Camera Trapping Wolves and Ghosts: Sensing Universality in the Conservation Sciences

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Abstract: This article examines how scientists sense the rewilding of wolves in Italy through camera traps. Specifically, I elaborate on two cases when footage of these elusive animals did not allow scientifically sound conclusions but instead lent itself to storytelling about the fragility of human–wolf entanglements. Turning 'the haunted data', they collect in the wild, into ghostly tales on social media or conservation blogs becomes an important way for scientists to engage with wider publics. Taking a processual view of how scientists work with camera traps – from setting them up to capturing imagery and eventually turning their data into stories – the article argues that the uncertain and unreliable imagery of camera traps allows scientists to sense and narrate the fragile interconnectedness between humans and other species. Such scientifically inspired stories are used explicitly to counter widespread opposition to rewilding. On the basis of this case study, the article explores the more general question of how disseminating a narrative of universal interconnection has become a central mission of contemporary conservation science.
[conservation, wolf, rewilding, scientific universality, sensing technology]

> Infine ringrazio loro, i lupi, fantasmi in grado di svanire ed essere invisibili in un fazzoletto di terra, per avermi fatto camminare nelle loro tracce ed entrare nelle loro vite.
> Finally, I thank them, the wolves, ghosts capable of vanishing and being invisible in a patch of earth, for making me walk in their tracks and enter their lives.[1]

After capturing over three hundred camera-trap videos of wolves that are attempting to settle in the densely populated Parma plain, conservation scientist Chiara still finds their lives elusive. Despite extensive monitoring, as she writes in this blogpost on the website of an environmentalist association, the animals often remain invisible or vanish from the view of her lenses. The wolves that her cameras trap often seem to resemble ghosts rather than data, and she finds it difficult to assemble a clear image of their movements. But for Chiara, this uncertain vision also evokes a sense of connection with them, highlighting the fragility of their existence on contested grounds. Camera-trapping ghostly wolves allows her to 'enter into their lives' and become part of the complicated relationships that they consist of. Her scientific inquiry is dedicated not

1 Quote from https://www.iononhopauradellupo.it/racconto-di-una-famiglia-di-lupi-della-pianura-parmense-nel-periodo-2021-2022/ (accessed March 26, 2024). Translation by the author.

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just to assessing the rewilding of wolves and its impacts, but also to 'walking in their tracks', to involve herself this process and even to guide it. It is this sense of connection and gratitude that Chiara wants to convey when she disseminates her camera-trap data online, as in this blogpost.

This article is an ethnographic examination of how scientists sense and make sense of the rewilding of wolves through camera-trap imagery. Specifically, I elaborate on two cases when camera-trap footage of these elusive animals did not allow scientifically sound conclusions to be made but instead lent itself to storytelling about the fragility of human–wolf entanglements. In these cases, sensing technology does not allow scientists to capture an 'image of totality' of ecological processes, evoking both the scientific dream of universal knowledge and the dangers of conservation surveillance regimes. Rather, these cases illustrate another notion of scientific universality – the premise of universal interconnection – as an important directive for self-proclaimed 'mission-oriented'[2] conservation sciences.

Today, wolves have resettled in most parts of the Italian peninsula in a process called spontaneous or autonomous rewilding. Until the 1970s, the Italian subspecies *Canis lupus italicus* had been almost reduced to extinction, with only a small number surviving in the Apennine mountains. While the killing of wolves had previously been rewarded in some areas, hunting them has been forbidden since then. Wolves have been slowly spreading out over the country again, as their young leave the pack and find opportunities in areas which humans are simultaneously depopulating. But given the widespread opposition to these potentially dangerous animals, this spreading would not have been possible without legislative protection and continuous lobbying by environmentalist organizations.[3] For instance, the organization that Chiara works for (called *Io non ho paura del lupo*, 'I am not afraid of the wolf') states that wolves are the victims of 'an enormous campaign of discrediting and disinformation' carried out by some local and national media that do not support the rewilding of wolves.[4] Opponents of wolves are often people with vested interests against radical transformations of rural (often mountain) environments, such as hunters or farmers (Rippa 2021).

To counter their opposition, non-state actors like *Io non ho paura del lupo* often initiate scientific inquiries in the hope that the results will further legitimize the presence of wolves, for instance, by delivering proof of their positive impacts on the wider ecology. In this article, I investigate how these scientific missions find expression in scientists' interpretations of camera-trap images. However, such statements do not only focus on delivering what they call 'scientific evidence and technical information'. Rather, they often also use scientific data, including camera-trap imagery, to engage in storytelling designed to inspire affection for wolves (Fish 2022). As a result, they

2 See, for instance, the Society of Conservation Biology's self-definition https://conbio.org/professional-development/education-programs/conservation-biology-faq (accessed March 3, 2024).

3 Currently the 2002 Piano d'azione nazionale per la conservazione del Lupo.

4 https://www.iononhopauradellupo.it/en/comunicazione/ (English version, accessed March 26, 2024).

engage two different notions of scientific universality – as universal knowledge on the one hand, and as universal interconnection on the other.

To delve into these different understandings of universality, I draw on ethnographic interviews with two conservation scientists involved in camera-trapping Italian wolves, as well as materials gathered from online platforms on which both scientists and citizen scientists share and narrate their footage. My primary interlocutors, Anna and Chiara, are two young conservation scientists who are actively involved in non-governmental organizations. They have both recently monitored wolves in two neighbouring regions and have also used this material for online dissemination, which led me to examine the lively online communities in which camera-trap videos are shared. I collected this material in the context of a research project on European rewilding I conducted in 2023, for which I interviewed a range of people in several EU countries. This article does not seek to present an extensive ethnography of rewilding in the Italian context but rather to provide a micro-study of scientific practices in which multiple senses of universality intersect.[5]

The two interviews and my analysis of online camera-trap communities have led me to identify two different but interlocking understandings of universality that guide the scientific monitoring of Italian wolves. On the one hand, camera traps promise to generate an understanding of wider ecological coherences by aggregating singular images – even blurry glimpses of passing wolves – into a quasi-panoptical, quasi-omniscient perspective (Simlai 2022). On the other hand, camera traps can communicate the contemporary scientific premise that ecological processes are inextricably interconnected with each other by invoking deep immersions in the life-worlds of other species (Zimmer 2023; Thaler 2022).

Scholars have long pointed out the central but ambiguous role of scientific images in environmental visualization (Carruth and Marzec 2014; Mirzoeff 2014). Since the second half of the twentieth century, the conservation sciences have prominently illustrated ecological relations through so-called 'images of totality' (Jardine and Drage 2018:9, 11),[6] which Donna Haraway famously labelled a 'god trick' (Haraway 1988:581). Images like photographs of the earth from space or the graph of the Living Planet Index appear to be representations of a totality of ecological processes and relations (Callaway 2014; Lynteris 2017) condensed into 'a fixed instantiation of universal knowledge' about them (Jardine and Drage 2018:6). In this vein, the Italian ecologist (and wolf expert of national fame) Luigi Boitani finds that camera traps provide 'eyes wherever we wish to have them, for any time and under any condition' (quoted in

5 For a detailed and rigorous anthropological analysis of the rewilding of wolves in Italy, see Rippa 2021.

6 Boris Jardine and Matthew Drage define 'images of totality' as 'the tropic representation of totality or universal knowledge, for example, through a diagram relating the disciplines, a figure or personage attempting to synthesise all learning, or an (imagined or real) object or system that stands for or provides access to (at least) a vast number of other things.' (2018:9).

Rovero and Zimmermann 2016). Such images of totality are said to offer justification for authoritative policies (Helmreich 2011; Lekan 2014). Particularly in relation to conservation practices, it has been argued that the 'panoptical gaze' created by aerial photography, GPS, or drones underlies so-called conservation surveillance regimes (Simlai 2022; Simlai and Sandbrook 2021). Showcased in campaigns and spectacular media productions, such images are promoted as 'fostering certitude in order to generate a compelling, crisis-laden truth' (Chua 2021:122; see also Igoe 2020).

However, when monitoring the rewilding of wolves in Italy, this ambition is rarely realized in practice. Chiara and her colleagues often retrieve footage on which wolves are entirely absent or unidentifiable. Instead of forming 'total archives' that represent a complete system of knowledge (Jardine and Drage 2018), their databases become 'spectral archives' oriented towards an emerging potential (Blackman 2019). But far from resenting what technical literature calls undetectability, my interlocutors do not see producing authoritative images as the sole purpose of their studies. Instead, they utilize the elusive presence of wolves to express a second scientific understanding of universality: universal interconnection. Before the edited images are disseminated, the process of setting up and monitoring camera traps transforms technoscientific monitoring into an intimate act of witnessing. As Daniel Zimmer has argued, contemporary conservation sciences are built on the discovery of inextricable entanglements between ecological processes. Crucially, he highlights that this understanding of vital interconnection was formed in a context of plausible existential threat from thermonuclear weapons, as well as anthropogenic environmental disturbances: 'the universally interconnected, mutually sustaining flows of life on Earth were discovered against the backdrop of universal death' (Zimmer 2023:189). This version of universality proposes a new form of human universality which is quite different from the often criticized essentialist tendencies of Enlightenment humanism. Zimmer argues that this premise does not seek to define what all human beings essentially are (thereby obliterating, for instance, differences and power structures), but instead points towards what all human beings collectively do (ibid.:171):

> Whatever may be most essentially true about human beings resides not at the core of their substance, but arises actively in the mutually sustaining connections that they form both with one another and all the other systems that they inhabit and that inhabit them. (Zimmer 2024:190)

Ethnographic examination of scientific practice reveals how sensing technologies like camera traps invoke this pervasive but fragile interconnection by creating affective responses. This happens, for instance, when drone footage makes scientists feel complicit in damaging marine life (Fish 2024), when radio-tracking rare bird species makes them experience wonder (Lorimer 2015), or when mobile observation platforms immerse them in forest lives (Gabrys 2022). Alongside factual evidence, these affective dimensions help to formulate new purposes and politics for the conservation sciences. Accordingly, the Society for Conservation Biology defines itself as a 'mission-oriented

science' which is simultaneously 'crisis-driven' (Meine, Soulé and Noss 2006). Like many scientists, my interlocutors find that this mission requires more than the publication of peer-reviewed papers, so they engage in a form of science-inspired storytelling (Fish 2022). In various online forums, they disseminate camera-trap images in order to convey their own experiences of feeling entangled with the wolves' lives to the wider public. Scientists approach universal connectedness by narrating their own experiences of connections, and by potentially stimulating online users to create virtual connections to the invisible wolves in their vicinity themselves.

By enabling emotional storytelling about the fragile and often invisible rewilding of wolves, camera traps become 'bridges between meaning and materiality' (Corsín Jiménez and Nahum-Claudel 2019:384). Mathias Thaler calls such stories 'powerful allegories of universal connectedness', an expression of the utopian desire for multispecies justice (Thaler 2022:267). Thus, in blogposts, social media entries, or on their own websites, scientists evoke not just the spectre of universal death, but also the utopia of universal conviviality (Büscher and Fletcher 2019; Schroer, 2021; Van Bommel and Boonman-Berson 2022). In a context where many people would prefer to sever their ties with the rewilding processes that is transforming familiar environments, these visions of co-existence may themselves appear as elusive as the ghostly wolves. This article traces them by following how scientists encounter haunted data in the wild and then turn them into ghostly tales on the screen.

Senses of Universality

But how do ghostly encounters through the lenses of camera traps affect the relationships between animals and the scientists who trap them? And how do the imperfect and sometimes unreliable images of camera traps stimulate scientific explorations of universal connection?

Camera traps originate from hunters' traps and to this day invoke the 'uncertain game of alignment' between hunter and prey (Corsín Jiménez and Nahum-Claudel 2019), although nowadays they have accompanied the transformation of hunters and prey into stewards and protégés, or enthusiasts and objects of fascination. In the 1880s, the US forester George Shiras experimented with adding a trip wire and a flash system to his traps to take stunningly beautiful photographs of animals in Michigan: brightly illuminated deer dancing in the darkness, the blurry contour of a bear in the woods. These images then also found audiences worldwide when they were printed in *National Geographic* and shown at the 1900 Paris World exhibition. Shiras' method was soon taken up as a sport somewhat akin to (and often in combination with) big-game hunting, often by European personnel in the colonies, for instance, by Carl Georg Schillings in German East Africa, or by Frederick Walter Champion in British India (Kucera and Barrett 2011).

Since then, camera traps have become central technoscientific directives in the creation of management plans and policies for nature reserves and protected areas all over the world. When the decline of wildlife populations led twentieth-century colonial administrations increasingly to implement conservation measures (Lekan 2014), the traps used by big-game hunters were gradually replaced by the camera traps used by conversation scientists (Rovero and Zimmermann 2016). Even though camera traps are not designed to kill animals but to help them survive, they are also bound up with animal deaths and survival in complex ways, and any protection they offer is tied to biopolitical decisions about which populations get to live or die.

Environmental sensing technologies like camera traps (but also GPS, radiotelemetry, or microphones) guide these reasonings. Camera traps can provide a wide range of valuable data: on species and population (presence or absence, species richness, abundance and density, occupancy models) and animal behaviour (habitat use, activity patterns, migration patterns, foraging, nest predation, environmental impacts, species inter- and intra-actions) (Rovero and Zimmermann 2016). Apart from addressing site-specific questions, such as species abundance, camera-trap images can also be aggregated to inform the study of larger contexts, such as monitoring population abundance over larger areas, and even assembling a global assessment. In the latter case, camera-trap data from a large number of studies is combined with other types of data (ibid. 2016).

Since these data have become central to various ways of governing ecologies, scholars from the environmental humanities or STS have often critically regarded their potential to substantiate so-called conservation surveillance regimes (Simlai 2022; Adams 2017). Critics lament the fact that environmental sensing technology also provides data about people who live in protected areas, which not only invades their privacy, but may also be used to incriminate them, or even justify their displacement. Trishant Simlai and Chris Sandbrook (2021) have therefore attributed a panoptic gaze to these specific uses of camera traps. Francis Massé (2018) describes this seemingly all-pervasive, near-omniscient scope of powerful conservation projects by dissecting the multidimensional reach of different conservation technologies when employed together – camera traps provide horizontal control, drones add vertical control, etc. However, others point out that the panoptic potential of environmental sensing technology is rarely fully developed, and in many cases even severely limited. For instance, Adam Fish (2024:12) describes how 'the elementality of the ocean' frequently complicates efforts to control marine life with drones. The spontaneous rewilding of wolves is another highly dynamic and uncertain process that similarly evades the control of scientific investigation and technological surveillance, albeit not because of wolves' sheer elementality, but because of their elusiveness.

Indeed, technical literature on camera-trap methodologies quickly reveals that these apparatuses produce anything but a panoptic vision. Their data can help produce accurate estimates, but researchers are aware that there is much that they do not capture. Thus, they generally do not claim that camera-trap data sets provide a complete and authoritative representation. For instance, it is impossible to determine whether

multiple images of an unmarked, unidentified animal indicate a single individual repeatedly passing the camera or many different animals (Gilbert et al. 2021). In relation to larger terrain, the movement of unmarked animals can make it difficult to define the sampling area clearly enough and can indeed introduce *more* inaccuracies into the entire estimate (ibid. 2021). Recognizing these uncertainties, researchers have developed statistical methods to account for detection error, and they have continually sought to improve their analytical methods (Morin et al. 2022). However, they generally accept that perfect detection is rare in ecological data (Valdez et al 2023).

This illegible excess of camera-trap footage resembles what Lisa Blackman calls haunted data: the errors, misunderstandings, or 'weird' excesses which are often considered blind spots in scientific approaches, but which might develop affective potential of their own (Blackman 2019). Instead of a panoptic gaze that takes in the landscape as a whole, camera-trap images rather show an irregular, even haphazard glimpse of ecologies in motion, a view that is highly dependent on specific conditions, such as the unevenness of the terrain or the camera's sensitivity. As a result, only a small number of images can provide useful data. This inaccuracy is aesthetically accentuated by the often blurry, almost spectral look of the images, in which animals are often captured at odd angles or only as a pair of eyes glowing in the dark. Sometimes, the animals themselves obstruct their surveillance when they become curious about the apparatus and reach out to touch them: lenses are splattered with mud or even broken when animals remove the traps from the trees. Even though camera-trapped animals might sometimes appear elusive or even unreadable, such limitations, disruptions, or errors may also create unexpected glimpses of animal lives which preoccupy scientists' thinking as much as their research questions do.

Also speaking against the notion that camera-trap methodologies provide a panoptical gaze is the fact that researchers depend on contextual, situated knowledge (Haraway 1988). While camera-trapping does not directly rely on the sensing human body as a moving methodology to gather empirical data, whether through an 'arts of noticing' (Tsing 2010) or 'attentiveness' (van Dooren, Kirksey, and Münster 2016), they are still closely connected to the embodied experiences of researchers. In a how-to guide called 'Data in the Wild', wolf expert Luigi Boitani suggests that camera-trapping remodels the tracking skills practised by 'The hunters of traditional societies' (Rovero and Zimmermann 2016). Usually installed on trees, camera traps take close-up photographs and thereby show multiple intimate viewpoints that are deeply nestled in specific environments. To install the traps, researchers have first to explore the territory on foot to find suitable points, usually in places where they find many traces of animal activity. Once the cameras have been set up, researchers need to check them periodically to replace batteries and collect data, as well as read animal signs like tracks or faeces until they know the area well enough to choose suitable observation bases.

The technoscientific governance of environments might be incomplete and often unreliable, but since its knowledge gaps and margins of error are filled with immersive encounters, this inevitable closeness might preclude some of the more dystopian

predictions about conservation regimes. In his work on ocean drones, Adam Fish argues that such 'enhanced intimacy' has the potential to insert care into management projects, and it reminds scientists 'to embrace their complicity' and be more reflective (2024:21, 7). In a similar vein, Jennifer Gabrys (2019) shows how these technologically aided intimacies have become the basis for more democratized environmental action at numerous intersections of science and citizen engagement, for instance, on mobile observation platforms or in participatory apps. Conversely, Charles Bergman shows that such entanglements can also be experienced negatively, as when encounters with macaws through radiotelemetry transforms endangered animals into 'signs of their own disappearance' (Bergman 2005). In this article, I argue that, precisely because camera traps cannot easily lend, in Boitani's words, 'eyes wherever we wish to have them', they create a space into which scientists can insert their own intimate experiences of ecological fragility and their own sense of interdependence.

When scientists perceive themselves to be interrelated with the ecological processes they are studying, they are participating in an important scientific recognition of the last century, namely the prospect that these processes are all inextricably entangled with each other, mutually sustaining, and pervasively influenced by human activities in their interconnections (Zimmer 2023; Thaler 2022). Observing the ocean with drones, following the radiotelemetry signs of macaws or trapping wolves on camera can convey a sense of being enveloped in a mobile network of relations. Since, in most cases, scientific inquiry is directed at ecological problems, in most cases encountering such universal interrelations also means confronting the possibility of universal death (Zimmer 2023). This intimate sense of universality becomes more than a phenomenological aspect of scientific practice because it can also be used, as Andrea Ballestero suggests, as a 'conceptual resource' (2019:762). In self-proclaimed mission-oriented sciences such as conservation biology, the joint prospects of universal interconnection and universal death become a powerful directory for future research, influencing scientists' self-understanding and the purpose of their work.

Haunted Data in the Wild

I now turn to a series of ethnographic interviews I conducted with Anna,[7] a PhD student whose research monitors the return of wolves to a depopulated Italian region. A typical image that Anna finds among her captured data is a blurry night-vision shot of leaves, of empty ground, with no wolves or other animals in sight. While the camera was set up facing a trail on which wolves sometimes wander, this particular capture was triggered not by their movements but instead by leaves' swaying in the wind. Anna

7 Upon request, I have anonymized my interlocutor's name and changed aspects of her story and context to make her and her research unrecognizable.

estimates that this happened in about eighty percent of her entire images. The only information that these images convey about wolves is their absence.

This absence is not entirely misleading, since wolves have only recently started to return gradually to the Lunigiana region. To date, relatively little is known about the precise numbers, activities and impacts of these carnivores in this sparsely populated rural area, but the sense that they are returning is already stirring people. On the one hand, newspapers sensationalize ever more spectacular encounters with wolves, as when, in April 2023, a group of people saw a wolf attack a deer on the air-rescue runway of the hospital in Pontremoli and then tried in vain to transport the fatally wounded prey in an ambulance.[8] On the other hand, tourist guides, hikers and conservationists are finding that the number of wolves permanently settled in the Lunigiana is still relatively small, not least because they sometimes find wolves shot dead by poachers.

With the help of camera-trap images, Anna had been hoping to view the wider context of these as yet unknown transformations. Apart from assessing basic facts like how many wolves have settled in the area, she hoped to find out more about which places they frequent, or how they interact with wildlife or domesticated animals. Making this context visible is important not only in mediating regional conflicts between those who welcome wolves and those who dont't, but also in arriving at a more substantial scientific understanding of how wolves that return to newly depopulated areas impact these surroundings. According to current assumptions about rewilding processes, scientists would expect these large animals gradually to change the ecological relations around them. Anna's data would be a valuable addition to knowledge about passive rewilding that is currently happening all over Italy and many other places in Europe, which is still seen as an unprecedented event about which little is known.

However, despite almost one million camera trap images piled up on her GBIF (Global Biodiversity Information Facility) account, Anna chose to show me an 'empty' image and told me that she could not see 'anything interesting' in all of these data. When I spoke to her in March 2023, she was already halfway through her funding period, and when she showed me these images of leaves, she lamented that there was 'not much happening' in her field site. Based at a German university, Anna began the project in 2020 and has since travelled to the site every six months to pick up the new data that the camera traps have collected in the meantime. Each time, Anna was left disappointed about the images' lack of expressiveness. Having already tried several modelling techniques so far, she has not produced any findings that would be worth publishing. Half-jokingly, she said that she was also considering submitting to the *Journal of Trial and Error*, which publishes insignificant findings or failed experiments.

While the images she captures do not allow Anna to see the larger contexts, she gained some understanding of the Lunigiana's ecology when setting up her study, for instance, when installing the cameras. Ideally, she aims to place the cameras evenly at

8 https://www.ilsecoloxix.it/la-spezia/2023/04/11/news/lupi_sorpresa_in_lunigiana_esemplare_e_arrivato_elisoccorso_pontremoli-12747503/ (accessed 2 May, 2024).

the intersections of a grid that she imposed on the terrain, and which she locates on site via GPS. First of all, since the area is mountainous, it is sometimes difficult for her to reach these predefined sites by foot. And once she found them, she often cannot place the cameras at the exact location because there is no tree to fix them, or because she herself cannot access steep slopes. She then has to search for the closest opportunity, which of course can involve even more hiking or climbing. What is more, the predefined spots do not always coincide with the places where she has found traces of wolf activity, so she sometimes has to find animal crossings in the vicinity. Over time, she told me that she had developed a good feeling for the area, and laughingly adds that this does not necessarily find expression in her data.

As her knowledge of the terrain grows, Anna needs to adjust the camera mechanism constantly. For instance, in order to capture less 'empty' images that were triggered by the movements of branches in the wind, Anna was trying to figure out a better sensitivity setting for her cameras. When she first took over the project, she had them set on the highest sensitivity, but ended up getting too many empty frames. She then switched to medium sensitivity, but got significantly fewer images with animals. When we spoke, she was still dissatisfied but acknowledged that empty images cannot be entirely avoided. Even though Anna herself cannot make use of the empty frame images with only leaves and branches, she stresses that they might potentially still be useful to someone in the future – or at least for machine-learning. Therefore, she does not delete the animal-empty frames, even though she struggles to find the space to store them (since the GBIF server only hosts images with animals in them, she has not yet made the empty images publicly available).

Every individual image that Anna's camera traps capture – glimpses of wolves, as well as of swaying leaves – bears the promise and potential to contribute to an 'image of totality' that would show a bigger picture. Therefore, not even the most spectacular image captured by a camera trap is significant by itself, but only in relation to numerous other pictures. Usually, scientists turn the data from camera-trap monitoring into maps or diagrams that show, for instance, the species richness in a certain landscape or region. Theoretically, a large number of such processed datasets can be aggregated to detect trans-regional or even global trends. Considering how difficult it is for Anna to camera-trap animals even in a relatively small, confined area, aggregating a very large number of uncertain, even partially empty images is ever more challenging.

Therefore, conservation scientists declare the 'undetectability of global biodiversity trends using local species richness' (Valdez et al. 2023). In their study, Valdez et al. argue that, while data on species richness is recorded by many people and organizations all over the world, this is done under very different conditions and through different methods, which renders the totality of 'global biodiversity' ultimately undetectable. A main reason for this undetectability is error: there is simply no 'perfect measurement' but only an 'opportunistic collection of studies' that are rarely conducted in a standardized way (ibid. 2023:6). For instance, researchers might work with different sampling intervals, which come with different likelihoods of being able to represent a trend

in species richness (the smaller the interval, the more samples are required). Errors also occur when researchers do not observe species even though they are present, or when they mis-identify them. As the study found, even smaller than usual errors already severely affect the validity of the statistics and render them unreliable.

Dealing with such uncertain vision motivates Anna to work on aligning the images she captures with the experiences she makes while doing so. Even though she finds it hard to collect scientifically sound data, she told me that she knows that wolves are already transforming the environment, for instance, because she has noticed the changing behaviour of their prey. Smaller animals, she finds, have avoided the vicinity of those camera sites in which she has most successfully trapped wolves. She has not yet managed to find proof of this in her images because the cameras are not set up to answer this question. Still, the issue inspires her to experiment with her data, for instance, by trying out modelling techniques that her supervisor praised as somewhat unusual.

For mission-oriented conservation scientists like Anna, this motivation to innovate camera-trap methodologies is part scientific curiosity, part vocation. In our conversation, Anna was as much concerned with the technological challenges of making the rewilding of wolves visible and knowable as she was with her intention to aid and guide the process. This was also true for other conservation scientists I spoke to, many of whom expressed a sense of urgency in substantiating their experiences of ecological degradation with more convincing data in order to improve conservation successes. For some of them, the experience of species loss precedes its proof through scientific data. Starting with their undergraduate training, their careers lead them to travel a lot and to immerse themselves in different environments. Close engagement with data from all over the world also gives researchers insights, even expertise, on places where they have never been themselves. Therefore, Valdez et al. fear that, 'even with thousands of perfectly sampled sites, many species will likely go extinct before we can adequately detect any meaningful global biodiversity change' (ibid. 2023:8).

Rather than evoking a 'panoptical gaze' of conservation surveillance regimes, scientists like Anna often endorse the uncertainty and even undetectability they encounter. In the following section, I examine more closely how the uncertain elements of camera-trap data allow situated knowledge and storytelling to take the place of scientifically sound interpretations.

Tales of Ghosts on the Screen

In the blogpost that begins this article, Chiara Alessandrini recounts her experiences in camera-trapping a wolf pack in the Parma plain. Instead of using mathematical modelling techniques to turn camera-trap images into 'images of totality' that visualize larger contexts, Chiara offers a 'tale', *un racconto,* of the fate of an individual pack, as well as of her own intimate relationship with it.

Every video that Chiara chose conveys some pieces of information. A young wolf licking an adult's muzzle as a request for care shows that the pack had reproduced the year before. The dominant female marking a spot with urine is captured from a position that shows an infestation with mange (parasitic mites). A puppy that stands right in front of the lens and stares at it shows signs of hair regrowth, which indicates that it might recently have recovered from the same disease. Even though these videos usually last only a couple of minutes, they reveal enough details of the wolves' lives to allow Chiara to tell a tale, even if only in parts.

Although the Parma plain begins at the northern end of the Lunigiana mountains, the wolf pack found themselves in a very different situation than their neighbours. In contrast to this depopulated mountain region, almost the entire Po Valley is densely settled, industrialized and cultivated. The plain suffers from a range of environmental threats, such as one of the strongest pollution rates in Europe or persistent drought, with parts of the rivers disappearing for periods over hot summers. The pack was one of first to try to settle in the area, which Chiara suspects 'must not have appeared very inviting to their senses'.[9] During the time that Chiara and her colleagues monitored them, the wolves had to move their location, but also seemed to have found a way to nourish themselves by eating waste meat from the area's numerous farms.

Chiara conducted the monitoring together with a number of colleagues from *Io non ho paura del lupo*, which uses the data to generate and disseminate knowledge about these controversial animals. For this project, they investigated a territory measuring about ten square kilometres by distributing five to seven camera traps in places that the wolves marked repeatedly, and leaving them in place for as long as possible. Another trap was placed on a half-decayed wolf carcass. The team also searched for signs of presence like tracks and faeces. Between spring 2021 and spring 2023, they collected over three hundred videos. However, Chiara does not consider their data to be entirely scientifically sound.

The camera-trap footage is so patchy that she struggles to relate a complete account of the wolves' lives. For one thing, the monitoring team was not always permitted to install camera traps in the most suitable spots because most of the land was private property. Moreover, many of the wolves caught on camera are difficult to identify. Most of them do not have clearly distinguishable features or simply pass by too quickly. Chiara therefore remains unsure about central aspects such as the total number of wolves and their offspring, but assumes that there are at least four adults and three pups, one of whom later died. She recognizes and even names some of the wolves, but remains unsure about the identity of others. Once she recorded a female wolf with a very recognizable trait (a diseased eye that is not fully reflected in the camera), but the animal never appeared a second time and left Chiara wondering: 'I've asked myself countless times who this never before seen female was, where she came from and where

9 Quote from https://www.iononhopauradellupo.it/racconto-di-una-famiglia-di-lupi-della-pianura-parmense-nel-periodo-2021-2022/ (English version, accessed March 26, 2024).

she ended up after… Questions that will forever remain unanswered.'[10] For Chiara, such personal and emotional reflections often fill in the gaps of unseen images and unknown answers:

> I had the privilege of being able to witness glimpses of their lives, unforgettable for me, with the awareness that I could only be a silent and discreet witness of their dramas and their successes, but with the same certainty that, if there hadn't been someone to be able to tell them, for us it would have been as if they had never happened. This story is an attempt to describe what happened in the family of wolves that I have been following for over two years, and it is only the tip of the iceberg of their complicated and for us elusive, lives but above all I want it to be my thanks to them, because the time dedicated to trying to understand them without interfering has been a path of rediscovery.[11]

Alongside factual information and analysis, these reflections themselves amount to a tentative conclusion: even though her images show 'only the tip of the iceberg of their complicated and for us elusive, lives', these lives are connected to the grander aspirations of ecological recovery in an intricately entangled world. Admitting her inability to compile a total account of their lives does not lessen the importance of her work because, 'if there hadn't been someone to be able to tell them, for us it would have been as if they had never happened.' For her, the more neutral act of monitoring wolves becomes the endeavour 'to witness glimpses' and to 'be a silent and discreet witness of their dramas and their successes.' As bearing witness becomes valuable alongside collecting data, Chiara simultaneously takes on the contradictory positions that monitoring and witnessing afford – the first requires her to be detached, the second to become deeply involved.

When Chiara disseminates her camera-trap images on her organization's website, or when a substantial number of citizen scientists share their own footage, witnessing gives way to what Adam Fish (2022) calls scientific storying, or science-inspired storytelling, which is supposed to invigorate public interest and to act as a prerequisite for legal and financial support for conservation. In the Italian context too, researchers often share camera-trap data with citizen scientists and other wildlife enthusiasts. Some of these images are taken from the large backlogs of unprocessed images, which are often not necessarily directly relevant for specific studies or routine monitoring. Conservation organizations sometimes draw on these backlogs to upload spectacular or comical clips on social media.

For instance, in the caption for a camera-trap video of an 'extraordinary encounter' between a wolf pack and a deer, the NGO Rewilding Apennines declares that such

10 Quote from https://www.iononhopauradellupo.it/racconto-di-una-famiglia-di-lupi-della-pianura-parmense-nel-periodo-2021-2022/ (English version, accessed March 26, .2024).

11 Quote from https://www.iononhopauradellupo.it/racconto-di-una-famiglia-di-lupi-della-pianura-parmense-nel-periodo-2021-2022/ (English version, accessed March 26, 2024).

footage is a way to 'to make us live these emotions of wild nature'.[12] One of the account's most frequently viewed videos shows a howling wolf, which instils in its viewers an almost eerie sense of wonder. Accompanied by music or commentary, such videos open up complimentary interpretations of the diligent analysis of camera-trap images one finds published in journals. Another example are dedicated websites like fototrappolaggionaturalistico.it, which has a section dedicated to storytelling through camera-trap images. For instance, one story recounts the life of the wolf Luna, who used to be the dominant female until her pack fell victim to poaching and she grew into old age entirely on her own. Another, more light-hearted story recounts the male wolf Ventasso's coming of age after leaving his natal pack and finding a companion with which to start his own pack. The narration turns wolves into public personalities with almost human, but nevertheless still somehow wild, lives. However, the most-viewed camera-trap videos seem to be those uploaded onto YouTube without commentary, but with a lively comments section where people post mostly humorous remarks.

Such storytelling can be seen as part of the conservation sciences' self-declared mission to protect ecological life-worlds. By turning camera-trap images into tales rather than data, scientists narrate both the knowledge and the sense of being entangled with other species' lives and disseminate it to the public. According to Adam Fish, this is 'an ethically responsible act of reciprocity or giving back to the animals whose lives are disturbed by scientific data collection' (2022:864). He argues that, since the relationships between scientists and animals have become so much closer through sensing technology (or at least feel so much more intimate), scientists are now morally obliged to assume more profound responsibilities for the care of animals. This also seems to be the opinion of scientists like Chiara, who make it their mission to publicize the narrative of the fragile survival of wolves. As her organization writes on their website, they do this also explicitly to address what they call 'an enormous campaign of discrediting and disinformation' carried out by some local and national media that do not support the rewilding of wolves.

Conclusion

In this article, I have examined how two scientists turn the haunted data they encounter in the wild into ghostly tales in online worlds in order to narrate the fragile rewilding of wolves. The first example has explored the experience of setting up camera traps in uneven terrain and collecting unreliable, often unreadable images. In this case, what the technical literature calls undetectability translates into a sense of productive haunting: the invisible presence of wolves and the subtle rewilding dynamics that the

12 https://www.youtube.com/watch?v=5RUnvzdM54c&ab_channel=RewildingApennines (accessed March 28, 2024).

scientist experiences when immersed in her research surroundings motivate her curiosity and creativity. The second example has shown how uncertain images and elusive data can become the basis for scientific story-telling. Foregrounding the researcher's subjective experiences of witnessing partially unknowable, fragile and precious events, these stories resemble tales of ghosts rather than conventional scientific analyses. Besides generating evidence-based knowledge about the rewilding of wolves, communicating these subjective and affective dimensions of scientific practice becomes a central endeavour for the researcher.

The article uses these ethnographic perspectives to illustrate the scientific mission that motivates many contemporary conservation scientists. More precisely, I have argued that the uncertain vision of camera traps inspires my interlocutors to formulate and disseminate scientific stories that might motivate the protection of delicate connections. Similar to the notion of scientists as custodians of universal knowledge employing the god-trick of quasi-omniscience, here scientists also take on the role of powerful stewards burdened with the responsibility for universal survival. But my interlocutors' endorsement of the unknown and unseen aspects of scientific practice lend a different tone to their stewardship. Rather than seeking all-pervasive, quasi-omniscient knowledge in order to exert control, they emphasize fragility. How, then, does the notion of universal interconnection motivate conservation efforts in perhaps different ways than authoritative constellations of quasi-surveillance regimes?

On the one hand, the emphasis on multispecies intimacies could be read as a spirited counter to the possibility of universal death which Daniel Zimmer has highlighted as a central theme in the current conservation sciences. It suggests that scientists also harbour hope for what could perhaps be called universal conviviality, thereby evoking radical ideas like multispecies justice that anthropologists and humanities scholars have put forward in recent decades (Chao, Bolender and Kirksey 2022). The prospect of convivial coexistence is particularly developed in the ways in which scientific findings are communicated. Science-inspired stories are meant to sustain citizens' acceptance of or even support for conservation efforts, while visuals like drone and camera-trap videos illustrate such narratives. Adam Fish even argues that such story-telling is an act of care which itself contributes to a kind of reciprocity between humans and the other species that contribute to scientific knowledge finding (2024).

This seems true in the cases I have examined in this article. Wolves may have autonomously reclaimed the Italian peninsula, but they rely on supportive groups in order to be able to remain there against the clear opposition of concerned citizens. Science-inspired storytelling becomes a way of countering the demands to minimize the wolf population, which abound on social media or in the local press. These suggest severing the emerging ecological interconnection that spontaneous rewilding processes are beginning to create. A brief and blurry YouTube video of a wolf might be a way to foster affinities and thus to convince people to accept this potentially dangerous animal in their neighbourhood. And even ghostly encounters might be more effective than the iconic images of planet Earth which are nearly omnipresent in environmentalist image-

ry, but which may appear abstract and static rather than convey an immediate sense of belonging and connectedness (Helmreich 2011; Lekan 2014; Jasanoff 2001).

On the other hand, like the panoptical gaze of more authoritative conservation organizations, science-inspired notions of conviviality also exclude other forms of co-existence which may not favour wolves but might be too easily vilified. The scientific ideal of universal interconnection is not easily aligned with concerns about particular interconnections. As Alessandro Rippa finds, anti-wolf narratives do not set out to stigmatise wolves but instead signify 'the abandonment of the mountain' and 'a point of no return for mountain communities' social and cultural livelihood' (2021:949). As his ethnography shows, the people who speak out against the rewilding of wolves do not always do so on the basis of misinformation that must be debunked by means of scientific evidence. For wildlife hunters, the rewilding of wolves is one of the transformations that make their familiar environments less habitable. Therefore, people who oppose the rewilding of wolves do not reject close entanglements with other species outright; instead, they try to protect a very specific form of them, precisely, as Rippa writes, the 'multispecies communities that they have participated in shaping over generations' (2021:968).

The loss of the latter might also evoke a sense of haunting which is not captured in the lenses of camera traps and does not find expression in the scientific ghost stories that this article has explored. In conclusion, by turning scientific attention towards invisible and fragile rewilding which is yet-unknown and yet-unrealized, the ghostly vision of camera traps illustrates universal interconnectedness as another partial mobilization of scientific universality in fractured environments.

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