

For Body and Society SI Indeterminate Bodies

Indeterminacy and More-Than-Human Bodies: sites of experiment for doing politics differently

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Abstract

This article analyses research that has explored the potential of a focus on indeterminate bodies for decision making, policy and politics. Drawing on different ways of conceptualising indeterminacy in scientific and policy domains (Schrader (2010), Greco (2004), Haraway (2008)) it describes the Loweswater Care Project, a participatory 'knowledge collective' that attempted to avoid converting the complexities of vital cyanobacterial bodies into a purely social or managerial set of questions around water quality. Through a commitment to opening out the nature of 'things', participants in this collective honed new questions and avenues of inquiry around cyanobacteria and its relations. The Loweswater Care Project was a kind of 'open' in Haraway's sense where questions and demands are put to bodies, and to the apparatus that allows us to sense them, in ways that do not shy away from the probabilistic character of entities and their relations. The implications of generating indeterminacies in this setting are explored for environmental decision making, policy and politics.

Introduction

You've got to look down a microscope...and try to identify tiny differences between different kinds of cells...And actually observationally it's quite difficult to distinguish between one genus and another genus, and even more difficult between one species and another species.... Within this broad grouping of cyanobacteria there's a range of different strategies, different skill sets if you like.... And not all cyanobacteria are toxic: some are and some aren't....

So in a lake like Loweswater you might expect that there are multiple colonies of different kinds of cyanobacteria with different life strategies...?

*Yes, and maybe different colonies at different times of the year.*ⁱ

The bodies that prompt consideration of indeterminacy in this article are those of cyanobacteria – the microscopic ‘blue-green’ organisms, referred to by the lake ecologist above. Cyanobacteria are neither algae nor bacteria but a combination of both, and are often found in freshwater lakes that have inadvertently become enriched with the nutrients that humans use to increase biological productivity (nitrogen and phosphorus, in particular). These cyanobacterial bodies, commonly read as signals of nutrient overflow and excess, are currently at the heart of hundreds of ongoing water quality controversies all over the world (Smith *et al.* 2015), but the site of my encounter with them is a lake called Loweswater, itself another kind of (water) body, found in the middle of a small rural hamlet, also called Loweswater, in the north-west corner of the English Lake District.

From the interview excerpt above it is easy to appreciate that cyanobacteria themselves are ontologically complex. Although we often bracket these organisms under one collective name, ‘cyanobacteria’, or ‘blue-green algae’, they consist of multiple species, each with subtly different life strategies, stages and forms. As we shall see later, the organic chemical elements that nourish and support them, ensuring their productivity, are equally complex and difficult to know. In this article, however, I am not so concerned with the complexity of ontologies, leading to a sense of the indeterminacies of things in themselves. Rather, I want to explore ‘indeterminate bodies’ as sites of intense involvement and experiment – sites where a specific potential can arise in the relations between a form of life and human questioning. In such sites, where ‘the experimenter’ involves herself, her body, her knowledge, her responsibility and her future, there are risks, but also, ‘new things can happen’ (Despret 2004: 131; Stengers 2005; Haraway 2008).

The paper aligns with recent research that has also been interrogating the co-habitations of human and non-human bodies using the philosophical resources of Science and Technology Studies (Science and Technology Studies), including feminist and new materialist inflections of Science and Technology Studies (Barad 2003, 2007, 2012; Haraway 2008; Hird 2010; Roosth and Schrader 2012; Schrader 2010, 2012; Hayward 2010). However, it differs from these accounts in that it concerns a deliberate, Science and Technology Studies-inspired experiment to create a public space where the ontological indeterminacies of more-than-human ‘things’ were able to take centre-stage in the context of an ongoing public controversy. Participants in this experiment opened up the inherent indeterminacy of things relevant to the controversy (for example, cyanobacteria’s own bodies, the

elements that nourish them, and the designated status of a water body) and explored different kinds of responsive scientific experimentation and questioning. As a way of exploring this public experiment, I draw in this article on the research of three authors who have each characterised careful ways of attending to indeterminate bodies in ways that can make a difference to nature-culture relations within public policy (for example, health policy, Greco 2004; or human-animal relations, Schrader 2010, Haraway 2008).

In what follows I first describe in more detail the empirical setting of the research. I subsequently look at how the three authors named above treat the issue of indeterminacy. All three authors point to the limitations of particular encounters with different kinds of bodies (micro-organisms, human and animal bodies). They argue, in different ways, for a re-calibrated mode of attention to the indeterminacies of these bodies in ways that matter for different policy settings, including those concerning environmental, health and nature-culture relations. Each author is aware of the theoretical and practical risks that attend this kind of attention to the indeterminate body and each one makes gestures towards recent theoretical debates concerning matter, (the new) materialism, ontology, relationality, and human apprehension of the world (Ahmed 2008, Braidotti 2013, Kirkby 2011, Grosz 2004). But these three accounts also offer an insistence on attending to, or reaching out to, living entities in ways that allow them to surpass our ordinary imagination of their qualities or effects. And it is the particular ways in which they advocate reaching out, questioning and encountering the more-than-human body that I draw upon in this article.

The above discussion implies that there are certain theoretical moves that I am less interested in for the purposes of this article and I outline these here so as to situate this research. First, I am not advocating an immersion into the materialities of cyanobacteria and their relations (e.g. the things that sustain them, such as phosphorus) in a way that eschews language, texts or representations. I am not, therefore, building on work that dwells on the material, or bodies, and the imperceptibility of these as an antidote to that which has allegedly become overly textual in recent years (McNeil 2010). Second, neither am I attempting to build, through an attention to indeterminate bodies, on a feeling for the non-relational, or a re-thinking of life 'beyond' anthropomorphic limits (Clark 2011ⁱⁱ). Rather, I am interested in the mundane meetings of materialities/bodies/natures with the social/cultural/ political and I argue that it is possible to apprehend these fusions in a way that acknowledges the ontological indeterminacies at their core. The research that I write about derives from a feminist and Science and Technology Studies interest in exploring 'how culture and biology

are mutually implicated; how neither are given, how they shape and inform each other' (Ahmed 2008). I am interested in how this state of affairs is both very ordinary but also extremely special because each natureculture encounter can be seen as a site where indeterminacies offer the possibility of something new (Haraway 2008). Thinking about encounters in this way allows us to rethink the kinds of knowledge-politics that may be possible for contemporary environmental decision making.

There is an element of risk to this. The authors that I draw upon below see indeterminacy as a mundane but also a risky space. The risk is partly one of theoretical location – where the challenge is to avoid putting all the conceptual responsibility on a vital body at the same time as avoiding loading all the explanatory power onto politics or 'the social' (Greco 2004). There may also be political risks: some theorists fear that a preoccupation with indeterminacies, or a lack of definitive knowing, may weaken politics (e.g. Murphy 2006). On the other hand, others see that these risks open out possibilities. As Schrader, Greco and Haraway have all shown, risky indeterminacies bring with them the possibility of reframing the ways in which we think about bodies (toxic *Pfisteria*, cyanobacteria, human bodies) but also the ways in which we encounter such bodies (e.g. through the trials, experiments and classifications used to determine public policy). The possibility of reframing the indeterminate body is important in the first story that I tell below. In the second story, I explore the potential for appraising the indeterminacies built into public policy through tools and classifications. In each case we can see that an attention to mundanely present, indeterminate and vital bodies opens up new possibilities for contemporary environmental politics.

Cyanobacteria at Loweswater

Since the early 2000s the small lake, Loweswater, found just within the boundaries of the Lake District National Park in the north-west of England, has been hosting increasingly high populations of cyanobacteria. These microscopic organisms are infrequently seen, but manifest themselves from time to time on the surface of the lake as a 'bloom' (a pea-green slime covering the surface of the water), or as a kind of sludge-like concentration when the bloom has been blown by the wind into a sheltered corner of the lake. As these blooms can sometimes be toxic to large mammals (including cows, dogs, and on occasion, humans) and as their presence contributes to the failure of Loweswater's freshwater to meet the criterion of 'Good Ecological Status' required under the European Water Framework Directiveⁱⁱⁱ, the periodically visible cyanobacteria that constitute them have been the focus of much local discussion as well as scientific monitoring and research.

Land and lake ecologists from the Centre for Ecology and Hydrology at Lancaster University, for example, have been working at Loweswater since 2000, trying to determine what practices and processes on the land around the lake are supporting these high populations of potentially toxic cyanobacteria. In 2003 they invited me to join them in a research proposal: I am a sociologist of scientific knowledge and the ecologists were aware that the algal blooms were, in a sense, at the centre of a controversy concerning their cause. Different 'stories' about the algal blooms were circulating locally, and the ecologists saw that relations between residents, and between residents and local agencies responsible for environmental protection, were becoming strained. Having a sociologist join their team, they thought, might equip them to understand the relationships between scientific investigations and public perceptions and also open up certain avenues of funding not otherwise available to a purely natural science team.

When a post-doctoral researcher, Jake Morris, and I began working with the ecologists in 2004 many questions were already in the air^{iv}. At the heart of local tensions was the feeling of a division between local farmers and other residents in the valley of Loweswater. Farmers' ordinary practices of fertilising grass crops with chemical fertilisers and animal manures, we were told, were suspected to be supporting the thriving of cyanobacteria. Cause-effect relations were being imagined and there was a sense in which local farmers were being held to blame for a situation of ever-more frequent blooms which amounted to the blight of lake water quality and a kind of disfigurement of the world-renowned beauty of the Lake District landscape. Questions were being asked about farmers' accountability for the appearance of the blooms: should they be disciplined through financial penalties, for example? Letters warning that such penalties may be forthcoming had been sent by the Environment Agency to several Loweswater farmers before the research began in 2004.

Out of this context the ecologists were carving out questions that were scientifically framed. Their inquiries built on previous knowledge about how cyanobacteria gain sustenance from nitrogen, phosphorus and sunlight to survive (Reynolds 1984). But our research together was interdisciplinary, and we were interested in the limits of the epistemic frameworks of our own communities of practice (Kuhn 1990: 10). It soon became clear that these microscopic organisms and their relations were elusive in both physical and conceptual terms (one could not often 'see' them; they were multiple, consisting of many different species; they had complex life cycles; they

were ephemeral and not always present). Even for ecologists, cyanobacteria were, in many senses, intangible, indeterminate, and difficult to make into research objects.

During 2004 the research team determined that it would be good to think about these things within a social collective – that is, a group including farmers, local residents, environmental agencies, social and natural scientists that would meet regularly to pool their understandings of ‘the algae problem’. A larger grant secured during 2007-2010 allowed those involved, including the author, to work together to build a ‘new knowledge collective’ (after Latour 2004) in which many questions could be supported and turned into small research investigations^v. The Loweswater Knowledge Collective initiated a series of bi-monthly meetings in 2007. By 2008 this collective had re-named itself the Loweswater Care Project or ‘Loweswater Care Project’ and it continued to meet every other month until 2010.

In the early days of the Loweswater Care Project an ecological perspective would sometimes predominate. One ecological understanding in play was the idea that phosphorus (P) is the main nutrient controlling phytoplankton production in Loweswater, and that raised P levels in the lake could be traced back to human sources with an emphasis on farming practices, especially the application of nutrients to fields (fertilisers, manures, animal feed, etc.), and the inappropriate storage of nutrient rich animal feed or waste (e.g. Bennion, 2000, Maberly *et al.* 2006). The determining of P subsequently became, at times, a strong motif within the Loweswater Care Project, in that it was imagined that once we knew more about P, and the way it was applied and used up in the soil, ‘the algae problem’ might be solved. Later on, I use my observations of the different ways in which the Loweswater Care Project tried to monitor and trace this element in order to highlight the ways in which this forum attended to P, responding to its inherent indeterminacy through different avenues of inquiry and questioning (Haraway 2008).

At this point it is important to suggest that the Loweswater Care Project was also *almost*, but only *almost*, a conventional ‘participatory’ forum. By 2007 it had become commonplace in the domain of environmental policy (and especially in the area of water policy) to acknowledge the multiplicity of different epistemological and ontological framings of nature/the natural. The quality of a body of fresh water, therefore, had become something that ‘policy’ recognized to be a collective social as well as an environmental issue^{vi}. Consequently, one move was not only to acknowledge this, but to inquire into the nature of this multiplicity, through various forms of bottom-up ‘participation’ in

democratic fora (Collins and Ison 2010, Marshall *et al.* 2010, Smith *et al.* 2015). But by the time the Loweswater Knowledge Collective got underway in 2007, some common risks of these kinds of participatory initiatives were becoming apparent. One such risk was the way in which they could tend to ‘close down’ the very natures they were purportedly aiming to investigate (Wynne 2007; Tsouvalis and Waterton 2012). The different identities of actively engaged citizens were also, ironically, often denied or policed (Welsh and Wynne 2013). Furthermore, a kind of avoidance of politics (a ‘post-politics’) seemed to occur in many instances, through a preoccupation with coming up with collectively derived, consensual and often scientifically framed decisions (Ranci re 2006;  i ek 1999; Tsouvalis 2015).

The Loweswater Care Project aimed explicitly to acknowledge and build upon critiques of the paradoxical closing down and silencing being witnessed in participatory initiatives ((Tsouvalis and Waterton 2012; Waterton and Tsouvalis 2015a and b). It was, in this sense, explicitly experimental. The way in which it endeavored to build upon such critiques was deceptively simple, but it is also key to the way in which this forum enabled encounters with the indeterminacy of things. Within the Loweswater Care Project participants adopted a number of principles derived from a recent publication of the science studies scholar Bruno Latour (*Politics of Nature: How to Bring the Sciences into Democracy*, 2004). The basic goal of such principles was to put ‘matter(s)’ centre stage in order to prevent what Latour calls a ‘foundationalist model of knowledge’ from taking the place of politics. Or as he alternatively puts it, to prevent ‘S’cience from rendering nature/bodies/matters mute and incontestable’ (Latour, 2004:10)^{vii}. The Loweswater Care Project thus deliberately turned a space that risked being void of lively politics into a meeting place where human and non-human participants would enter into new adventures together. Nature/bodies/matter were to the fore but in particular ways. The Loweswater Care Project was styled as a political forum:

- where nature is not self-evident;
- where knowledge and expertise has to be debated;
- where it is accepted that uncertainty is the main condition humans are in (rather than a condition of having knowledge);
- where what is important is the creation of connections between people and things;
- where doubt and questioning is extended to our own representations^{viii}.

Judith Tsouvalis and I have described elsewhere why participants in the Loweswater Care Project embraced these principles from the earliest Loweswater Care Project meetings. Many of them

wanted to voice their own connections and explanations concerning the problems of the lake. Participants were amenable to the idea that there would be ‘no unmediated access to agreement; no unmediated access to the facts of the matter’ (Latour, 2005:12). As a result, ‘things’, ‘matters’, and their very nature, but also the apparatus that enables us to encounter them (Barad 2003, 2007), were collectively and critically scrutinized and debated within Loweswater Care Project meetings^{ix}. Seemingly simple, the above principles created an inquisitive mood and epistemic spaciousness for our many discussions and activities through the years 2007-2010. As I will go on to narrate, they carved out a kind of novel epistemological space – an ‘open’ in Haraway’s terms - that allowed for new ‘adventures’ between indeterminate bodies and the demands put to them (Stengers 2005^x). Before exploring two different empirical ‘Loweswater Stories’ that highlight these adventures in different but complementary ways, I turn to the work of Schrader, Greco and Haraway whose analyses will help us interpret these stories.

The response-able body

As part of research investigating an ongoing scientific–political controversy over the toxicity of a fish-killing microorganism, *Pfiesteria*, feminist philosopher and Science and Technology Studies scholar Astrid Schrader (2010) has closely examined the experimental practices set in train to try to determine whether this microorganism could be regarded as the ‘causative agent’ of massive fish kills in the estuaries of the US mid-Atlantic. Contrasting her approach with that of policy makers, Schrader argues that the experimental practices that were established to close what was perceived by policy as an uncertainty gap erased the essential ontological indeterminacy of *Pfiesteria*’s ways of being and doing and so denied both researchers and the organism the possibility of a ‘response’.

Schrader relates how *Pfiesteria*, micro-organisms that ‘bloom’ (not unlike cyanobacteria), undergo spontaneous metamorphoses in response to changing environmental conditions. It is thought that they become toxic and rapidly multiply as a kind of response triggered by the fish on which they then prey. As Schrader reports, ‘this produces ‘something like a “catch-22” regarding *Toxic Pfiesteria*’s identification as a species’:

[T]he presence of fish in culture ... is needed both to stimulate and detect toxin activity, hence *Toxic Pfiesteria* only ‘are’ in relationship to fish and specific environmental conditions. In simpler terms: without fish there is no fish killer. (Schrader 2010: 287)

Two experiments, one using molecular visualization technology for identity production, and the other looking for genes encoding for toxin-producing substances, were carried out to determine whether *Pfiesteria* could be regarded as the ‘causative agent’ of fish kills in the estuaries of the US mid-Atlantic. Schrader notes that both experiments ‘assume that toxicity must be locatable somewhere within the genetically defined organism’ in a way that is independent of the environmental circumstances of the experiment (Schrader 2010: 287). As we have seen above, however, the precise opposite is the case for *toxic Pfiesteria* which are thought to only really exist *in relation to* fish. By ignoring this essential indeterminacy and paying no attention to the cultured environment (fish free, or fishy) in which the experiments were conducted, the existence of *toxic Pfiesteria* is, as Schrader puts it, ‘precluded by design’ (*ibid*). She suggests: ‘The possibility that *Pfiesteria*’s doings affect their beings is simply ignored’. Schrader argues that responsibility in experimentation is thereby effaced: the experiments ironically foreclose the organisms’ ability to respond (*ibid*).

Schrader thus opens out the question of the ‘response-ability’ of the organism, as well as the responsibility of the experiment, arguing for a move from imagined epistemological uncertainties (a knowledge ‘gap’ that could be erased through definitive research) to ontological indeterminacies:

I develop a notion of responsibility in scientific practices as a consequence of fundamental indeterminacies in *Pfiesteria*’s beings and doings. Responsibility in my account entails not a particular response, but an enabling of responsiveness within experimental relations.
(Schrader 2010: 277)

We shall see resonances of this sense of responsibility in attending to the living and complex phenomena at hand in the account, provided by Monica Greco, of an altogether different ontological problem, but one that again has a relation to issues of public policy questioning.

The Mundane and Vital Body

Monica Greco calls for renewed attention to the indeterminacies of a hiatus – the space between life and knowledge of life – in the areas of health research and health policy (Greco 2004). She locates indeterminacy in the mundane and ubiquitous human practices of apprehending something unfamiliar and trying to make sense of it. Countless instances of this kind of act occurring in

everyday, daily, interactions, mean that indeterminacy is all around us, all of the time. And indeterminacy for Greco, has the ability to bring about transformation and change. Her analysis requires, however, opening up the 'black box' of indeterminacy, and to do this she draws on Canguilhem's book *The Normal and the Pathological* (1989). In this book, Canguilhem proposes that health is to be thought of as a form of active and dynamic 'normativity' – understood as a capacity to institute, to adapt, and to change. Normativity is considered to contrast directly with a further concept – 'normality' – which refers to a fact or entity that is already given. Following Canguilhem, Greco suggests that normativity, 'life', or what she calls the 'vital order', has a surplus of possibilities over those being actualised in any given situation: it must therefore have priority over what we already know. It is life, not existing knowledge 'which suggests to the physiologist the ways to explore, for which he codifies the laws' (Canguilhem 1989: 100).

Situating this within wider theoretical debates, Greco argues that an emphasis on life or 'the vital order',

does not mean supporting an order of existence uncontaminated by human artifice or by the social, as social theorists often assume. The point about a vital order...is that it encompasses but exceeds both human consciousness and knowledge. As such it refers to an order of possibility that includes the social *and much more besides* – that is, also possibilities that remain unrecognised or misunderstood in social practice (Greco 2004: 10, italics in original).

And the vital order, described as a 'margin of excess with respect to a socially actualized imagination', is that which allows the concept of health itself to be seen as essentially indeterminate (Greco 2004: 5).

It is important to specify the above, since what Greco sees as mistaken moves have resulted from a misunderstanding of these dynamics. One unfortunate move, seen in areas of biotechnology, has been to privilege a particular way of seeing (e.g. through bioethics, consumer choice, or consumer ethics) at the expense of acknowledging the 'vital' that may exceed the socially actualised imagination (Rose 1998: 165; Rose 2001: 19-20 in Greco 2004: 9). For Greco this denies the possibility of paying attention to the value of phenomena, 'things' or processes that may be relevant to life, running the risk of silencing them. Illustrating this by reference to the 'placebo effect' Greco shows how, in biomedical clinical trials, placebos are used to isolate vital phenomena and processes considered anomalous or outside of mainstream medical discourse. These phenomena are

characterised as 'non-specific noise' within the context of the trial and their effects are identified only in order that they can subsequently be 'subtracted out of the picture' (Harrington 1997: 2 in Greco 2004: 11). Thus the confident assumption that experimental questioning will only be directed to the therapeutic effects of the pharmaceutical at hand is executed at the expense of any insight as to the 'living body's ability to be healed through the imagination' (Stengers 2000: 24 in Greco 2004: 11).

Greco argues that reference to life 'itself' must point to more than social and moral judgements. It must also, she suggests, 'refer to an order of vital phenomena and possibilities – like the placebo effect – that will answer to certain ways of posing questions but not others, that are at risk of being silenced' (2004: 12).

Indeterminate bodies in the contact zone

The problem of silencing, identified above, introduces the idea of demands, questions, and making space for a response. In an altogether different context, the Science and Technology Studies scholar Donna Haraway shows that to understand this is to understand the real potential of indeterminacy. This is a potential for those things that are involved in demands and responses to become, together, something *new*: something different to that which they both previously were. This capacity for something new to happen is at the core of life (Grosz 2013). It is 'the vital' that Greco refers to, and as Haraway and Greco both make clear, it is ubiquitous and 'mundanely present' (Haraway 2008: 223). Haraway locates this capacity in what she calls 'the contact zone' and, below, I briefly describe her rendition of this as a space in which two different entities had to organise around a 'demand' that was non-natural to both of them (2008: 240).

In chapter 8 of *When Species Meet* (2008), Donna Haraway writes about a particular woman (herself) and a fast-herding dog (her dog, Cayenne) performing 'agility' training together. Haraway needed to get Cayenne to run quickly over an obstacle, between 5'.5' and 6'.5' high, called the 'A' frame. The rules of agility stipulate that the dog must pause, within 2' of the end of the 'A' frame, with two rear paws resting on the yellow-painted 'contact zone' and two front paws remaining simultaneously on the ground, before continuing through the course. Cayenne repeatedly failed to do this, regularly leaping over the end of the frame, not even touching the yellow area before she raced on to the next part of the course (2008: 215-216).

At the time Haraway was puzzled: 'I could not figure out what she did not understand; she could not figure out what my ambiguous and ever-changing cues and criteria of performance meant' (Haraway 2008: 216). But Haraway later analyses this situation as one in which two different entities, already relationally embedded, enter new relations. As she describes the scene, an 'invitation to respond has been tendered' (Haraway 2008: 221). This invitation, or demand, establishes a situation of reciprocity but also one of tension - a zone - between the entity doing the inviting, and the entity which is expected to respond. This is a space of indeterminacy but also risk. What is important here is that new things - change - can come into being in the contact zone.

In theoretical terms it is important to note here that this is not about auto poetic immanence, non-relational happenings, or re-writing the self/body/organism. This is about timed interactions in which organisms, 'mundanely present', have to figure out a way to associate. Just as importantly there is nothing 'natural' about the invitation to respond. Haraway suggests that the criteria of performance on the 'A' frame are 'not natural to either dogs or people but are achievements dependent on invented as well as inherited naturalcultural possibilities' (2008: 223). Despite the artifice, however, the real human and real dog, both mundanely present, and now entangled in the contact zone, have to work something out:

Fixed by the specter of yellow paint, the human must finally learn to ask a fundamental ontological question, one that puts human and dog together in what philosophers in the Heideggerian tradition call 'the open': who are you, and so who are we? Here we are, and so what are we to become? (Haraway 2008: 221).

Haraway and Cayenne both had to learn what it meant to communicate meaningfully in 'the open'. To paraphrase Haraway here, the dog and the woman had to 'raid each other's repertoires' and 'interpret each other's fluencies'. They then had to 'risk letting go of the literal' and 'reinvent their own repertoires through affective semiotic intra-action'. Work and play reinforced one another in this vital, renewing contact zone. Here both parties could 'taste the open': they were co-present in a space that was propositional, a something and somewhere that 'was not yet', a 'social adventure' (Haraway 2008: 240).

I now draw on insights from the accounts of Schrader, Greco and Haraway to explore two different ways in which the Loweswater Care Project created a kind of novel epistemological space

– an ‘open’ in Haraway’s terms - that allowed for new ‘adventures’ to be had between bodies and demands on bodies (Stengers 2005; Haraway 2008) . Both stories give a sense of the way in which the Latourian principles by which the Loweswater Care Project worked helped the participants in the Loweswater Care Project do environmental politics through indeterminate bodies. The first adventure concerns the nature of the element, Phosphorus, or P.

Loweswater Story I: vital bodies in the contact zone

P is thought to be the main nutrient controlling phytoplankton production in Loweswater (ecologists call P the ‘limiting’ nutrient). As I have suggested ecologists were interested in previous evidence taken to indicate that raised P levels in the lake had resulted from human sources with an emphasis on farming practices. From the Loweswater Care Project’s very first meetings in 2007 and 2008, ecologists were framing ‘P’ as ‘the thing that you want to get at’^{xi}.

Typically, farmers were also interested in P but for different reasons: for farmers their own routine application of P to the land was caught up in issues of sensitivity and stigma. They had felt for years a tacit blame amongst the wider community at Loweswater and amongst environmental agencies and NGOs for over-fertilising fields and prioritising agricultural ‘productivity’ above the ecological limits of the landscape. And so, it was not surprising that one of the first questions that arose within the Loweswater Care Project was, ‘What precise amounts of P needs to go on the land? Can we specify that, and agree that farmers should only allocate only that amount to the land, and no more?’

This question was turned into one of many small research investigations supported by the Loweswater Care Project. A local agricultural consultant, John Rockcliffe, was commissioned to test soils on the nine working farms with ‘in-bye land’^{xii} that drained into the catchment and to interview farmers with a view to understanding how much Nitrogen (N), Phosphorus (P) and phosphate (K) they normally apply to the land each year. He was to carry out a ‘nutrient budget’ to measure was how much P was needed for the crop being grown (in all cases this was grass, upon which cattle and sheep would fatten). Once this level was ascertained he would advise the farmers to apply organic and non-organic fertilisers up to that level, with no exceedances over it.

Rockcliffe’s research spoke perfectly to the preoccupations and practices of Loweswater farmers. In Haraway’s terms, the questions being addressed to P, were, ‘How much of you is there in the

soil?' 'How much P can we additionally apply so that our grass grows optimally, taking up all of the P it needs, and leaving nothing left to run down to the lake?' The assumption was that it was possible to ascertain the optimal amount of P that should be retained in soils as readily available for uptake by plants, 'to allow for the desired level of production and to reduce the risk of a reduction in soil nutrient reserves' (2009: 4)^{xiii}.

Rockcliffe carried out his investigation and came back to the Loweswater Care Project to 'report back' on his findings. His report to the Loweswater Care Project brought about a palpable sense of relief to Loweswater farmers. The soils of only three farms in the catchment were judged to have excessive P levels required for plant growth, and the three farmers concerned subsequently agreed not to apply any chemical phosphorus fertiliser that same year. Using this evidence-based approach, it seemed that the concerns about farmers applying excessive P might come to an end. But the principle that '*doubt and questioning is extended to [all of the Loweswater Care Project's] own representations*' meant that anyone in the Loweswater Care Project could suggest another way of re-framing the question to P. The lake ecologist therefore suggested another question. However, instead of framing P as an element that should be provided in adequate quantities for *uptake by plants*, he entirely switched the discourse. His question to P was instead: 'What if uptake of you, from soil to plants, is optimal for plant growth but also entails release of you through the soil to nearby watercourses?'

The very asking of this alternative question to Phosphorus, within the context of the Loweswater Care Project, opened up a space of indeterminacy about what happens to P in soil. The idea of 100% *uptake* suddenly had to incorporate *loss*. It became very unclear how P might nourish the grass and simultaneously nourish cyanobacteria in the lake. In a discussion reflecting back on this new questioning and the space that it opened up, I asked the lake ecologist whether he was aware that he was creating a different framing for questioning P:

It's a good question. It actually it speaks to one of the fundamental issues...The agronomist is looking at [the question] 'Can we make the grass grow as much as possible? We don't want to put more P on than we need...I was saying, 'Even if you had considered an optimum amount of Phosphorus, not too much but enough for the crops, that still might be too much for the lake'.

So, in a way you really did open up the whole politics of that whole valley?

Well I think it really is the whole crux of the matter and the issue for many agricultural catchments: because of this high connectance between what goes on on the land and the water...

What the lake ecologist identified here is the fact that there is not just one 'process acting upon P' (just as, to refer back to Greco's example, in drug trials there is not just one healing process acting upon the body). At least two important processes or pathways are at stake: one of P uptake by plants, and another of P loss to watercourses. But what also happened here was the entry of a *new* discourse and framing - that of *connectance* within the soil-water system. Through this new framing, it becomes necessary to re-think P: P is being taken up 100% to support good grass growth; *and* P is being lost to water courses and hence polluting the lake. Both are happening at once (Mol 2002).

In this example, the Loweswater Care Project constituted a kind of 'open'. Stephen Maberly was able to pose an alternative question to the vital bodies of cyanobacteria and the P that nourishes it. The Loweswater Care Project became an 'open' because it was acknowledged that there was nothing 'natural' about the questions of P uptake to grass and there was no 'correct amount' that could silence the question of P loss to watercourses. As Haraway suggested in her story about the troubles that she and Cayenne experienced around the A frame, there were no natural warrants for any particular question or demand to be made. Both woman and dog had to engage in invention and learn what it meant to communicate meaningfully in 'the open'. The lake ecologist suggested that this is a question of using one's expert judgement. But he also noted the risks involved in posing new questions:

Sometimes it turns out to be wrong of course.... you've made a mistake.

In the context of the Loweswater Care Project, however, the risk is not the posing of a question that may be wrong. In the Loweswater Care Project, this logic is reversed: the risk is of failing to pose questions in the 'open', which brings with it the risk of silencing vital bodies.

Loweswater Story II: querying bodily apparatus

In this second Loweswater Story, I switch the emphasis - from looking at the way in which the Loweswater Care Project allowed for response-able encounters with indeterminacy in the 'open',

to looking at the way that Loweswater Care Project participants, drawing on Latour's rules of engagement, were able to appraise how such an 'open' may be foreclosed through policy.

One of the Latourian principles which informed the way that the Loweswater Care Project worked was to *create connections between people and things*. This commitment was closely related to a further principle: to *extend doubt and questioning to our own representations*. Taken together these two principles had the effect of enhancing awareness, within the Loweswater Care Project, of the 'apparatus' through which participants could come to know, or see, the kinds of elusive bodies (cyanobacteria, clean water, or the nutrient P) in which they were becoming interested as meetings progressed. This apparatus might have been something like an ultrasound scanner (for detecting fish in the lake), or a scientific representation of cyanobacteria, good water quality, or P flows, in the form of an image, text, photographs, graph or model, etc.. The important point is that all of these things were considered as entities that mediated with the facts of the matter (Latour 2004) and that intra-acted with other materialities and human practices in complex ways (Barad 2003, Barad 2007^{xiv}). And so, the Loweswater Care Project was a forum for encouraging connections between things; as well as a forum in which the very practice of rendering things visible and present was laid open to critical scrutiny (Tsouvalis, Waterton and Winfield 2012).

At the fourth Loweswater Care Project meeting, for example, participants met to discuss the European policy legislation – the EU Water Framework Directive (2000) – that had been driving much of the concern about Loweswater's water quality amongst government agencies since the early 2000s. Two talks were given on the subject of the WFD, one given by Susan McKirdy from the UK's Environment Agency, the other by a PhD student from Lancaster University who was studying this new policy framework. Both speakers explained to Loweswater Care Project participants that one of the main aims of the directive was to achieve 'good ecological and chemical status' for all European fresh water bodies by 2015 and to prevent deterioration of this status.

As part of this explanation, the speakers introduced participants in the Loweswater Care Project to the complex classification of water quality underpinning the directive. For a water body to attain the class of 'good ecological status' it must undergo biological tests along four different parameters - dissolved oxygen, macrophytes, phytoplankton (or 'algae') and fish. Loweswater Care Project participants were informed that if any one of those four parameters fails to meet the standard measure given to indicate 'good' status, then the water body as a whole is deemed to fail to meet

good status and is relegated back to a 'moderate' or 'poor' status. This classificatory convention was introduced as the rule, 'one out, all out!'

During the evening it was made clear that, following an Environment Agency assessment, Loweswater was not thought likely to meet the criteria for 'good ecological status' by 2015. Three elements appeared to be responsible for this. Dissolved oxygen, macrophytes, and phytoplankton all seemed to be represented on the PowerPoint slide as having 'moderate' status. But a result for fish was not represented. Consistent with normal Loweswater Care Project practices, vigorous questioning followed these 'facts':

Loweswater resident: *On the ecology side, I assume it was the algae that made only 'moderate' status?*

PhD Student [flicking back through the slides]: *They're all moderate, aren't they?*

Environment Agency Speaker: *They're all moderate.*

Loweswater resident: *Even the fish?*

PhD Student: *The problem with the fish was... in this district there was some problems with the monitoring of fish data, so I think that in the North West it has not yet been included in the Draft River Basin Management Plan. But it will be...*

Loweswater Farmer: *If they can't monitor, and they don't know how many fishes is the outcome, how can they state any of it? Because they seem to be saying of status, that ours is 'poor'.*

Environment Agency Speaker: *We use the data we've got to come up with a status for it. In terms of fish, we don't monitor fish in lakes because it is very inaccurate...*

Loweswater Farmer: *Sounds like guesswork science to me...*

Environment Agency Speaker: *Sorry?*

Loweswater Farmer: *Sounds like guesswork science to me...*

Environment Agency Speaker: *Well...I mean, certainly...*

Loweswater Farmer: *If one of these things [referring to the four parameters] can knock it back to 'poor' and you can't count the fish, you haven't a hope, if fish is one of them!*

The farmer had a point. How could the lake water attain 'good ecological status' if one of the ('one out, all out!') parameters was not even monitored? Susan McKirdy from the Environment Agency later acknowledged that there were indeed 'some problems with the fish classification tool we are using'. She explained how this tool for classifying water status had been designed at 'national level' and was unsuitable for the specific types and more limited range of fish species found in the North

West of England. At this specific point in time, this contingency meant that Loweswater was unable to achieve 'good ecological status', even if the three other parameters had independently achieved such a 'good' status.

Several points are important here: first, the commitment of the Loweswater Care Project (to critiquing the connections between 'things') enabled participants to explore how this tool (or set of classificatory practices) limited the questions that could be posed to the water in the lake and how it allocated power to the answers given (through the 'one out, all out!' rule). The Loweswater Care Project debate, in other words, gave detailed insight on the way that policy ways of knowing may foreclose the 'open', shutting out response-ability in particular, complex and perhaps even arbitrary ways, silencing indeterminacies that may matter (Haraway 2008: 223).

Second, the Loweswater Care Project understanding that there are 'no unmediated facts of the matter' reminds us that putting questions to a vital order such as a body of water 'does not mean supporting an order of existence uncontaminated by human artifice or the social' (Greco 2004: 10). A focus on the indeterminacies of bodies frequently entails scrutiny of the apparatus through which that body comes to be present.

Third, the Loweswater Care Project imperative to doubt and question all representations helped create an 'open' or 'contact zone' in which the non-naturalness of the WFD could be clearly witnessed and interrogated. And yet, despite the evident artifice and contingency of the classification practices underpinning this directive, the power of the designations arrived at were also exposed. The contact zone became charged with the evident tension and emotion of the exchange between the farmer and the Environment Agency representative as they worked together to make sense of these designations. In this 'open' it became clear that this debate was not solely theoretical: a material interest was at stake for the farmers in Loweswater. The decision to label Loweswater as of moderate status might mean that a series of 'measures' would need to be set in place by the Environment Agency, directed at farm management practices. The Loweswater Care Project brought into being a contact zone in which the contingencies of policy tools, as well as their power could be felt and were in play. As a result, the politics of environmental policy making were laid bare for debate.

Conclusion

My interest in this paper has not been to open out the ontological indeterminacies of bodies in themselves, but rather to see indeterminate bodies as sites of encounter and experiment where the posing of questions about things enables new things to take place. By insisting on opening out the nature of things, through a simple set of principles (Latour 2004) participants in the Loweswater Care Project learned how to identify the limits of our ways of knowing cyanobacteria and to hone new questions and avenues of inquiry around this organism and its relations. The Loweswater Care Project was a kind of 'open' in Haraway's sense where questions and demands were put to vital bodies in ways that may open up new perspectives on policy and public decision making. I speculate briefly on what such new perspectives might offer for each of the stories told above.

In the first story, a critical and continually questioning mood within the Loweswater Care Project contributed to the reframing of the way in which participants considered the movement of the nourishing element Phosphorus. Through this reframing, participants stopped thinking about Phosphorus as something that was taken up by grass crops in known quantities and could be controlled. P had to be re-thought in relation to a wider connectivity within the soil-water environment. Seen thus, P became something like a 'hyperobject' (Morton 2013), an entity that is spatially and temporally unbounded, that is intangible, engulfing, more problematic than we thought, acting in multiple ways and dimensions, and in ways that we cannot necessarily capture. Perhaps apprehending P in this way might engender different modes of policy caring (Singleton, Waterton and Gill forthcoming) around the problem of nutrient enrichment that Loweswater exemplifies (but which, of course, is a global problem)?

In the second story, Loweswater Care Project participants laid bare the contingencies and powers of the classificatory tool used to designate water quality under the European Water Framework Directive, enabling questions to be asked about the combination of nature and technology that contrived to give Loweswater a designation of 'moderate ecological status'. Knowledge of the Directive became the subject of work and play within the Loweswater Care Project, and the silencing of the contingencies and indeterminacies built into 'moderate ecological status' was avoided. Perhaps the creation of a contact zone in which the designated ecological status of the water body is seen as non-natural might contribute to a re-thinking of the classificatory framework of this policy as well as its starkly felt affects?

The two stories rehearsed in this article are examples of many encounters that contributed, over time, to a shift in the way that the Loweswater Care Project considered the cyanobacterial bodies that continued to manifest themselves through unsightly blooms on the surface of Loweswater. As particular kinds of questioning and the formation of particular kinds of research objects got underway within the Loweswater Care Project a proliferation of indeterminate relations began to be imagined and researched. What was fascinating was that, over time, a solutions-based discourse transformed, for a while, into a discourse of steady, energised inquiry. The particular approach of the Loweswater Care Project made space for participants to open up many connecting questions including some very difficult questions about the co-production of fattened animals, farm incomes and an excessively enriched local ecology. These kinds of questions, ultimately connecting Loweswater's particular algae problem to the global phenomena of P enrichment for productive agriculture, are very often silenced - they are feared to be too difficult, too ambitious, perhaps? But in the radical openness of the contact zone there was also a kind of modesty and groundedness to the Loweswater Care Project. Since 2010 a group of residents, farmers and organisations have been able to continue working on projects to improve animal waste infrastructures on farms between 2012 to the present. As the current project officer recently reflected, she cannot definitively say if this work is having an effect on P in the lake, or on the populations and productivity of cyanobacteria, or whether it will bring Loweswater into line with the standard of 'Good Ecological Status' required by the European Water framework Directive:

It has to be accepted that there is a certain amount of uncertainty. I mean if we were working alongside somebody else that had a good system for knowing exactly what was going on then we'd want that. But no-one knows what the exact requirements are... [no-one knows] what we need to do to get waterbodies into 'Good Status'... [no-one knows] what in fact 'Good Status' looks like...^{xv}

Through its particular commitment to the questioning of lively bodies, the Loweswater Care Project made space for indeterminacies to be responded to and to proliferate; it made space for new and risky ideas to come into play; and at the same time it fostered modest and collective actions. All of these things constitute a different way of 'doing policy'. People within and connected to Loweswater are learning to 'stay with the trouble' (Haraway 2008), living within a risky indeterminate space rather than attempting to erase it.

References

- Ahmed S (2008) 'Open Forum. Imaginary Prohibitions: Some Preliminary Remarks on the Founding Gestures of the "New Materialism"'. *European Journal of Women's Studies* 15 (1): 23–39.
- Barad K (2003) Posthumanist performativity: toward an understanding of how matter comes to matter. *Signs* 28(3): 801-831.
- Barad K (2007) *Meeting the Universe Halfway – Quantum Physics and the Entanglement of Matter and Meaning*. Durham and London: Duke University Press.
- Barad K (2012) On touching—the inhuman that therefore I am. *Differences* 23(3): 206-223.
- Bennion H, Appleby P, Boyle J, Carvalho, L, Luckes, S, Henderson, A (2000) *Water Quality Investigation of Loweswater, Cumbria* Environmental Change Research Centre, University College London.
- Braidotti R (2013) *The Post-Human*. Cambridge: Polity Press.
- Canguilhem G (1989) *The Normal and the Pathological*. New York: Zone Books.
- Clark N (2011) *Inhuman Nature: Sociable Life on a Dynamic Planet*. London: Sage Publications.
- Collins, KB and Ison, RL (2010) Trusting emergence: Some experiences of learning about integrated catchment science with the EA of England and Wales. *Water Resources Management* 24(4): 669–688.
- Despret V (2004) The body we care for: Figures of anthropo-zoo-genesis. *Body & Society* 10 (2-3): 111-134.
- European Union (2000) The European Water Framework Directive (2000/60/EC).
- Greco M (2004) The politics of indeterminacy and the right to health. *Theory, Culture & Society* 21(6): 1-22.
- Grosz E (2004) *The Nick of Time: Politics, Evolution, and the Untimely*. Durham and London: Duke University Press.
- Grosz E (2013) Habit today: Ravaisson, Bergson, Deleuze and us. *Body & Society*, 19(2-3): 217-239.
- Haraway D (2008) *When Species Meet*. Minneapolis MN: University of Minnesota Press.
- Harrington A (1997) Introduction. In A. Harrington (ed.) *The Placebo Effect: An Interdisciplinary Exploration*. Cambridge MA: Harvard University Press.
- Hayward E (2010) Fingeryeyes: Impressions of cup corals. *Cultural Anthropology* 25(4): 577-599.
- Hird MJ (2010) Indifferent Globality Gaia, Symbiosis and 'Other Worldliness'. *Theory, Culture & Society* 27(2-3): 54-72.
- Kirby V (2011) *Quantum Anthropologies: Life at Large*. Durham and London: Duke University Press.

Kuhn TS (1976) (1962) *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Kuhn TS (1990) The Road Since Structure. In *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association*: 3-13.

Latimer J (2008) Introduction: body, knowledge, worlds. *The Sociological Review*, 56(s2), 1-22.

Latour B (2004) *Politics of Nature*. Cambridge MA: Harvard University Press.

Latour B (2005) From realpolitik to dingpolitik or how to make things public. In *Making Things Public – Atmospheres of Democracy* Eds B Latour and P Weibel Cambridge, Mass.: MIT Press. 4-31.

Maberly S Norton L May L De Ville M Elliot A Thackeray S Groben R and Carse F (2006) *An Investigation into the Potential Impacts of Farming Practices on Loweswater*. Centre for Ecology and Hydrology. Rural Development Service and National Trust Report Nr LA/C02707/4.

Marshall K Blackstock KL Dunglinson J (2010) A contextual framework for understanding good practice in integrated catchment management. *Journal of Environmental Planning and Management* 53: 63-89.

McNeil M (2010) Post-Millennial Feminist Theory: Encounters with Humanism, Materialism, Critique, Nature, Biology and Darwin. *Journal for Cultural Research*, 14, 4:427- 437

Mol A (2002) *The Body Multiple: Ontology in Medical Practice*. Durham, NC: Duke University Press.

Morton T (2013) *Hyperobjects: Philosophy and Ecology after the End of the World*. Minnesota MI: University of Minnesota Press.

Murphy M (2006) *Sick Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers*. Durham and London: Duke University Press.

Rancière J (2006) *Hatred of Democracy*. Verso, London.

Reynolds C S (1984) *The Ecology of Freshwater Phytoplankton*. Cambridge: Cambridge University Press.

Rockliffe J (2009) *Loweswater Catchment Management Project - Summary Agricultural Report for the Catchment*. Loweswater Care Project commissioned report.

Roosth S & Schrader A (2012) Feminist Theory Out of Science. *differences*, 23(3): 1-8.

Rose N (1998) Life, Reason and History: Reading Canguilhem Today. *Economy and Society* 27: 154–70.

Rose N (2001) The Politics of Life Itself. *Theory, Culture & Society* 18: 1–30.

- Schrader A (2010) Responding to *Pfiesteria piscicida* (the Fish Killer) Phantomatic Ontologies, Indeterminacy, and Responsibility in Toxic Microbiology. *Social Studies of Science*, 40(2): 275-306.
- Schrader A (2012) The Time of Slime. *Environmental Philosophy* 9(1): 71-93.
- Singleton V Waterton C and Gill N (forthcoming) Special Issue: Care and Policy Practices: Translations, Assemblages, Interventions. *Sociological Review*.
- Smith L Porter K Hiscock K Porter MJ and Benson D (eds.) (2015) *Catchment and River Basin Management: Integrating Science and Governance. A Volume of Case Studies and Synthesis*. London: Earthscan: Taylor and Francis.
- Stengers I (2000) *The Invention of Modern Science*. Minneapolis MN: University of Minnesota Press.
- Stengers I (2005) Deleuze and Guattari's last enigmatic message. *Angelaki* 10(2): 151-167.
- Tsouvalis J and Waterton C (2012) Building 'participation' upon critique: The Loweswater Care Project, Cumbria, UK. *Environmental Modelling & Software* 36: 111-121.
- Tsouvalis J Waterton C Winfield I J (2012) Intra-actions in Loweswater, Cumbria: New Collectives, Blue-Green Algae, and the Visualization of Invisible Presences through Sound and Science. In Rose G and D Tolia-Kelly (eds.) *Architectures of Visuality*. London: Ashgate, 109-132.
- Tsouvalis J (2015) Latour's Object-Orientated Politics for a Post-Political Age. *Global Discourse*. doi:10.1080/23269995.2015.1011915.
- Waterton C and Tsouvalis J (2015a) On the political nature of cyanobacteria: experimenting with intra-active collective politics in Loweswater, the English Lake District *Environment and Planning D* 33(3), 477-493.
- Waterton C and Tsouvalis J (2015b) An experiment with intensities: village hall reconfigurings of the world within a new participatory collective. In Chilvers J and M Kearnes (eds.) *Remaking Participation: Science, Democracy and Emergent Publics*. London: Routledge-Earthscan, 201-217.
- Welsh I and Wynne B (2013) Science, scientism and imaginaries of publics in the UK: Passive objects, incipient threats. *Science as Culture*, 22(4), 540-566.
- Wynne B (2007) Public participation in science and technology: performing and obscuring a political-conceptual category mistake. *East Asian Science, Technology and Society*, 1(1), 99-110.
- Žižek S (1999) *The Ticklish Subject – the Absent Centre of Political Ontology*. London: Verso.

ⁱ Interview with Professor Stephen Maberly, Lakes Ecosystems Group, Centre for Ecology and Hydrology, Lancaster, 11 September 2014.

ⁱⁱ Clark (2011) invokes the idea of a radical asymmetry in relations between humans and the earth/nature whereby the human/non-human interchange is 'just a region in a vast inhuman expanse' in order to explore the possibility of 'non-relations'. The expanse beyond relationality, the 'abyssal world' beyond us, changes everything according to Clark and other speculative realists (Clark 2011: 50). See also Hird (2010).

ⁱⁱⁱ European Water Framework Directive (WFD) (EC, 2000). This directive imposes legally binding demands on all EU member states to achieve 'good ecological status' (an internationally comparable ecological state) in European freshwater bodies.

^{iv} Jake Morris was employed as a researcher on a six-month Rural Economy and Land Use (RELU) Programme 'scoping study', July to December 2004 (RES-2254-25-0039).

^v 'Understanding and Acting in Loweswater: a community approach to catchment management' was supported by the RELU Programme, July 2007 to December 2010 (RES-229-25-0008). Ecological data and social scientific interview data was archived with the UK Data Archive, University of Essex, Colchester, Essex CO4 3SQ.<http://relu.esds.ac.uk/>

^{vi} The European WFD (see note iii), for example, requires this social element to be opened out and explored through various participatory frameworks and initiatives.

^{vii} This foundationalist model of knowledge was symbolised by Latour largely by the use of a capital 'S' for the word 'science' – i.e. 'S'cience. Latour differentiates *the sciences* - in the plural and in small letters- from *Science* - in a singular and capitalised version. He defines 'S'cience as the politicisation of the sciences through epistemology in order to render ordinary political life impotent through the threat of an incontestable nature' (2004:10). This contrasts with the sciences whose task is to create collective propositions with which to constitute the world (Latour 2004: 249).

^{viii} These principles were adapted from *The Politics of Nature*, Latour 2004.

^{ix} Overall, fifteen evening meetings (5.30-9.00 p.m.) were held between then and December 2010 – one roughly every two months. Much 'work' was also done between meetings. An average of twenty-five participants attended meetings, often more, and sometimes up to around 40 people.

^x Isabelle Stengers (2005) describes the way that science can be seen as a local, selective process whereby links and knots are made between two parties. The two parties are: non-humans that can be seen as experimentally reliable witnesses; and humans, their competent colleagues. She suggests that this is a kind of marriage, but that this is not a scientific fairy tale of 'man' and 'nature'. Rather, each scientific event produces a different kind of 'adventure' between the human and the non-human, each producing very strong and specific obligations and loyalties (Waterton and Tsouvalis 2015b).

^{xi} Interview with Stephen Maberly, Centre for Ecology and Hydrology, 11 September 2014.

^{xii} In-bye land is grassland that is usually near the farm or homestead and bound by a fence or wall or hedge, in contrast to open 'fell'. It is often 'improved' through the creation of drainage and the application of fertilisers and animal wastes in order to increase the productivity of the grass crop.

^{xiii} Rockcliffe, J. (2009) *Loweswater Catchment Management Project: Summary Agricultural Report for the Catchment*.

^{xiv} For the feminist STS scholar, Karen Barad, intra-action '*signifies the mutual constitution of entangled agencies*. ... in contrast ... "interaction"... assumes that there are separate individual agencies that precede their interaction... intra-action recognizes that distinct agencies do not precede, but rather emerge through, their intra-action' (Barad 2007: 33)

^{xv} Interview with Vikki Salas, West Cumbria Rivers Trust, Staveley, Cumbria, 1st June 2015.