that also challenges the current attitudes towards nature and provides guidelines and reasoning for why we need to treat and value nature better.

INTRODUCTION

In a world which may sometimes feel completely divided, there are many aspects in which we are also completely connected. Organisms and microbes that make up ecosystems, species, nature[1] and humans are all around us and interconnect with one another. But finding a way to live and coexist together seems to have become increasingly difficult. As our environmental crises intensify across the globe, the need to find a more harmonious relationship with nature is becoming even more important. The way humans have industrialised with such ferocity has led to a string of problems that have impacted our environment and nature from mass consumption, over-production and exploitation. The accumulation of greenhouse gasses in our atmosphere from excessive production has led to increased warming temperatures (IPCC 2023, 4), affecting ecosystems, biodiversity and multiple species. Habitat fragmentation, biodiversity loss, deforestation and exploitation have exacerbated, which has largely been associated with the intensity of agricultural practices (Oliver and Higashi 2021, 264). The list could go on. What seems to be clear is that human intervention is inevitable, and at the same time, we cannot depend on nor carry on with our previous ways of ecological care and management. What we need to do is change how we view and handle nature and come up with a way of coexisting without destruction.

Changing our current trajectory in ecological management means finding a new framework that can provide a more holistic relationship between nature and humans. One environmental movement that has become prominent is the 'probiotic turn' from environmental geographer Jamie Lorimer. This movement is associated with moving away from modern practices that Lorimer describes as "antibiotic", referring to ways in which "unruly ecologies" are eradicated, simplified and controlled (Lorimer 2020, 2). What Lorimer suggests in place of this 'antibiotic' way of living is "going probiotic", referring to using "life to manage life" by expanding, enhancing and working with biological processes rather than against them (Lorimer 2020, 2). To illustrate this 'turn', Lorimer uses examples of rewilding and restoration practices by introducing specific and prominent species that he labels "keystone species" to engineer ecosystems (Lorimer 2017, 27). What Lorimer also focuses on is the idea of 'symbiosis' in being dependent on each other, referring to symbiotic relationships that occur in probiotic management between species and humans and the mutual[2] benefit that can arise from such

[1] I use 'nature' in this thesis in a broad sense, referring to the environment and the natural world. Whilst I infer that humans are part of nature and this concept of the natural world, they also have an influence on it and can makes changes to it, which is why use humans to refer to humans as a species and nature as their environment.
[2] In this thesis, mutual refers to the notion of reciprocity in the symbiotic relationships in probiotic management.

management and relationships. The main reason I have chosen this movement as an example of moving away from current environmental conceptions is that probiotic management does not start with humans at the centre or the superior being but together with nature and nonhumans[3]. The need for mutual benefit between each other is important, and whilst compromise is bound to arise between parties in such management practices, it does not mean that nature's needs will be disregarded.

Another author I refer to in this paper is anthropologist Anna Tsing. Her work in her novel *The Mushroom at the End of the World* helps illustrate the importance of human impact and interaction with nature and the need for diversity in our ecosystems. Tsing acknowledges that interference with nature from humans is not the problem, but how we interfere and attach human-centred values to nature and treat nature as a commodity is the problem. Tsing's work ties in well with Lorimer's as it highlights the importance of particular species and symbiotic relationships.

Arguing the need for change is one thing, but understanding why change is needed is another. Although the idea of 'going probiotic' is indeed attractive with its focus on nature and mutually beneficial relationships, there is still cause for concern which needs to be addressed. These concerns include how and why nature is managed in probiotic management, looking at how nature is valued in this process, and how far probiotic management can go in an ethically viable way. To address these concerns, I look to environmental ethics for a framework that can be applied to probiotic management. The theory that I consider best to do this is with deep ecology, an environmental framework that regards humans and nature as part of one another, promoting a holistic relationship with nature that does not stem from human-centred values.

To illustrate deep ecology, I use the work of philosopher Arne Naess, who coined the concept of deep ecology in 1972. Naess developed eight principles to create a framework that deep ecology stemmed from, highlighting the need for change in human behaviour and policy and respecting nature for its inherent worth rather than just as a resource (Naess 1995, 68). While these principles are important, Naess developed his own philosophy within the realm of deep ecology, which he labelled 'Ecosophy T'. In this philosophy, he expands on his principles to reject human-centred values but expands on his notion of 'self' and the importance of 'self-realisation' for humans to be able to connect with nature. The idea for Naess is that humans are

[3] I use the word nonhumans in this thesis to reference all living entities that are not human. This then includes animals, microbes, organisms and ecosystems that have a relationship with humans within probiotic management.

a part of nature, and thus, we should treat it as part of an extension of ourselves. It is this particular part on self-realisation that is important for applying this theory to probiotic management and being able to view this management of ecosystems as management within ourselves and nature, which I think would help foster a better understanding and attitude towards ecological management processes.

However, although deep ecology rejects the notion of human-centred values, there is cause for concern that the idea of 'self-realisation' insinuates a human-centred view on viewing nature, as because it is a part of us, that is why we should respect it. Philosopher Peter Reed acknowledges this and goes one step further to say that this idea of 'self' being an extension of nature rejects the notion of 'Otherness', explaining that we should respect nature *because* it is apart from us (Reed 1987, 65). These concerns are important in addressing the potential shortcomings of deep ecology and how this also applies to probiotic management.

The Setup

This thesis is made up of six chapters following the introduction. The first chapter describes ecological management and highlights important literature on ecological management from Eric Higgs and Jozef Keulartz. This chapter paints the picture of what ecological management is and the introduction of the probiotic movement in ecosystem management. The second chapter follows into the realm of what I have defined as 'probiotic ecology', what probiotic management is and what the 'probiotic turn' and 'going probiotic' really mean in reference to the work from Lorimer. The benefits of probiotic management are considered, followed by the ethical concerns that such management can bring and why we should consider environmental ethics to help address these concerns. The third chapter then addresses current environmental ethics, zoning in on deep ecology from the perspective of Arne Naess and the concept of 'self-realisation'. I use Peter Reed's critique of Arne Naess' concept of 'self-realisation' to address the potential problems that deep ecology still seems to hold regarding human-centred values. In the fourth chapter, I evaluate what has been discussed in this paper and examine why deep ecology is useful to apply to probiotic management. Although deep ecology can be interpreted to have undertones of human-centredness in its concept of self-realisation, I conclude that the argument that Naess makes is useful for understanding how we can better connect with nature. Applying such a theory to movements such as probiotic ecology can be helpful in building boundaries on what is too much and what is too far in our treatment of nature. The fifth chapter briefly addresses points in this debate that were not explicitly mentioned but are still important

for future research. The final section concludes the thesis and confirms what has been addressed in this paper.

1. ECOLOGICAL MANAGEMENT

As a species, we humans have been manipulating and managing nature in more ways than can be accounted for. Whether this is done explicitly (on purpose) or implicitly (a consequence of something else), the environment and nature have changed drastically due to human impact. The Intergovernmental Panel on Climate Change (IPCC) has stated that human activities have "unequivocally" caused global warming (IPCC 2023, 4), and whilst not all changes to nature or the environment are related to or have caused global warming, it is a clear example the impact changing the environment can have.

There are many reasons for the management of ecosystems and nature. Some changes are made as mitigation practices due to climate change impacts, such as how the Netherlands have made dikes and controlled water drainage in soil surfaces to help prevent and manage flooding (Ritzema and Van Loon-Steensma 2017). Other changes are made for economic gain, such as the administration of pesticides and fertilisers in agriculture to maximise yields. Some changes are made to help restore nature from other impacts (human or natural), such as rewilding projects, and some changes are made for research and scientific developments. The capacity of environmental change and management has and always will be present, but the reason for making such changes is what raises ethical concerns about how nature is treated and perceived.

The emergence of managed ecosystems has long been acknowledged, often referred to in literature as 'novel ecosystems', 'emerging ecosystems' and 'designer ecosystems' (Keulartz 2012, 48-49). While 'novel ecosystems' are considered to have unknown functional characteristics with new combinations of species, 'designer ecosystems' are classed as synthetic systems that have purposely been invented to achieve ecological, social and economic goals (Keulartz 2012, 49, 51). According to philosopher Eric Higgs, humans are in the process of choosing between 'focal' and 'technological' design of nature, where focal design is concerned with the relationships between nature and humans, and technological design is concerned with the patterns of technological design and the commodification of nature (Higgs 2003, 186; Keulartz 2012, 49). In other words, what Higgs seems to suggest is that we have one co-habitable outlook on nature and another outlook that perceives nature more as a resource we can modify, such as through technological advancements. Philosopher Jozef Keulartz expands on this, making the distinction that focal design is based more on a balance of needs and values between nature and humans, whilst technological design is based more on human-centred needs and values, using technological advancements to have a degree of agency over nature (Keulartz 2012, 49).

One of the main points of concern that Keulartz mentions in his essay about ecological restoration is the commodification of nature; that if nature is not perceived to have agency of its own, then it will be treated as a commodity (Keulartz 2012, 49). Keulartz illustrates the issue of nature already being treated as a commodity through an example given by Higgs on mitigation practices with emissions. Through mitigation practices, companies are able to compensate for the damage done to the environment by restoring or improving an area of equal ecological value, enabling these restored or renewed ecosystems to be converted into tradable units (Keulartz 2012, 54-55; Higgs 2000, 206; Higgs 2003, 208). The problem that arises from this is that human intervention is needed to help repair the damage that humans have caused. The key problem that follows here, then, is that nature is not being considered as a stakeholder in this intervention and management process but as a replaceable unit.

At his time of writing, Higgs believed that we were at the crossroads of choosing a technological or focal path on ecological management and restoration (Keulartz 2012, 53). His solution in addressing this was to "wait a decade or two" before making drastic changes to nature [through the technological path] (Higgs 2012, 98; Keulartz 2012, 67). The problem is, more than a decade has now passed and we are still facing the same problems and concerns about how to balance nature and human needs and whether this is even possible. It is clear that human intervention is inevitable, but how this is carried out needs to be reviewed.

Assessing the degree of human-centred values in ecological management has become a growing issue. Whilst there are many forms of ecological management that are human-centred, there are also new forms of ecological management progressing that appear to be motivated by more than monetary gains. One of these forms of ecological management is referred to as 'probiotic management', coined by Jamie Lorimer in his novel *The Probiotic Planet*, which looks to manage ecosystems in a holistic way to mutually represent the values and needs of both humans and nature.

To understand what probiotic management is, I will first address the concept of probiotic ecology, which is the theory that I consider probiotic management to fall under. After extensive research, it seems that the concept of 'probiotic ecology' has not been coined nor defined, so I am taking this opportunity to do so in this thesis. Although there is no specific definition to this concept, it does not mean that it has not existed, but more discussed and addressed under different names with similar meanings, such as those above by Higgs and Keulartz. The debate

of probiotic ecology thus derives from other ecological and ethical concepts that address the same goals and concerns as probiotic ecology.

The term 'probiotic' is defined as living microorganisms that are beneficial to the host that it is administered to (Amenyogbe 2023), and the term 'ecology' is defined as the study of relationships between organisms and their environment (Smith and Pimm 2024). With these definitions in mind, I define probiotic ecology as the science of studying and examining the relationships in probiotic management and using this knowledge to make changes in ecosystems and relationships with nature. Probiotic management is the key focus here, as this seems to be a concept that has had many meanings over the years. I take probiotic management to mean precisely that: the management of probiotics, with the main point here being the management of these probiotics (the organisms) in ecosystems and nature.

Lorimer introduces the concept of probiotic management as a way of "managing life with life" in ecosystem management and studying how biophysical systems change and modulate their ecological reactions, looking at their tipping points and boundaries, and how they can control their functioning because of this (Lorimer 2020, 2). Whilst probiotic management is carried out through human intervention, the level of human-centredness does seem to differ from the projections that Higgs suggested would come from ecological management. The idea behind probiotic management that Lorimer proposes is to find a mutual benefit for humans, nature and nonhumans, even if that means compromises on both sides (Lorimer 2020, 9). The difference here is that the 'technological' advancements that Higgs and Keulartz were concerned about can be perceived differently in probiotic management, as rather than managing ecosystems in a synthetic way, such as in novel ecosystems, the notion in probiotic management is to manage life with life and to use available resources to act as they would but in specific contexts.

There are two main concerns that can be attributed to probiotic management and that is: 1) *How* is nature managed and why? Is it to manage it to be more efficient? Economic gain? More attention to the internal dynamics of organisms? The key point being that probiotic management is still using nature as a resource and defining its usefulness based on how it can be managed. And 2) is the concern about how far this management will go and the ethical viability behind such management. I address these concerns in this thesis and look to find an environmental ethical framework that can be applied to such an ecology to address these concerns.

2. PROBIOTIC ECOLOGY

This chapter will discuss what probiotic ecology is, distinguishing the differences between ecology, management and movement, where probiotic ecology stems from and how it is now being developed. Jamie Lorimer's book *The Probiotic Planet* will provide the basis and guidance in explaining what 'going probiotic' means, how this works and what is needed to do so by exploring the Gaian theories, keystone species and the importance of symbiotic relationships. Anna Tsing's work from her book *The Mushroom at the End of the World* will be used to demonstrate elements of symbiotic relationships and what she refers to as 'assemblages'. The following section will then discuss the need for probiotic ecology and probiotic management, focusing on ecosystem shifts with rewilding and collaborative relationships in ecosystems. The chapter will then end with reflecting on the ethical concerns that arise from probiotic management, such as the general ethical concern of manipulating ecosystems for external benefits and potential animal labour exploitation.

What is Probiotic Ecology?

As I defined in the previous section, the term 'probiotic' is defined as living microorganisms that are beneficial to the host that it is administered to (Amenyogbe 2023), and the term 'ecology' is defined as the study of relationships between organisms and their environment (Smith and Pimm 2024), which I combine to define probiotic ecology as the science of studying and examining the relationships in probiotic management, and using this knowledge to make changes in ecosystems and relationships with nature. Lorimer uses the term 'probiotic' in the expansive sense to describe human interventions in nature that use "life to manage life" (Lorimer 2020, 2), and refers to the process of probiotic management as studying how biophysical systems change and modulate their ecological reactions, looking at their tipping points and boundaries, and how they can control their functioning because of this (Lorimer, 2020, 2). How and why these changes are made is a crucial part of the process and how they get to their end result. This notion of probiotic ecology is thus focused on the functions, interactions and management of organisms in ecosystems and the mutual benefits that they can provide in these relationships. In this thesis, I use 'probiotic management' to refer to the management, engineering and changes of ecosystems, and 'probiotic ecology' when referring to these processes as a whole.

Lorimer further expands on this notion of probiotic management in ecosystems in his book *The Probiotic Planet* and other publications that has created a foundation for this new movement on what he calls the 'probiotic turn'. For such new and innovative ways of looking at

ecosystems, Lorimer is able to explain and expand on this probiotic concept very well, so I will reference and use his work to illustrate arguments around probiotic ecology and management.

The Probiotic Turn

To understand the concept of probiotic management, we must first introduce why it needs to be considered. I use Lorimer's concept of the 'probiotic turn' to illustrate this, looking at the need to move away from current management practices and use his reference to Gaian ontology to understand how the world functions and the need for planetary understanding.

Away from Antibiotics

Lorimer argues how humans and the environment are currently used and managed seems to be more purified and controlled (Lorimer 2017, 27), which he refers to as an "antibiotic" approach to managing life (Lorimer 2020, ix). An example of this can be seen in the use of fertilisers to manage bacteria and organisms in agriculture. According to Arden-Clark and Hodges, inorganic fertilisers struggle to preserve soil structure, which can cause fluctuations in nutrients and can reduce soil faunal populations, such as earthworms (Arden-Clark and Hodges 2012). In comparison, organic fertilisation tends to maintain soil structure, encourage the growth of beneficial soil fauna and contribute to controlling microbial pathogens (Arden-Clark and Hodges 2012). Environmental scientists argue that these processes of eradicating species and rationalising environmental processes undermine the functionality of ecosystems (Hinchliffe et al. 2016; Lorimer 2017, 28).

It is not that Lorimer rejects this 'antibiotic' approach, acknowledging the good that this way of living has evolved hygiene practices and lives (Lorimer 2017, 27). We can see how the use of pesticides has been an integral part of agriculture over the years, with food grain production increasing from 50 million tonnes in 1948 to 198 tonnes in 1997 in India (Aktar et al. 2009, 1). However, although this is arguably beneficial in terms of food production and meeting the needs of growing populations, it seems to come at a cost. In 1990, the World Health Organisation (WHO) conducted research into pesticide poisoning, estimating one million cases of unintentional pesticide poisonings per year (WHO 1990, 88), which has still not officially been updated. Boedeker et al. conducted research that was published in 2020 to try and update these findings, estimating that 385 million unintentional acute pesticide poisonings happen annually (Boedeker et al. 2020).

What Lorimer is promoting with the 'probiotic turn' is more of a post-antibiotic approach that he strives for and a recalibration of good and bad organisms in ecological management

(Lorimer 2020, 8). Instead of using chemical pesticides and fertilisers, the probiotic approach would be to use predators of agricultural pests in place of these synthetic chemicals (Lorimer 2020, 48). This is not only in relation to agriculture but in ecosystem management as a whole. Lorimer thus argues for the need to move away from this current antibiotic mode of living and introduces his concept of 'going probiotic' through probiotic management to do so. This is what I perceive to be a way to manoeuvre into a new kind of ecology: probiotic ecology.

Gaian Ontology

Works from biologist Lynn Margulis and environmental scientist James Lovelock created a foundation for understanding how microorganisms work with their 'Gaian Hypothesis', a theory that states the biosphere is an "active, adaptive control system" able to stabilise earth in homeostasis (Lovelock and Margulis 1973). The connection to probiotic ecology is that this stabilisation comes from the interactions and relationships between organisms and the biological processes in ecosystems that carry out this adaptive and stabilising role. Lorimer references Margulis and Lovelock in *The Probiotic Planet*, where he expands on these biological processes and refers to the Gaian hypothesis as the framework which the 'probiotic turn' is founded upon (Lorimer 2020, 6).

Gaian ontology is based on the idea that the world is a self-regulating nonlinear system, shaped by the interconnected relationships in these systems (Lorimer 2020, 6). This Gaian concept is used to relate to probiotic management by looking at ecosystems as a network of systems, each dependent and interconnected in their roles and functions. In Gaian thinking, the world is unpredictable and complex, with multiple stable states that have no clear and definitive way of being managed (Lorimer 2020, 6, 8). The systems and the relationship between the systems that enable the earth to regulate itself are what need to be looked after and maintained to ensure that Gaia is able to self-regulate. One can then infer from this thinking that in connection with probiotic ecology, looking after these systems and seeing ourselves as part of these systems makes way for a more interconnected realisation of ourselves in Gaia. Using probiotic management to maintain and enhance ecosystems and their functions can then ensure Gaia is able to thrive.

Gaian ontology is an important starting point in probiotic ecology, understanding that the world is not finite or predictable but a system that we rely on and that also relies on us to maintain our practices in order for it to regulate itself. Probiotic management is thus used to regulate

these systems in a more natural and organic way[4] in terms of this probiotic movement, rather than the 'antibiotic' way that is currently being used and create mutually beneficial relationships in the process.

Probiotic Management

Now that the need for probiotic management has been addressed, I will proceed to define the actual process of probiotic management. I will use Lorimer's concept of 'going probiotic' and the case studies of rewilding and biome restoration to illustrate this, expanding on the importance of symbiotic relationships and keystone species in probiotic management.

Going Probiotic

The idea of 'going probiotic' for Lorimer relates to ecosystem management used for specific reasons, including farming, pest control, bioremediation and waste management (Lorimer 2020, 2). This can be related to other modes of environmental engineering that we have already seen with flood management systems, coastal realignment strategies and afforestation to manage changing weather patterns. The difference with probiotic management is that the focus lies in how organisms in these ecosystems function and react with each other and the mutual benefits that can come with this. These mutually beneficial relationships are symbiotic relationships, referring to the interconnectedness and dependencies between life forms (Lorimer 2020, 6), which will be explored more below.

The two main case studies that Lorimer refers to to illustrate 'going probiotic' are rewilding and biome restoration (Lorimer 2020, 25). Rewilding is referred to as the management process of biophysical systems, such as natural flood management and coastal realignment (Lorimer 2020, 3). Lorimer refers to biome restoration as the "proactive management of the human microbiome for the purposes of restoring health" (Lorimer 2020, 37). Whilst Lorimer's views on human biome restoration are important and interesting, this thesis is specifically looking at ecological management within nature and the challenges of this, and so I refrain from delving into human biome restoration and instead relate the concept to ecosystem biome restoration.

For the first case study, the main type of rewilding that Lorimer focuses on is 'trophic rewilding', which is an approach that introduces species to restore ecological interactions, hoping to promote more regulatory and biodiverse ecosystems (Lorimer 2020, 26). This type of rewilding is more about managing the processes within ecosystems, which is important in

[4] In this instance, natural and organic refer to ways of ecosystem management that are not 'antibiotic', such as the use of synthetic pesticides or fertilisers, or other ways of mimicking nature.

the process of probiotic management as this focuses on how ecosystems work and how to ensure that they work most efficiently. The idea behind this is to create more interactive networks in ecosystems, rather than keeping these conservations separate from humans and other ecosystems, to breed a more connective relationship. One of the key components of probiotic ecology is focusing on these interconnected relationships of ecosystems, and so creating a more interconnected rewilding process will hopefully foster these relationships.

An example to illustrate trophic rewilding can be seen in the reintroduction of beavers to help manage issues in ecosystems. Whilst once extinct in Britain, beavers have been reintroduced back into Britain from Bavaria and are now a protected species (Lorimer 2020, 32). Their ability to reshape streams as they make damns and slow water flows, thus preventing flooding and drought and improving water quality are some of the many reasons why beavers are being introduced to manage ecosystems (Tsing 2015, 22; Lorimer 2020, 32). Rather than keeping beavers separate in closed-off conservation, this process of rewilding allows us to co-exist with beavers in a way where they help us with flood management by building damns, and we ensure they remain protected.

For the second case study, Christon Hurst defines a biome as a specific geographical area that is interconnected with an ecosystem with a particular biological community (Hurst 2021, 7). Biome restoration is restoring a specific biome after it has been degraded or damaged, which we can see in agricultural practices and the degradation of soil microbes. Hurst defines microbes as the "foundation upon which our living world rests" (Hurst 2021, 6) and that the functions of agricultural fields depend on the microbial functions of their soil (Hurst 2021, xv). In probiotic management, biome restoration in agricultural soil health would look to restore the microorganisms that sustain agricultural soils and look to use probiotic processes that enhance these organisms rather than deplete or destroy them, as with synthetic pesticides and fertilisers.

The concept of 'going probiotic' is not about putting human-centred approaches ahead of nonhuman interests but finding a common ground to work with. Whilst our interests as humans are still important, we have to consider networks and ecosystems as a whole and understand that nature has value in its own right, and we should work with nature rather than just use it. Instead of killing animals or organisms that might considered a pest in one way, the idea is to let them do their thing where they do it best.

Symbiotic Relationships

To understand probiotic ecology, we need to understand the relationships that are being studied. These studied relationships are referred to as symbiotic relationships, which shape the systems of Gaia (Lorimer 2020, 7). Symbiotic relationships function around the ecological dynamics of ecosystems, working to secure what is deemed to be the desired[5] ecological service or role (Lorimer 2020, 8). The concept of symbiotic relationships derives from the Oxford definition of symbiosis, where two different organisms live attached to each other and contribute to each other (OED n.d.). The mutual dependence and benefit that is experienced is what is meant to come out of symbiotic relationships, with species/organisms working with each other to reach a mutually beneficial outcome. In reference to probiotic management, where and how the symbiotic relationships occur can be orchestrated, such as placing certain species in certain areas to create a specific result. In probiotic management, some relationships need more management and intervention than others to produce specific results.

An example of a symbiotic relationship in probiotic management is the relationship between beavers, nature and humans. Whilst carrying out their innate behaviours of water management, they not only provide benefits for themselves as a species but also for the ecosystem and other surrounding species. With the elevation of water quality, the surrounding areas are able to store and deposit nutrients and increase interaction with aquatic vegetation, which extends wetland areas and increases plant growth and diversity (Brazier et al. 2020). These incredible natural manoeuvrers that beavers carry out not only benefit the surrounding ecosystem but also benefit humans. The introduction of beavers as natural water source managers is being deployed as a natural way of ecosystem management without the use of manmade damns or flood defences in small streams and dikes. The expansive impact that beavers have and the multiple connections that they have with their surrounding environments is what makes them an essential example of a symbiotic relationship.

However, in the case of beavers, more management and intervention are needed compared to other symbiotic relationships. Beavers have been proven hard to enclose, breeding well and gnawing through fencing (Lorimer 2020, 32), which was not exactly the desired outcome through their reintroduction. Nonetheless, this is a key example of how probiotic management

[5] Here, the word ‘desired’ refers to the preferences of the results by the people who are carrying out the process of probiotic management.

looks to work, and whilst every action of a beaver is not desired, it is understood that there will have to compromise on both human expectations and beaver behaviours.

Another example of a symbiotic relationship can be seen in biome restoration between an earthworm and soil. A worm's natural burrowing cycle through soil creates pathways that allow water and oxygen to move more freely (Spurgeon et al. 2013). These burrows contribute to soil macropores, stimulating soil microbial activity and mineralisation from plant residues (van Groenigen et al. 2014). These little ecosystem workers are able to improve plant growth and soil filtration just by following their evolutionary routine of burrowing. This symbiotic relationship can be a low-level way of probiotic management, as the worms are left to do their thing in the soil they are distributed to. There is less need for guidance or interference, such as with beavers, as they are a less invasive species to other parts of their ecosystem.

Anna Tsing shows an example of a particular symbiotic relationship in her book *The Mushroom at the End of the World* through fungi. Tsing's example is the matsutake mushroom, which is now the most valuable mushroom on earth (Tsing 2015, 4). Matsutake mushrooms live in human-disturbed forests and require dynamic diversity from multispecies (Tsing 2015, 4, 40). Matsutake mushrooms are able to nurture their host trees, even in poor soils and without fertile humus, due to how their fungus absorbs its nutrients from its host tree (Tsing 2015, 40). This mutualistic relationship functions based on the positive feedback loops, with the fungus gaining nutrients from the tree and the tree gaining nourishment from the fungus. It is this incredibly specific and dynamic relationship that makes it impossible for humans to grow matsutake mushrooms on their own, thus contributing to making them the most valuable mushroom in the world (Tsing 2015, 40). What is crucial here is that, although the process starts off with the initial human disturbance in a particular area, the rest of the relationship is not managed by humans. It is still a symbiotic relationship and is still a way of illustrating how organisms influence each other, however, the 'management' in this is purely dynamic and natural[6] after the first initial 'disturbance'.

Another way of viewing these kinds of relationships and their impact is through Tsing's concept of 'assemblages' to describe the complex functions in ecological communities and how organisms in assemblages influence each other (Tsing 2015, 22). The concept of assemblages derives from the work of Gilles Deleuze and Felix Guattari, who use the word assemblages to

[6] In this instance, dynamic and natural refer to unfixed and untouched; the management here was only the initial step of creating the initial disturbance and the rest of the 'management' is thus natural in the sense that there is no human interference.

describe the gathering of things into unities which form functional wholes that are ever-changing and work together in harmony (Nail 2017, 22, 35; Deleuze and Guattari 1987, 7, 16). Tsing uses this concept in a similar way in relation to how symbiotic relationships function. The earthworm example can also be applied to this and expanded, where not only the earthworm and soil are in this assemblage but all the organisms that exist within the soil, the plants that grow in the soil, and so on. All of these interactions shape each other and the outcomes of their functions, depending on each other to work well together. For probiotic management, understanding how these assemblages' function is useful to understand how best or how much to manage these assemblages and how the outcomes of these functions can be made of use to each part of the ecological community.

Keystone Species

The above examples show how these symbiotic relationships work, but the species themselves are the key workers in managing these relationships. Lorimer discusses how symbiotic relationships exist through what he refers to as "keystone species", an organism that has disproportionate influence on an ecology (Lorimer 2020, 60). Keystone species are also what Jones et al. labelled "ecosystem engineers", referring to organisms that are able to "directly and indirectly modulate" resources, ecosystems and habitats (Jones et al. 1994). Jones et al. explain how there are two types of ecosystem engineers: autogenic engineers and allogenic engineers (Jones et al. 1994). Autogenic engineers are able to change their environments through their own physical structures, such as their living or dead tissues, such as corals (Jones et al. 1994). Allogenic engineers are able to change their environment through the transformation of materials from one physical state to another, such as beavers (Jones et al. 1994).

After identifying keystone species, the idea in probiotic management is to identify their behaviours and how they function, manage the distribution of these keystone species, such as introducing them into specific areas that need ecological management, and look at ways to maintain and develop these relationships (Lorimer 2020, 87). These keystone species are not selected based on their rarity or productive potential, as can be seen in conservation projects and agriculture, but instead valued for their "topological centrality" within their ecological network (Lorimer 2020, 87). What Lorimer means here is that keystone species are prioritised over their ability to maintain leverage and control over the network that they have been distributed to, rather than prioritised just because they are a rare species or are specifically productive. This does not mean that these characteristics are never taken into account, but for the sake of probiotic management, the emphasis is not on these characteristics.

Keystone species are at the centre of probiotic management, as they are the species that enable ecologists and ecosystem managers to be able to design experiments based on the actions these keystone species show in certain environments. Examining how they function and work can enable us to see what the tipping points of ecosystems are, where connections can be improved and what can be done to improve relationships in these networks. In the case of beavers, if we can see how beavers function in an ecosystem, then we could add them to a deteriorating ecosystem that would benefit from their behaviours to modify and improve the ecosystem in a natural (probiotic) way. This concept relates back to Gaian ontology, where environments shaped by symbiotic relationships develop a common set of management practices which are "geared toward nurturing and modulating ecological dynamics" to create "desired ecological functions and services" (Lorimer 2020, 7). The point of identifying keystone species and how they function is important to be able to recognise best where their efforts will be best suited.

Keystone species are deployed and distributed to certain environments to provide some sort of ecological management with the hope of creating a more efficient and mutually beneficial network. The ecosystem engineers are able to create, modify, maintain and destroy habitats (Lorimer 2020, 60; Jones at al. 1994). As they are able to conflict such change, the idea in probiotic management is to see where they can do this best in the most mutually beneficial way. The example of beavers can be used here to demonstrate this, as beavers flourish most by water and are thus most efficient when near water. Beavers are being introduced to multiple landscapes across Europe as flood managers with their ability to be able to slow water flow (Lorimer 2020, 33). Projects from the OVP in the Netherlands also use beavers in their techniques to accelerate and slow water tracks and rewetting initiatives, with the aim of enhancing biodiversity and water quality (Lorimer 2020, 49).

However, as both Lorimer and Jones et al. state, keystone species do not only provide benefit but can also cause disruption. Although the behaviours of beavers outside of their ability to modulate water flow might not be mutually beneficial to all the considered relationships in the beavers' network, this is a key consideration that we have to look at in probiotic management. While the idea within probiotic management is to foster mutually beneficial relationships, this will not always be the case. Keystone species are powerful in their own right, and whilst it is useful and efficient to hone in on their skills, the idea is not to change how they work specifically but rather to benefit from how they act in a mutual way. Ways in which this can be managed can be seen in the use of 'beaver deceivers', which are devices that silently lower the water level in a beaver catchment without the beavers noticing (Lorimer 2020, 33). The beaver

does not act any differently per se and still functions, but the outcome is more beneficial to other parties involved in this symbiotic relationship.

Why do we need Probiotic Management?

One of the key aspects of promoting probiotic management seems to be centred around moving away from current ways of ecological management that are more focused on human interests and view natural resources as commodities. Probiotic management focuses on the need for mutually beneficial relationships between humans and nonhumans, even if humans have to make compromises to make this work. Of course, this does not mean that nonhumans will not compromise either. Having beavers running wild is not only unbeneficial for humans but also for other species and organisms in their ecosystem. It is the very concept of probiotic ecology in studying probiotic management and working out what works best and how relationships function that is different from current ecologies. In this section, I look at some of the reasons that are mentioned in the literature on probiotic management and ecosystem engineering on why it is needed. The first reason highlights the antibiotic era that Lorimer refers to and how probiotic management provides an alternative to this. The second reason is the need for a better environmental outlook, which probiotic management seems to help provide. The final section draws on Tsing's concept of collaboration and the importance of such unified approaches to nature that can be seen in probiotic management.

'Antibiotic Era'

Lorimer refers to the 'antibiotic era' as the era we are currently living in. The term antibiotic is used to describe the ways to "control unruly ecologies" and "eradicate, control, rationalise, and simplify life" (Lorimer 2020, 2). While Lorimer acknowledges that being 'antibiotic' has extended human life, he argues that this approach has become excessive and that these modern modes of management may be disturbing and intensifying natural processes (Lorimer 2020, 3). Lorimer states that ecologists describe the current missing microbes and keystone species stem from the antibiotic management of life, which seems to contribute to dysfunctional ecological conditions. (Lorimer 2020, 6-7). Again, the argument is not that management is the problem but how it is conducted. With probiotic management, the focus is on strategically deploying keystone species to areas that would benefit from such management (Lorimer 2020, 7).

Environmental Outlook

Probiotic management seems to offer a new way of perceiving nature and the environment, moving away from viewing nature as a commodity and as somewhere that we are also part of.

The process of probiotic management is to find mutually beneficial ways of co-existing together with nature, which means that nature's values and needs are taken into account, as well as our own values and needs. In environmental ethics, we cannot completely disregard human interests, and doing so is impossible; we have to take care of ourselves (Plumwood 2001, 128). But taking care of ourselves also includes taking care of nature; we rely on and live off nature. Probiotic management seems to offer a way to better take care of nature whilst still providing space to take our interests into account.

Collaboration

For mutual relationships to exist and function, there has to be some sort of partnership for those involved. This is an important concept for probiotic ecology, which Anna Tsing illustrates through this idea of collaboration. Tsing argues that collaboration is needed for every species to survive (Tsing 2015, 28). Tsing's idea is that purity is not an option and changing with the circumstances in a collaborative sense is what enables species to survive (Tsing 2015, 27). This collaboration is based upon the idea of precarity, which Tsing defines as the state of acknowledging our vulnerability and in order to survive, we have to depend on each other to help one another (Tsing 2015, 29). It is through these collaborations and dependencies that we are able to transform and evolve (Tsing 2015, 29).

The connection we can make with Tsing's concept of collaboration with probiotic management is that orchestrating and managing ecosystems is a collective effort between those involved. Each organism and species become intertwined together, reliant on the other and functioning together. Tsing makes the connection that this collaboration stems from 'contamination', with contamination meaning the instigation of such a process that contributes to change (Tsing 2015, 28), with this being the case in probiotic management with the orchestration or management of an ecosystem as the 'contamination'. This is not to say that contamination is bad as the word may suggest, but that this contamination is what creates the diversity within the collaboration of organisms and species; and without contamination, there is no diversity, and for Tsing, it is the diversity that has enabled the creation of the Matsutake mushroom.

We can then see that collaboration should be encouraged in probiotic management, as collaboration is part of the foundation of what makes these ecosystems function. The collaboration of organisms can be seen as part of the symbiotic relationships that Lorimer refers to, which are at the very core of how probiotic management functions.

Ethical Concerns and Limitations of Probiotic Management

While there are many advantages of introducing probiotic management, there are also limitations and ethical concerns of how probiotic management is carried out. This section will start with the concern of excessive management and how far this could go in probiotic management, reflecting on Anna Tsing's concept of the 'latent commons'. The second point will look at one of the biggest concerns of probiotic ecology and probiotic management, which is how animals are used in management practices.

Excessive Management

While the reasons for probiotic management stem from needing to move away from this 'antibiotic' way of living, there still seem to be some underlying reasons for probiotic management. One of the first concerns that stands out to me is the notion of control over nature. Making changes to nature implicitly is one thing, but manipulating and managing ecosystems takes this to the next level. Regardless of how extensive our research and science go, there is no definitive way of predicting exactly how an ecosystem will react to such management practices.

Anna Tsing introduces the concept of the 'latent commons', which highlights the implications of interference in nature and its predictability. Tsing states that the opening of these commons "shifts everything" (Tsing 2015, 255), as once one species is introduced, it does not mean that everything will act as we expect it to. Tsing states that we "can't hope for harmony" and that "the lion will not lie down with the lamb" (Tsing 2015, 255). In other words, whilst we may hope for the 'desired' results Lorimer refers to in probiotic management, nature has its own way of existing, and we cannot expect it to act accordingly. This can be applied to the example of beavers: what happens when beavers no longer act how we want them to act? Although there are many beaver experts and research to suggest how beavers will act, there is, again, no definitive way to predict such outcomes. Tsing argues that the best thing to do in this respect is to aim for "good enough", enabling there to be room for improvement, but hoping for the best possible outcome (Tsing 2015, 255).

Tsing goes on to further state that the latent commons "are not for everyone" (Tsing 2015, 255), meaning that some species can be disadvantaged, whilst other species may be more advantaged. Between beavers and their ecosystems, other microbes and organisms may be more advantaged as they reap the benefits of what beavers provide. Whilst they also provide their own

advantages to the ecosystem, we could look at beavers having less control over where they are able to perform their duties as they have been placed there for that specific reason.

Another concern that probiotic management raises is this idea of efficiency in such a management practice. Although it is not explicitly stated that this is the reason for probiotic management, it does seem to be an inferred consequence of such a practice. What seems to be the issue here is the subjectivity of efficiency; what may seem to be efficient for humans may not be efficient for nonhumans. An example could be that of rewilding landscapes and the creation of parks that allow humans and nonhumans to interact. However, although adding green spaces and nature is beneficial for humans, this is not always the case for nonhumans. For example, some wild boar populations have lost their fear of humans and thus graze their landscape at will and damage crops in their vicinity (Lorimer 2020, 206).

These concerns highlight the need to consider what the threshold for probiotic management is and if mutual benefit really exists. There does not appear to be a set of guidelines or consequences for going too far, which seems to suggest that this has not been fully explored. And while the idea is to foster mutual benefits in probiotic management relationships, 'mutual' is also not fully defined. What humans may consider 'mutual' benefit may not be what nonhumans would consider 'mutual' benefit, and what humans may consider as not too far in management services, nonhumans may consider too far. Of course, there is not necessarily any way of knowing this, but I think this is an important consideration that needs to be taken into account if this way of management is really there to benefit nature and nonhumans.

Animal Labour

Another cause for concern from probiotic management is the treatment and perception of animals. Using animals to inflict specific changes in ecosystems can be viewed as exploiting what animals do for the sake of human needs and treating them as mere commodities. In probiotic management, keystone species are able to shift from being seen as pests to ecosystem managers when placed in the right setting. In these settings, they are used to perform certain labours under the management of humans. Lorimer acknowledges how animals have previously been viewed and states that in this shifting mindset in probiotics, keystone species form a "multispecies commons" that is communally managed and maintained (Lorimer 2020, 194). This notion of 'communal' management seems to suggest there is this mutual agreement of all species working together, and while that might be the case, there still feels an air of human superiority of organising such a system. The use of the words 'mutual' and 'communal' in

Lorimer's arguments for probiotic management seems to suggest this level playing field between humans, nature and nonhumans, but it still seems unplausible.

There are two points that Lorimer refers to that seem to confirm this concern about human superiority. The first is this perception of animals as commodities, as Lorimer states that keystone species become "lively commodities" and "service providers" (Lorimer 2020, 188), and there does not seem to be a distinction on whether this an aim in probiotic management or whether this is good or bad. When referring to the creation of commons in rewilding management, Lorimer also states that commoning does not seek to return to modes of economic organisation, nor imagine animals as not being treated as a commodity (Lorimer 2020, 198). Whilst it seems that Lorimer is arguing for better conditions for nonhumans through better ecological management and argues how mutually beneficial this would be for everyone, there does not seem to be a clear framework to ensure animals are treated more than mere services in ecological management.

The second point of concern is how value is attached to nonhumans. Lorimer states that, for example, beavers have been valued instrumentally as game, or they are "afforded" intrinsic value as an animal in the wild (Lorimer 2020, 188). The word 'afforded' insinuates that it is a favour, almost a gift, that humans 'afford' a species value. The concepts of instrumental, intrinsic and inherent value and worth have long been debated in environmental ethics. The general idea is that intrinsic value is a value that humans ascribe to something not for its usefulness but for its own sake, but also value that something has independent of the existence of the ability to ascribe value to something (Benson 2000, 5). These notions of value are still not completely clear because the argument stands to ask, do we value good things because they are good, or are they good because we value them? (Benson 2000, 5). What might be more useful to apply here is the concept of inherent worth, which is intended to mean value independent of human needs and purposes and the ability of humans to attribute value (Benson 2000, 5; Taylor 1996, 44-6). This then infers that nature and nonhumans are valuable, in and of themselves, without our view on whether they are good, bad, useful, not useful or economically viable. Whilst Lorimer wants to move away from this current conception of ecological management, and he does acknowledge that there is a danger of centralising the concept of labour of animals in probiotic management, there seems to be a mismatch with still ascribing types of hierarchical value to nonhumans.

Overall, while the advantages of probiotic management are clearly beneficial in multiple ways, there is still cause for concern. It seems comforting to tell ourselves that we are living in a mutually beneficial environment with nature in these symbiotic relationships and that we are providing a helping hand to nature in providing probiotic management over antibiotic management. It is nice to imagine that the beavers enjoy building damns in the spaces we place them to do so, and it is nice to imagine that this is something that is in the interest of all parties of the ecosystem. However, there seems to be a very thin line of what is in the interest of humans and what is in the interest of nature and how or if the two can be mutually exclusive. While nature can certainly benefit from such management in probiotic ecology, it is hard to distinguish if this is really for the greater good of nature and all concerned, or if this is just as human-centred as our current ways of ecological management and is just disguised under the idea of mutual benefit. The fact that humans still manage nature is something that needs to be highlighted, as although it is argued to be better than our current ways of ecological management, it seems that humans still have the central focus and upper hand in the results of such management practices.

Although these concerns of human-centredness are valid, the whole probiotic movement seems to be motivated by an ethic that is not purely human-centred but with a genuine concern for finding a better relationship with the world. What I want to provide with this thesis is a connection of an environmental ethic that would be suited best to accompany probiotic ecology to better articulate its ethos. The environmental ethic that I believe would be best suited to do this is deep ecology. Deep ecology is an environmental framework that looks at caring for nature as caring for ourselves and that nature is a part of us. We can attribute this to probiotic management in the context of symbiotic relationships and finding a balance between human and nonhuman interests. Here, deep ecology could be used to understand why we need to take care of nature aside from the benefits of the results from probiotic management.

3. ENVIRONMENTAL ETHICS

Environmental ethics is the study of ethics on the relationships and interactions between humans and nonhumans and is generally applied to questions that arise from environmental problems. It was in the 1970s that environmental ethics started to emerge in academia, where questions were raised about the relationships between humans and the natural environment, the impact of these relationships on the environment and the problems that were then occurring from these impacts (Brennan 2021). These questions posed a challenge to the traditional human-centred values of assumed moral superiority of humans over nonhumans and the issue of attributing value to nature (Brennan 2021). The practical purpose of introducing environmental ethics was to address these concerns and to provide a moral grounding for policymaking to help protect the environment (Brennan 2021).

During the emergence of environmental ethics as a separate branch of ethics, there have been many theories and frameworks that suggest how best to view and treat nature. Two of the central issues in environmental ethics are the type of value attributed to nature and how humans should view nature (Benson 2000, 2)[7]. Traditional environmental ethics advocates for the appreciation and conservation of nature through intrinsic value, often in connection with the rejection of the human-centred value of nature, such as in the theories from John Muir and Aldo Leopold (Brennan 2021). Richard and Val Routley (later Sylvan and Plumwood) expanded on this in their notion of intrinsic value. Routley and Routley state that taking human interests into account in assessing the value of nature already instrumentalises nature (Routley and Routley 1980, 121-3), which insinuates then that there has to be a separateness between humans and nature. Although they do indeed argue that we are a part of nature, they make clear that cultures that have taken on their perception of intrinsic value are the cultures that have seemingly been less destructive of nature (Routley and Routley 1980, 121-3).

Other environmental ethical theories pose a different perspective in environmental ethics, which advocate for inclusive relationships between humans and nature whilst still advocating that nonhumans have intrinsic value, such as the theory of deep ecology. Deep ecology was coined by Arne Naess, where he advocates for "biospherical egalitarianism", where living things have value in their own right (Naess 1995, 151). Naess uses this definition of deep

[7] A crucial part of environmental ethics is the notion of value, such as intrinsic value and instrumental value. I will use John Benson's definitions of value, where intrinsic value is twofold: it is the value we ascribe to something that we value not for its usefulness but its own sake, and value that something has independent of the ability to value something. Instrumental value is where something is value based on its usefulness. (Benson 2000, 5, 35).

ecology in contrast to what he called the "shallow ecology" movement, which is the focus on the fight against pollution and resource depletion from the interest of human needs (Naess 1995, 151). The difference between the two concepts is that whilst shallow ecology is regarding environmental issues (such as pollution), the reasoning behind addressing this issue is primarily for the health of humans rather than humans and nature. For deep ecology, these issues are addressed, but from the perspective of both humans and nonhumans and the effects that these issues have on both, looking at humans as a part of nature rather than separate. Due to deep ecology's perception of the interconnectedness of humans and nature, I use this ethical theory to address the concerns of probiotic ecology and the usefulness this could bring to the probiotic movement.

In this chapter, deep ecology will be defined, focusing on Arne Naess' concept of deep ecology, what that means for humans and nature, and the ethical framework that accompanies this theory.

What is Deep Ecology?

Deep ecology was first coined by Arne Naess in 1972, used to create a different and more applicable environmental movement in environmental ethics. Naess claims that "the essence of deep ecology is to ask deeper questions" in relation to our society and nature, focusing on the importance of his idea of 'self-realisation' in accordance with nature (Naess 1995, 4). Further elaborations of what deep ecology means can be seen by philosophers David Rothenberg and Peter Reed, who defined deep ecology as the belief that "today's environmental problems are symptomatic of deeper problems in our society" and these problems not only need to be solved but also questioned, along with developing methods that address the core issues (Reed and Rothenberg 1992, 1). They go on to state that it is not that we should stop industrialisation but question the extent of it and whether we need to be so reliant on what we produce, and while land might be useful, it may be better to preserve land for its own sake and value rather than that of humans (Reed and Rothenberg 1992, 1).

Whilst there are many aspects that are reflected by many authors on deep ecology, the main aspects behind deep ecology that I will focus on are from Arne Naess. The section will look at the eight principles that Arne Naess devised for deep ecology and connect these with probiotic management. The second part will focus on Arne Naess' own Ecosophy T, which includes the rejection of human-centred views, the attribution of intrinsic value to nonhumans and

biological life and the holistic relationship between nature and humans through Naess's concept of self-realisation.

Deep Ecology's Ethical Framework

Arne Naess developed a framework consisting of eight principles for deep ecology which can be referred to for environmental guidance. The eight principles stemmed from what Naess considered to be the most important issues of environmental ethics, which could be agreed upon by people regardless of religious or philosophical views, by reaching a common ground on what was needed to address environmental concerns. The eight points were not used to create a strict set of rules but a description that could be referred to that differed from the concept of shallow ecology.

The Eight Principles of Deep Ecology

The first point from Naess' deep ecology framework states that deep ecology rejects the "human-in-environment" image for a "total-field image", where organisms are the "knots in the biospherical net" and have their own intrinsic value, regardless of whether they are valuable to humans or not (Naess 1995, 151; Naess 1995, 68). This point refers to all forms of life, such as species, land, rivers and ecosystems, which all deserve concern and respect (Naess 1995, 68). We can connect this principle to probiotic ecology in the sense that probiotic management is not focused on human interests but the mutual benefit from symbiotic relationships. In probiotic management, keystone species are not based on economic value but on their contribution and function in an ecosystem.

The second point states that richness and diversity of life forms are precisely what contributes to richness and diversity and, regardless of whether these organisms seem less important or essential, should be valued in themselves (Naess 1995, 68). The complexity of these life forms is not something that we can judge just based on our own needs or values (Naess 1995, 69). The need for diversity can be seen in Tsing's concept of collaboration and the need for diversity in symbiotic relationships.

The third point states that humans have no right to reduce this richness and diversity, except for vital needs (Naess 1995, 68). This follows on the second point of respecting the value of an organism's richness and diversity, but Naess allows room for subjectivity here. He states that the word "vital" is left vague on purpose to leave room for discretion based on different societies and different environmental needs (Naess 1995, 69). This principle can be connected to probiotic management as keystone species and ecosystems can be considered vital in their

own right, and although we have the room to manage and manipulate nature, the point is not to do it based on human-centred interests, but for mutual benefit whilst still respecting the inherent worth of nature. It also seems here that the antibiotic way of management is indeed reducing nature's richness and diversity, which is what probiotic management also wants to move away from.

The fourth point states that the flourishing of human life that has been developed needs to be decreased significantly, as well as assuming an anti-class posture (Naess 1995, 68; Naess 1995, 151). The current form of human diversity and life is (in part) built on the backs of exploitation and suppression of certain groups (Naess 1995, 153). Naess emphasises that human consumption and exploitation cannot just be stopped overnight, and thus, interim practices need to be put in place to put this in motion (Naess 1995, 69). This principle can be connected to the reasons on why probiotic management is needed. It is acknowledged within the probiotic movement that capitalism has led to environmental degradation, which has led to the commodification of nature, which is part of what the probiotic movement wants to move away from.

The fifth point states that "human interference in the nonhuman world is excessive" and only seems to be worsening (Naess 1995, 68). The important part here is that human interference with nature is not always a bad thing, but it is particular activities and the level at which we interfere that is the problem. Naess states that non-interference is not possible, as humans have been interfering with nature since always, but the nature of this interference needs to change and should be focused more on ecological functions rather than values (Naess 1995, 69). Probiotic management shares this same concern that certain interference with nature is harmful, such as the antibiotic management that Lorimer refers to. The concept of interference is not the problem, but how it is carried out is the important part, which can be said for both deep ecology and probiotic ecology.

The sixth point states the need for policy change focused on ecological responsibilities (Naess 1995, 68). Naess explains that the current ideology of commodity value and consumption is unsustainable which requires global action to change these deep-seated attitudes (Naess 1995, 70). Although I have not mentioned the specific political regulations of probiotic ecology in this thesis, this does not mean that it has not been considered. Lorimer acknowledges that the probiotic turn is marginal in its political and environmental policy reach (Lorimer 2020, 51). One of the problems that seems to be consistent is that going probiotic is economically

configured (Lorimer 2020, 9), which seems to suggest that if it is not economically viable to go probiotic then policy will not advocate to do so.

The seventh point states that ideological change needs to be centred around appreciating life for its value rather than continuous progress (Naess 1995, 68). What we deem as "quality of life" is, to Naess, an "unquantifiable term", leaving the reader to interpret this based on their situation and aims (Naess 1995, 70). Probiotic management is also not focused on this neoliberal notion of continuous growth, but on the improvement of nature and our relationships with nature.

The eighth and final point leaves room for discussion, stating that those who agree with the points should then implement the necessary changes (Naess 1995, 68). This allows the reader to decide what is most important and what needs to be prioritised first based on their situation.

Overall, this framework is able to give an objective list of what is expected from deep ecological ethics, but also allow room for the subjectivity of applying this to certain situations. This broadness allows us to be able to attribute this framework to probiotic ecology, addressing the similarities is their principles.

Beyond the Eight Principles

Naess, purposely, left the interpretation of deep ecology to be fairly broad and subjective in accordance with his eight principles of deep ecology. The idea of the eight principles was not to create a rule-give definition of deep ecology, but a way in which to foster thinking and feelings over the important tasks of considering and dealing with how humans treat nature (Naess 1995, 214; 241). Keeping a broader and more interpretive framework was made to allow for a more integrated approach to deep ecology. Naess believed that there was no reason why supporters of the same movement had to adhere to the exact same definitions, and so for this reason created basic principles and phrases to propose a foundation for what deep ecology is supposed to mean (Naess 1995, 67). You can thus interpret the points that Naess devised, but if you disagree, then you are not a supporter of deep ecology (Naess 1995, 67-68).

Ecosophy T

While Naess created the general principles of deep ecology, he also had his own philosophy, which he named Ecosophy T. In this philosophy, Naess expands on some of the points in his eight principles, focusing on the intrinsic worth of nature and his concept of self-realisation. Whilst the main concept of deep ecology is important for probiotic ecology, Naess' Ecosophy

T is particularly important, as the relation to self-realisation and intrinsic value are key concepts that can be explicitly related to probiotic management.

Rejection of Human-Centred Views and Intrinsic Value

Deep ecology rejects viewing the environment and nature from a human-centred perspective and instead creates space for nature to be viewed in its own right, for its own sake. This perspective is interrelated with attributing intrinsic value to nature, as in deep ecology, nature is recognised to have its own intrinsic value outside of the value that humans appropriate to nature (Naess 1995, 153). In terms of how deep ecology views the earth, it recognises that the earth does not belong to humans and exists in and of itself (Naess 1995, 74). For example, in regards to pollution, the concern lies in how this affects all life (Naess 1995, 71). The fight is not against humans as such, but more against the economy that drives the demand that creates pollution and the technologies that cause it (Naess 1995, 71-2). The problem and the fight do not lie in the protection of humans, but the protection of all life in general (Naess 1995, 72).

Another example can be seen in how resources are viewed in deep ecology. No natural object should be perceived or treated merely as a resource or commodity (Naess 1995, 72). The issue lies in how far the resources that humans use is for "vital needs" or excessive consumption (Naess 1995, 72). For deep ecology, the emphasis needs to be placed on the ecosystems and how the use of resources interacts with the rest of nature. Mass consumption by humans is thus not a valid reason for ecosystems and nature to suffer and needs to be reconsidered in such cases.

Ecological Self and Self-Realisation

This section identifies the "ecological self", which illustrates how humans need to identify with nature and how in doing so will create the foundation of realising the holistic relationship between humans and nature. Naess explores what the term "self" has to offer in defining "self-realisation", which he argues is a key factor of deep ecology.

For Arne Naess, there is the Self and the self, with the Self referring to this notion of absoluteness, deriving from the Hindu Atman, which every living being is connected to (Naess 1995, 233). The self is the human individual self, and to reach the concept of self-realisation with the Self, we have to be able to reach a level of empathy in which we are able to identify with another living thing outside of ourselves (Naess 1995, 233, 227). This concept can seem quite complicated, and that is because it is, but what I infer from this notion of self-identification in regards to deep ecology for Naess is that we have to be able to see ourselves

as a part of nature, and to be able to do this, we have to realise ourselves and see past this Westernised view of being apart from nature. It is this very concept of realising our 'self' that will enable us to connect and see ourselves in nature.

Naess acknowledges that in our development of the "self", we have lacked to include nature in our realisation (Naess 1995, 226). He introduces the idea of the 'ecological self' to include nature in this paradigm, explaining that the meaning of life and the joy we experience are increased with the concept of self-realisation and identification with others, including nonhumans and nature (Naess 1995, 226). This ecological self is the part of our self that is connected to nature, such as where we come from, and should not be treated as separate (Naess 1995, 231).

However, the problem he identifies in the concept of self-realisation is that an enlightened self-interest from this self-realisation, albeit from humans and nonhumans, is not always in the same interest of the planet (Naess 1995, 226). By acknowledging this, Naess made space for understanding that if humans are expected to give up their self-interest for nature, it will not be sustainable in the long term (Naess 1995, 229). The idea he proposes is that we need identification *with* nature to create a natural and genuine self-love for nature, explaining that if humans can identify that conservation for nature is also in their own interests, they will be able to connect better with nature (Naess 1995, 226).

On one hand, this can still seem human-centred that humans need a reason to be able to connect with nature to be able to respect it. However, Naess reflects that this is part of human nature (Naess 1995, 237). A way in which he addresses this is through acknowledging our "potentialities"[8], where recognising our own potentialities and the potentialities of nature will create a deeper identification with nature (Naess 1995, 229-30). The idea is that understanding and knowing our potentialities will enable us to be more enlightened when recognising our ignorant behaviours (Naess 1995, 230), such as bad behaviours that negatively impact the environment.

The formation of the ecological self is built upon these above notions, with the idea in mind that by creating an ecological self in ourselves through identification and relation, we will be able to respect nature from a more genuine and empathetic point of view. Naess states that we have created this for ourselves if we are able to honestly see the destruction of nature as part

[8] What we are capable of doing as beings.

of a destruction of ourselves (Naess 1995, 232). We want to defend nature as we would ourselves because we are able to identify with nature through our ecological self and as a part of our extended self; it is not about defending something "over there" but something that is part of our vital interests as part of nature (Naess 1995, 232). It is this kind of relationship that is important for deep ecology compared to other environmental ethics, as we are not separating ourselves from nature but identifying and connecting with nature to defend and preserve it as piece of our extended self.

However, this notion of self-realisation has been contested by other philosophers. Peter Reed argues in his piece *Man Apart* that it is human-centred in itself to base our self-realisation of nature on the idea that nature is a part of us and that is why we should take care of it, not because it has its own intrinsic value (Reed 1987, 65-66). Reed's point here is understandable, as it seems that humans cannot be respectful towards nature without having a reason to be, and the reason that is used in deep ecology is that we are actually a part of it, so harming nature is harming us and we should not do that. However, I think the key point that Naess tries to reiterate is that, although this is true, identification is meant to enable someone to understand nature from a deeper and more profound perspective. Naess argues in his response that he "deplores" the utilitarian view that humans can have towards nature and only treating nature as a means of human interest (Naess 1990, 189). But I think the deeper meaning here is that Naess believes that this self-realisation would enable people to see that viewing nature as a commodity or without respect as wrong, and would thus want to develop a more meaningful connection with nature.

Another point that Reed makes in relation to self-realisation is that humans should respect nature and value it simply *because* it is not a part of us (Reed 1987, 56). Reed argues that although we are a part of nature, nature is also *apart* from us and exists independently of the human mind (Reed 1987, 56). Reed states that whilst we have connections with nature and are part of it in many ways, there is also this "awesome depth" between us and the Other which no amount of identification can fully comprehend (Reed 1987, 56). The 'Other' that Reed refers to is this part of nature that is separate from us and our understanding. Reed seems to state that humans may act as significant beings with the ability to understand everything, but in reality, we are only a drop in the ocean in comparison to the vastness of the physical world.

In contrast to Reed's argument that humans should value nature for the fact that it is Other than us, Naess recognises that this has not been clearly stipulated in the framework of deep ecology

(Naess 1990, 192). Naess argues that such levels of existential difference (in relation to the vastness that Reed is talking about) does not mean that these thinkers together cannot find a middle ground (Naess 1990, 192). What is important in Reed's challenge of deep ecology, and providing space to dig deeper into what self-realisation really means and if it can actually be acquired, because if it cannot, then the holistic relationship between humans and nature falls short in deep ecology. If humans are unable to acquire self-realisation – not because they do not want to but because they are unable to – then there is no empathetic connection to nature, as Naess argues is needed to be able to have true respect and value for nature. With that being said, Reed's point that humans should value and respect nature for its Otherness enables humans to be able to value nature without this psychological trip into self-realisation, but more of a solid comprehension that nature is, and so it deserves respect.

Overall, the concept of self-realisation is a useful way to relate humans to nature and see themselves as a part of something other than themselves, but also nature as something more than just a commodity. However, relying on this notion of self-realisation to provide a level of intrinsic value leaves the door open to the interpretation that humans can only value something if they are able to be a part of that process or the need to only value something because if it would happen to them, they would not like it. Whilst empathy is important to understand how something else is feeling, you should not *need* empathy to understand, or in this case, attribute value to the situation or thing at hand.

4. IS DEEP ECOLOGY USEFUL TO APPLY TO PROBIOTIC ECOLOGY?

Deep ecology and probiotic ecology share a lot of similar perspectives on how nature should be perceived and treated, which makes applying the deep ecology framework to probiotic ecology more suitable compared to other environmental frameworks. My idea behind applying the deep ecology framework to probiotic ecology is to address the ethical concerns and potential problems that can occur with probiotic management. Both ecologies acknowledge similar values, such as the holistic relationship between humans, nonhumans and nature, without the focus being based on human interests. With the broadness of deep ecology's framework and flexibility in probiotic ecology, I argue that this can be achieved and would help address the potential issues that could arise from probiotic management.

One of the ethical concerns of probiotic management was the issue of conducting ecological management from human-centred interests. Although the concept of 'mutual benefit' is used to describe the relationships in probiotic management, there is still the concern of this being human-centred, whether that is the outcome or the reasoning behind the action of probiotic management. The theory of self-realisation could help contribute to a less human-centred approach to this, allowing humans to be able to empathise better with nature and hopefully opt for decisions that are just as beneficial to nonhumans as they are to humans. This is not to say that the concept of self-realisation is full-proof, and there will be no decisions made purely based on human interest, but a new foundation of perception of nature could be formed with this notion of self-realisation with nature.

Another ethical concern of probiotic management was the issue of treating animals and nature as commodities. In deep ecology, resources are meant to be viewed intrinsically rather than instrumentally. In the case of animals in probiotic management, although their usefulness can be valued, we have to value these animals regardless of whether what they do is useful to us. In the case of beavers, we have to value their destruction as well as their intelligence; this does not mean we have to like it or even tolerate it, but we as humans cannot decide on what is worthy. Landowners may find it disrupting to have their trees gnawed by beavers, but what about how beavers feel? Do they like how landowners act? This is where the concept of self-realisation is useful because a level of empathy in this situation would hopefully bring a more balanced view of such situations. Humans could then be more open to understanding the implications of our behaviour on nonhumans and not just nonhumans' behaviour impacting us.

This is quite a crucial point in the whole debate, as for probiotic management to really work and move away from the antibiotic era, there has to be a huge perspective change in how we view nature and allowing ourselves to think about how nature and nonhumans view humans.

What is an important part of implementing deep ecology ethics into probiotic management is that it provides a more philosophical take on the practicalities of probiotic management and the concept of ecological management in general. I hope that using an ethical framework will be able to provide a better moral foundation in treating nature, and guidelines on how to move forward from a holistic point of view of humans and nonhumans. What deep ecology can help us to do is think more clearly about what probiotics can and cannot do and take into account the consequences of ecological management, such as commodifying nonhumans.

Overall, I am not sure if probiotic management, or any kind of ecological management under human reign, can ever really be on equal terms with nature. The process of shifting management practices is not only a physical and economic change but also a psychological change. Humans have been dominating nature for thousands of years, regardless of whether it has been morally right or wrong, so creating a shift in such a prominent mindset of societies seems to be a huge task to implement. This concept of self-realisation from Naess is an interesting and convincing starting point on how this help humans connect better with nature, but how long does, or would, this process take? In the face of such environmental problems, it does not feel like we have time to take our time with being able to empathise with nature on the hope that this will enable humans to treat nature better. However, it is clear that not everyone is able to identify or empathise with nature, and so maybe this could be one of the most useful options to start the process and be able to view ourselves from a nonhuman perspective.

5. FURTHER RESEARCH CONSIDERATIONS

I have incorporated this small section to give room to some of the important parts not mentioned in this thesis about the probiotic movement and considerations that could be considered in further research.

Probiotic ecology seems to offer goes beyond offering another perspective and way of ecological management. Probiotic ecology also looks to offer a new strategy in regards to climate change and how mitigation and adaptation processes can be managed and understood. All of the above aspects of why probiotic management is needed can enable a better understanding of how nature works, not just for the sake of nature and the mutual interests in the symbiotic relationships in probiotic management, but also for how to manage the current climate crisis.

An issue that Lorimer did highlight in his book, but which I did not go into, was how the concept of 'going probiotic' has an air of eliteness attached to it. The ability to use probiotic practices and be in the position of such knowledge and technology is not something that every country will have access to. Unequal geographies of dysbiosis and the capacity to go probiotic have emerged through long histories related to colonialism and capitalism (Lorimer 2020, 220). It is thus important to note that if the probiotic movement becomes a viable method of ecological management, these issues need to be taken into account.

Lorimer also mentions the discussions that involve current natural resource management and "the ways in which modern, antibiotic forms of agriculture, forestry, and fishing degrade the resilience and functionality of ecological systems" which can be linked to the "degradation of the ecological irrationalities of capitalism" (Lorimer 2020, 135). From this perspective, it is not that management is necessarily the problem, but how it is carried out. A key point here that would be useful to further research is that human-centred did not suddenly stem from capitalism, but neoliberalism does fund this notion of individualism, which further broadens the gap between humans and nature.

A criticism that has to be taken into consideration from deep ecology if it were to be applied to probiotic management is made by Murray Bookchin, who addresses the notion of relating humans to nature, highlighting that grouping all humans together as the perpetrators against nature tars all humans with the same brush. Allowing oppressed people such as poor, queer, women, Indigenous and people of colour communities to be grouped with the oppressors that are arguably more to blame for the ecological crisis causes the theory to drastically overlook

social injustices (Bookchin 1988). This is definitely a shortfall of deep ecology in its wording of ‘humans’, although Naess states in his eight principles of deep ecology that the current exploitation of the environment has been carried out on the backs of exploited people and thus calls for an anti-class posture against this.

CONCLUSION

In conclusion, this thesis has looked to evaluate the new probiotic movement and how deep ecology can provide an environmental framework to acknowledge the ethical concerns of probiotic management. By first outlining the context of ecological management, I then described and evaluated probiotic management, leading to the discussion of what the concerns of such a management process entail. This was then followed by the explanation of environmental ethics, why it is necessary, and how ethical frameworks can be applied so environmental problems. I used the environmental ethic of deep ecology to illustrate this in the case of probiotic management, explaining how deep ecology would be useful to address the ethical concerns of this management practice due to its similar views and environmental standpoints. The thesis was concluded by explaining how deep ecology can address the concerns of probiotic management and be a useful environmental ethic to do so. I end the thesis with some extra considerations for further research into this field that were not mentioned directly in this thesis, in the hope that this will foster a wider discussion.

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