# Monitoring extinction: defaunation, technology and the biopolitics of conservation in the Atlantic Forest, Brazil

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## Abstract

Due to habitat fragmentation, Brazil's Atlantic Forest is considered one of the world's most threatened biodiversity hotspots. Much of the biome has become extinct of its largest-bodied mammals, leading some to refer it as a 'half-empty forest.' One of the ways conservation actors are responding to this crisis is by utilizing Global Positioning System (GPS), camera trapping, and remote sensing satellite imagery. Together, these tools enable the collection of data at unprecedent levels. By intensifying wildlife monitoring, it is thought that better-directed actions can be taken to avoid species extinction. Although there is a nascent body of research in political ecology examining the role of these new technologies in conservation, so far there has been little exploration of what this implies for the transformation of the governance of conservation spaces. Bringing together literatures on biopolitics of conservation and conservation technologies, this article reflects on the ways new technologies are changing the biopolitical governance of conservation in the Atlantic Forest. I argue that the increase of information flows, together with the ability to process data through models and algorithms, intensifies the capability of biopolitical governance to justify claims for new protected areas, while changing ecological subjectivities. With the increased use of remote sensing technologies, some ecologists are being distanced from the field, and are consequently having less interactions with rural communities. As pressures on biodiversity increase, this may facilitate advocacy for coercive conservation measures that have adverse impacts on local communities.

**Keywords:** Atlantic Forest, Brazil, biopolitics, conservation, Foucault, new technologies

## Résumé

En raison de la fragmentation de l'habitat, la forêt atlantique du Brésil est considérée comme l'un des points chauds de la biodiversité les plus menacés au monde. Une grande partie du biome a perdu ses plus grands mammifères, ce qui a conduit certains à parler de "forêt à moitié vide." L'une des façons dont les acteurs de la conservation répondent à cette crise est l'utilisation du système de positionnement global (GPS), du piégeage par caméra et de l'imagerie satellitaire de télédétection. Ensemble, ces outils permettent de collecter des données à des échelles et des niveaux sans précédent. En intensifiant la surveillance de la faune, on pense pouvoir prendre des mesures mieux ciblées pour éviter l'extinction des espèces. Bien qu'il existe un ensemble naissant de recherches en écologie politique examinant le rôle de ces nouvelles technologies dans la conservation, il y a eu jusqu'à présent peu d'exploration de ce que cela implique pour la transformation de la gouvernance des espaces de conservation. En réunissant les littératures sur la biopolitique de la conservation et les technologies de la conservation, cet article réfléchit à la manière dont les nouvelles technologies changent la gouvernance biopolitique de la conservation dans la forêt atlantique. Je soutiens que l'augmentation des flux d'informations, ainsi que la capacité à traiter les données par le biais de modèles et d'algorithmes, intensifient la capacité de la gouvernance biopolitique à justifier les demandes de nouvelles zones protégées, tout en modifiant les subjectivités écologiques. Avec l'utilisation accrue des technologies de télédétection, certains écologistes s'éloignent du terrain et ont donc moins d'interactions avec les communautés rurales. Comme les pressions sur

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la biodiversité augmentent, cela peut faciliter le plaidoyer pour des mesures de conservation coercitives qui ont des impacts négatifs sur les communautés locales.

**Mots-clés**: Forêt atlantique, Brésil, biopolitique, conservation, Foucault, nouvelles technologies

## Resumen

A causa de la fragmentación del hábitat, la Mata Atlántica de Brasil se considera uno de los puntos críticos de biodiversidad más amenazados del mundo. Un gran parte del bioma de sus mamíferos de mayor tamaño se ha extinguido, lo que lleva a algunos a referirse como un "bosque medio vacío." Una de las formas en que los actores de la conservación responden a esta crisis es utilizar el Sistema de Posicionamiento Global (GPS), cámaras trampa y imágenes satelitales de teledetección. Juntas, estas herramientas permiten la recopilación de datos a niveles sin precedentes. Al intensificar el monitoreo de la vida silvestre, se cree que se pueden tomar acciones mejor dirigidas para evitar la extinción de especies. Aunque existe un cuerpo de investigación incipiente en ecología política que analisa el rol de estas nuevas tecnologías en la conservación, hasta ahora existe poca exploración de lo que esto implica para la transformación de la gobernanza de los espacios de conservación. Al reunir literatura sobre la biopolítica de la conservación y las tecnologías de conservación, este artículo reflexiona sobre las formas en que las nuevas tecnologías están cambiando la gobernanza biopolítica de la conservación en la Mata Atlántica. Sostengo que el aumento de los flujos de información, junto con la capacidad de procesar datos a través de modelos y algoritmos, intensifica la capacidad de la gobernanza biopolítica para justificar los reclamos de nuevas áreas protegidas, mientras que tambien cambian las subjetividades ecológicas. Con el uso cada vez mayor de tecnologías de teledetección, algunos ecólogos se mantienen lejos del campo y, en consecuencia, tienen menos interacciones con las comunidades rurales. A medida que aumentan las presiones sobre la biodiversidad, esto puede facilitar la promoción de medidas de conservación coercitivas que tienen impactos adversos en las comunidades locales.

**Palabras clave:** Mata Atlántica, biopolítica, conservación, Foucault, nuevas tecnologías

## 1. Introduction

The Atlantic Forest, spanning the eastern coast of Brazil, is considered one of the world's most important 'biodiversity hotspots', due to its significant number of endemic species facing extinction (Myers *et al.* 2000). Since the 1500s, colonial rule, commodity booms and urban expansion have left the forest highly fragmented (Dean 1996). Notably, around half of the remaining fragments are under 100 hectares in size, meaning they contain insufficient resources to sustain larger-bodied mammal populations (Ranta *et al*. 1998). These include jaguars (Panthera onca), white-lipped peccaries (Tayassu pecari), tapirs (Tapirus terrestris), and woolly spider monkeys (Brachyteles arachnoides) – mammals that require bigger territories to thrive. As a result, research shows that 95% of the Atlantic Forest is extinct of the ecological functions of these mammals (Jorge *et al.* 2013). This phenomenon is called *defaunation* and has been the focus of increasing research, both in Brazil and globally (Dirzo *et al.* 2014; Galetti *et al*. 2017). This is not a new scenario, but at present even some of the largest forest fragments have been left with extremely low levels of biodiversity (Metzger *et al*. 2009). If the current situation is unchanged, species extinctions are sure to follow in the future, with larger-bodied mammals being most severely at risk (Bogoni *et al*. 2018).

As this biodiversity crisis intensifies, new technologies have simultaneously emerged that promise to aid conservation efforts by transforming the flows of information in biodiversity monitoring (Ritts and Bakker 2018). Since the 1990s, there has been a surge in development of technologies that provide data on where animals are and how they move. With technological advances and costs becoming more accessible, the use of these emergent technologies has become viable and is now commonplace in biodiversity conservation. As an example, whereas earlier radio-collars used for tracking animal movement were heavier and bulkier, collars available now are more compact and satellite-based (Kays *et al*. 2015). Likewise, using film cameras to collect information on the locations of species has given way to digital cameras with infra-red sensors. Innovations have also occurred in other areas of biodiversity monitoring. Now, data can be collected through animal tissue (such as isotopes and genetic material), as well as through other remote sensing tools, such as drones (Pimm *et al.* 2015: 685). There has been a recent call for scaling up the use of camera traps and establishing a global network of cameras, researchers and citizens dedicated to monitoring biodiversity trends (Steenweg *et al.* 2017).

Similarly, the relatively new sub-field of movement ecology making use of low-cost sensors, smartphone apps and predictive capabilities of big-data analysis promises to change the status-quo of how conservation is done (Adams 2019: 2; Bakker and Ritts 2018).

There is now a growing body of literature in political ecology addressing the use of these new technologies in conservation (Adams 2019; Benson 2016; Sandbrook *et al*. 2018; Verma 2016). This runs parallel to another body of literature exploring conservation governance as an expression of biopolitics. Michel Foucault identified biopolitics/biopower as a shift in governance emerging from the 18th century onwards. The biopolitical modern state's power to "make live or let die" was juxtaposed against sovereign power's authority to "take life or let live" (Foucault 2003:241 in Fletcher *et al*. 2019:3). A characteristic of biopower is that "the population" became an object of study, and hence its onset was accompanied by the advent of research on public health and demography (Foucault 1980 in Cavanagh 2018). With this focus on populations, research began to attempt to understand their particular qualities, and how they could be improved. One of the key contributions of Foucault's biopolitics is the acknowledgement that knowledge production is itself political. This is because forms of "power-knowledge" create normative standards of how populations should be, which in turn affects the way populations are governed (Cavanagh 2018: 405). Additionally, life itself comes under the scrutiny of "explicit calculation", and knowledge is seen as the steering force through which transformation of life occurs (Biermann and Anderson 2017: 2). Although the concept of Biopolitics has now been taken up in different ways by scholars (for an overview see Cavanagh 2018), my analysis follows the Foucauldian tradition. In its original formulation, Foucault intended biopolitics to be a framework to analyze human populations, yet some argue "that we have an anemic understanding of biopower if we look only at human life" (Biermann and Mansfield 2014:259). Consequently, a growing body of work has extended Foucault's biopolitics framework to explore human-nonhuman relations (Youatt 2008, Braverman 2015, Fletcher *et al*. 2019) including biodiversity conservation (Biermann and Anderson 2017, Cavanagh 2018).

Seeing biodiversity conservation through the lens of biopolitics or 'making nature live', marks a shift away from emphasizing a purely sovereign governance over nature, where it is seen merely as a resource to be dominated and exploited (Biermann and Mansfield 2014:258). Instead, nature conservation is a biopolitical endeavor to care for particular forms of life and is a practice that has become increasingly complex through the use of database tools, population management models, and algorithms (Braverman 2015). While new technologies increasingly play an integral role in contemporary conservation governance, only Braverman (2014, 2016) has hitherto explicitly analyzed how they play into the biopolitical governance of conservation. Building on Braverman's work, I utilize Jeffrey Nealon's concept of 'intensification' and Byung-Chul Han's 'Dataism', which are both engagements with biopolitics, to add an additional yet critical component to the discussion.

Rather than focusing on algorithms, as Braverman does, I explore the implications of camera trapping and GPS collars technologies on conservation biopolitics. My main argument is that due to the increase of data flows, digital conservation intensifies biopolitics and its ability to conserve a particular type of life, which leads to claims for new conservation territory. Remote sensing technologies distance researchers from the field and local communities, which has an effect on their subjectivity. As extinction pressures grow, this may facilitate advocacy for coercive conservation measures against human subjects deemed a potential threat to endangered nonhuman life. Therefore, care must be taken in ensuring the adoption of these technologies are not detrimental to local communities around conservation-critical areas.

The research for this article is based on fourteen months of fieldwork in São Paulo, Rio de Janeiro, and Brasilia states in Brazil between October 2016 and November 2019. More specifically, the empirical data for this article was collected through two camera trapping campaigns, both of which lasted six and five days respectively (2018, and 2019). The 33 interviews were collected on two separate fieldtrips, between March-April 2019, and October-November 2019. These were semi structured interviews with relevant conservation scientists, practitioners, and university researchers from governmental, non-governmental and private organizations. Due to the participants of this research, the focus of this article rests on camera trapping and GPS collar technologies. A majority of the interviews were conducted with ecologists working with the jaguar, which is an apex predator. Jaguars are considered an umbrella species and are proxies for environmental quality and surrogates for defaunation. For this reason, research conducted on jaguars has better funding for high technology monitoring, and the empirical data collected may vary in contrast to biodiversity monitoring of less 'charismatic' species.

The first section of the article outlines literatures on new technologies and the biopolitics of conservation and how they can be productively brought into dialogue. The second section applies this conceptual framework to outline six main themes that emerged from my fieldwork concerning the implication of new technologies for conservation in the Atlantic Forest. Specifically, I argue that new technologies have implications for conservation because they: 1) generate more data; 2) solidify claims to new territory; 3) highlight problem areas for intervention; 4) have implications for hunters and poachers; 5) distance researchers from the field; 6) have their limitations. The third section will discuss what these dynamics mean for biopolitics of conservation.

## 2. Emerging technologies and the biopolitics of conservation

The literature on technologies used in conservation is sparse but growing. In his book *Wired Wilderness: technologies of tracking and the making of modern wildlife*, Etienne Benson takes a historical approach in understanding the earliest wildlife tracking technologies (2010). In the 1950s, wildlife scientists utilized small radio transmitters developed by the military during the Cold War to create devices to track animals. Benson chronicles how these radio-telemetry devices were harnessed to track marine mammals, together in India, as well as bears in Yellow Stone National Park. The book shows how error-prone these early technologies were, that animal-tagging was often markedly violent, and that they starkly divided the conservation community. Some scientists reveled in the possibilities that radio-telemetry offered, whilst others, such as the naturalist Adolf Murie, said it "destroyed the very essence of the poetry of wilderness" (Benson 2010:69; Hamblin 2013: 5). Ultimately, the book draws from 'The trouble with wilderness' (Cronon 1996), in highlighting the contentious debates over the ethics of 'interfering' with nature by tracking it. These informed the early days of radio-telemetry in conservation.

Lately, radio-telemetry is being superseded by satellite-based GPS collars, geolocators, isotope-based tracking and more complex forms of tracking life (Benson 2016). These devices, in confluence with other developments like improved computational power, cheaper data storage, and the ability of transmitting data through the internet, are contributing to the production of data in unprecedented amounts and rates. Some have argued that this move towards 'data-centric', or 'data-intensive' science signals an ontological shift in conservation science (Benson 2016: 137). Moving away from previous scientific models that rely on hypothesis-testing, the vast quantities of data available now skews scientific inquiry towards 'pattern-identification' (Ibid). According to Benson, in movement ecology there is a prioritization of looking at the digital 'tracking' data, at the expense of examining evolutionary and ecological processes.

Some have argued that images produced by these technologies are increasingly used to spectacularize nature, which also serves to (further) commoditize conservation (Igoe 2010; Adams 2018). Discussion has also focused on the effects digital technologies and citizen science have on how conservation organizations monitor and visually present wildlife (Verma *et al*. 2016). Here, the digital tracking of animals is seen to create 'wildlife cartographies', enabling novel visual representations of nature which influence the public narrative and policy on conservation. By focusing on the animal census, Verma *et al.* call into question whether utilizing these technologies for surveillance merely extends human domination over wildlife. Although Verma *et al.* draw from a theoretical framework focused on surveillance and census-making, they do not include the notion of biopolitics into their analysis. Since the primary goal of biodiversity conservation is to *make certain forms of life live*, I argue that a biopolitical conceptualization is an appropriate lens of analysis (Youatt 2008).

Surveillance is a common theme in the literature on new technologies, and scholars have also looked at the social implications of camera-traps for neighboring human communities (Sandbrook *et al.* 2018). Camera trap technology is presented as devices that can increase data availability on species presence, and with this enhance conservation. At the same time, the ethics of using such technologies is called into question, as it also extends surveillance into human populations living in and around protected areas. In these scenarios, camera traps not only collect information on those breaking the law, but also those merely carrying out their lawful everyday lives (Sandbrook *et al*. 2018: 501). In certain situations, these cameras can serve to make a separation between 'natural' and human spaces. Similar issues can be seen in the use of drones in conservation (Sandbrook

2015). Sandbrook suggests that if these negative social impacts are not addressed, they could hamper conservation goals in the long-term (2015: S644).

Big data, integrated databases and increased computational processing power is also changing the way that data is analysed (Adams 2018). The collection of data through some newer technologies 'bypasses' skilled fieldworkers by being able to automatically upload GPS and time-stamped data directly to databases through web or phone systems (Adams 2017). This expands the reaches of monitoring capacities far exceeding earlier human limitations. Due to the change in the volume of data flows, data analysis in conservation is also changing. Now, automated data management, modelling, and technologies from computer science and engineering are central to conservation (Adams 2018: 1). This automation of conservation decisions by digital technology has been termed "conservation by algorithm" (Adams 2018). This is characterized by animal tracking data being used to inform land demarcation and control, surveillance technology being used in coercive conservation, and the use of digital data in the automation of conservation decisions.

Due to the evident implications of new technologies for surveillance of biodiversity as well as its human users, the connection with biopolitics is apparent. Thus Sandbrook and colleagues (Sandbrook 2015; Sandbrook *et al*. 2018) link the surveillance afforded by new technologies with notions of the 'panopticon', which Foucault (1977) used to characterize the way biopolitics operates to compel subjects to internalize a sense of self-control (see Fletcher 2010; Fletcher 2017). Building on this, Adams (2017, 2018) explicitly frames the use of new digital technologies in conservation as a shift in the biopolitical regime of conservation. While an intriguing conceptual intervention, it lacks empirical data to back up its claims. Examples that do use empirical data in conjunction with a biopolitical framework to understand the implications of new technologies for conservation governance analyze the use of databases and algorithms calculating 'species viability' (Braverman 2014, 2017). These analyses reveal that processing of databases through algorithms is making previously distinct practices of *ex-situ* and *in-situ* conservation increasingly blur with one another. Surveillance in this case means extensive records and data management, which is seen as an integral part of biopower. Algorithms calculate numbers based on these databases that symbolize species' populations risk, making it possible to commensurate, rank and classify species according to the threat levels they face.

Unlike other cases that view surveillance and technologies through a Foucauldian framework, here surveillance is explicitly framed as harnessed to *make nature live* (see Biermann and Mansfield 2014). As this process utilizes increasingly complex calculations, it also relies on a small number of experts that translate raw data. This encourages a top-down and technocratic type of conservation. Algorithms are essential in the calculation of global threatened species lists, such as the IUCN Red List (Braverman 2016). The Red List is the standard amongst governmental and non-governmental organizations, serving as a tool to assess the health of species populations, and to rationalize conservation action worldwide. The act of listing and ranking species according to their level of extinction threat is a biopolitical act, as Braverman argues, "the *listing* of life is thus also *making* life – it grants life" (2016: 134). The act of listing makes use of algorithm and automation in making complex calculations, which attempt to anticipate future threat to species.

Other studies have unpacked how biodiversity censuses function as biopolitical techniques (Youatt 2008), and how different conservation approaches embody multiple forms of biopolitics (Biermann and Anderson 2017). Biopolitical conservation has also been situated within social contexts that are in a constant state of development, demonstrating that social changes have a mutually constituting relationship with conservation governance (Cavanagh 2018: 409). Despite these initial interventions, the scholarship on conservation biopolitics has devoted little attention to the emerging technologies that promise to alter the *status quo* of conservation thus far. Pimm *et al.* (2015: 689) characterize emerging technologies as a "toolbox" of diverse instruments that contribute to distinct stages of the "analytical pipeline." These stages are: data collection through devices, the connection of this data through cloud computational systems, the analysis of this data through algorithmic automation, and the execution of actions. The few studies that have sought to bring together discussions of biopolitics and new technologies thus far have focused on the implications of the algorithms and data analysis automation on biopolitical regimes (Adams 2017; Adams 2018; Braverman 2014; Braverman 2017). By instead focusing on the role of camera traps and GPS collars in conservation research, my study adds to this discussion by focusing on the devices that collect data for algorithms and experts to analyze.

In order to help understand the phenomenon of the biopolitics of technology and conservation, I draw especially from Jeffrey Nealon and Byung-Chul Han's interpretation of biopolitics. Jeffrey Nealon argues that Foucault views 'intensification' as the driving force for social change (Nealon 2008). For Foucault, the imperative of biopower is to "first, obtain the exercises of power at the lowest possible cost (economically, by the low expenditure it involves; politically, by its discretion, its low exteriorization, its relative invisibility, the little resistance it arouses); secondly, to bring the effects of this power into their maximum intensity and to extend them as far as possible, without either failure or interval"(Nealon 2008: 39; Foucault 1975: 218). I argue that new technologies serve the purpose of bringing the power of biopolitical conservation to its maximum intensity, precisely by "lowering the cost" of extending its power. Yet, as Benson (2016) argues, the use of these technologies affects the ontology of science, and has its consequences.

Byung-Chul Han characterizes the current confluence of digital technology and neoliberal capitalism as 'Dataism' (2017). Han explores how the rise of Big Data has led us to a 'Second Enlightenment', which is "the age of purely data-driven knowledge" (Han 2017: 58). At its core, Dataism is the belief that everything should be measured and quantified, revealing hidden correlations and the ability to foretell the future. Data fetishism signifies a shift from theory-based causality to correlation-based knowledge, which Han argues is "driving Spirit from the realm of knowledge" (2017: 68). Much like Nealon's conceptualization of intensification, Han argues that biopolitical data-centric systems have a compulsion to eliminate and calibrate the resistance of 'The Other' that may interfere with the smoothness of its operation (Han 2015: 2). This loss of 'Spirit' in knowledge production and the compulsion to calibrate 'The Other', are two key concepts that I will return to later in the article, as they will help to explain how new technologies are shaping the subjectivities of ecologists, and what implications this may have for conservation's relationship with local communities in face of species extinction.

Next, I will briefly outline the current biodiversity crisis in the Atlantic Forest to contextualize the pressures on the forest's fauna, which scientists are working hard to alleviate. Much of the literature on defaunation is relatively recent, and the effects of fragmentation and defaunation on species remain uncertain. Hence, in efforts to prevent extinctions in the biome, a current focus of conservation actors is to expand ecological research on the effects of environmental pressures on the health and behavior of the biodiversity in the Atlantic Forest biome.

## 3. Biopolitics of biodiversity monitoring in the Atlantic Forest

Depending on sources, estimates of the remaining Atlantic Forest cover range from 7-12% (Ribeiro *et al.* 2009). Yet, despite its loss of forest cover, it still holds a similar biodiversity per kilometer squared as the Amazon, and is designated as one of the world's most threatened biodiversity *hotspots* (Joly *et al*. 2014; Myers *et al.* 2000). In recent years, the deforestation rates have slowed, yet the remaining fragments have been left with a level of biodiversity unviable in the long run (Halley *et al.* 2016). Taking this into account, the Atlantic Forest currently has an 'extinction debt', where extinction will follow, but *the extent and rate* are not known yet (Metzger *et al.* 2009). In fact, there is evidence that even the biggest and best-protected fragments of the Atlantic Forest are losing their larger mammals (Galetti *et al.* 2017). The first species that are affected by the fragmentation of habitat are the larger bodied mammals, who require larger tracts of lands for their territory. Not only are their prey base more scarce, forcing them to travel further for sustenance, but also inaccessibility between fragments leads to isolation of populations. With populations being confined to specific fragments, their DNA becomes dangerously unvaried, leading to birth abnormalities, and eventual local extinction. Therefore, genetic variability of species has become important for scientists when speaking of fragmentation and defaunation. There has been some literature exploring *minimal species viability,* which estimates the smallest number of species populations needed to prevent local extinction (Paviolo *et al.* 2016). For example, it is thought that to maintain a viable population, jaguars need at least 50 individuals. Unfortunately, if trends align with current projections, they could be extinct from the biome by 2050 (*Ibid*).

According to scientists, the primary reasons for this are habitat loss, fragmentation, and the illegal hunting of wildlife throughout the Serra do Mar, which some have called a "war zone" of conservation for this reason (Galetti *et al*. 2017). Therefore, the primary means of combating defaunation are efforts to connect to make law enforcement more effective in curbing poaching rates. Likewise, creating new protected areas and connecting fragments through biodiversity corridors through initiatives like the Forest Code, are the priority for addressing habitat loss. Whilst the pressures on wildlife amplify, a succession of governmental administrations have consistently cut environmental funding (Azevedo *et al.* 2018). Most dramatically, the election of Jair Bolsonaro in early 2018 has seen an overtly anti-environmental platform pushed by federal powers. Together, these separate components make up a situation in the Atlantic Forest that is highly pressurized, wherein the local and absolute extinction of species is a real possibility – and in some cases an eventuality. These are elements that need to be factored in when understanding the politics of conservation in the region. One of the primary ways that conservation actors deal with these pressures is through monitoring biodiversity. The knowledge compiled through digital devices enables directing actions to species and areas that need it the most. Effective prioritizing of resources is essential, especially given that organizations must operate with budgets that have suffered from sustained cuts.

Biodiversity monitoring is a primary activity that conservation actors operating in the Atlantic Forest carry out in order to understand forest life. As defaunation and its effects continue to claim wildlife numbers, these actors are utilizing increasingly more sophisticated technology to focus on the minutiae of remaining life. The remainder of the Section introduces and discusses empirical data on how this process interrelates with biopolitical governance in the biome. The empirical material shows six important dynamics of new technologies that have an effect on the biopolitics of conservation. Firstly, the increase of data digital technologies generates in comparison with earlier analogue and radio-based technologies. Secondly, this data allows for a finer-grained analysis, which helps to make claims for new conservation territory more robust. Thirdly, these technologies highlight *sinks* and *sources* of biodiversity, highlighting priority areas for action. Fourthly, there are considerations for avoiding cameras to be damaged or stolen by palm poachers and hunters. Fifthly, a side effect of the use of remote sensing technologies is the separation of (some) ecologists from the field. And lastly, the limitations of utilizing both camera traps and GPS collars in the context of the Atlantic Forest's thick vegetation and difficult topography.

*More quantity, more quality of data*

Knowledge production is a central steering force propelling biopolitical conservation action. The most direct shift that new technologies have on conservation is the ability to produce more wildlife data. As was shown in the literature review, digital technologies produce substantially more data than their earlier analogue and radio iterations. When speaking about the difference between previous methods and trapping, a field ecologist explained:

> What did people used to do? They used to go to the forest and look to see if there were footprints, or not, and then they would identify the species. These were the older techniques. So, you would have to study what the form of the animal's footprint was, and with that you could answer some things about the animal with this methodology. With camera traps, you can say exactly what animal walked through the area and what time it passed. With a footprint you can only say that the animal was in the area, but not if it was night-time, or if it was windy, for example. So, with camera traps you can also say if the animal was reproducing or not, because sometimes there are cubs. Sometimes you can also have an idea of the behavior too. We have videos of jaguars and their cubs grooming each other. Or at times we have gotten footage of an animal eating a specific fruit we didn't know they ate. So, we are able to collect an enormous richness in animal behavior, which we wouldn't have been able to without camera traps. This is why I say we really have a lot of data.[2]

Similarly, the shift from radio to satellite-based collars has dramatically increased the number of locations collected by scientists. Here, one of the veteran jaguar specialists talks about the difference between two studies done in the same site, but twenty years apart:

[2] Ecologist, interview by author, April 6, 2019.

> It's wonderful. Because you learn so much more about the animals, so much. Just to give you an idea, when I finished the project after four years studying jaguars, we had a total of the six jaguars that we had radio tracked through VHF telemetry. We had less than 500 locations. When [another researcher] did her work with GPS collars 20 years later, in the same location, she had an average of, I think it was 2,500 or 3,000 locations, *per animal* that she monitored. So, there's no comparison and the level of detail that you can study and that is extremely positive.[3]

These digital technologies change the way that nature is perceived by biologists. Not only can they now know the presence of certain species, but additionally, they can learn much more about how they behave and what environmental conditions were present at the moment the footage was captured. Likewise, whilst using GPS collars, the movement of animals is not dependent on field ecologists being within reach of the signal from the tagged animal. Now incredibly accurate, real-time data is automatically collected on the animal's movement. This information gives a clearer idea of what sort of terrain the animals prefer, and moreover what territory each individual occupies. All in all, this advancement in the quantity *and* quality of data collection greatly refines the biopolitical gaze has on nature, giving more fodder to conservation actors to make claims for new protected areas.

*Claims to territory expansion*

An essential part of biopolitical conservation is the need for classification and categorization. The more finely grained analysis afforded by camera traps and GPS collar technology is used to recommend priority areas for the expansion of protected areas. Much like the practice of threatened species lists, species occupation and other data considerations are used for "affirming and justifying which [territories] are most important to save" (Braverman 2016: 136). As this quote from a researcher working with pumas demonstrates, by placing GPS collars, they are using the animals themselves as 'landscape detectives', in order to understand what environments and conditions are viable for the particular animal. This data, triangulated with other methodologies, creates more convincing and scientifically backed claims for biodiversity corridors and protected areas. Data is collected on the environmental preferences of threatened species, the spatial necessity for particular forms of life is then delineated, and consequently the areas which should be prioritized for conservation are interpreted:

> What we're doing with pumas for example is trying to use them as tools for conservation. In other words, by placing radio collars on their necks and finding out where they are and how much they walk. And not only that, we were pretty lucky because we caught young individuals, and they're traveling all over the place. But the idea is to use them as landscape detectives. Through this we find out where are the places that could be used as restoration areas, preservation areas, creation of corridors and everything. So, by doing that we can help in the CAR [Rural Environmental Registry] by saying, well, if you are going to create your reserve, it's better to do in this area than in that area.[4]

By using animals as 'landscape detectives', conservation actors can make a strong case for which areas of land should be protected. In order to avoid defaunation, it is important to connect genetically isolated populations, and therefore this data is fed into algorithms to determine which areas would be most effective in creating corridors connecting fragments. Due to the Forest Code in Brazil, rural dwellers in the Atlantic Forest are obligated to set aside 20% of their property as forested land. The CAR (Rural Environmental Registry) that the research participant mentioned in the above quote is a project by the government to create a registry of rural properties throughout Brazil. Hence, what the interviewee was referring to was the possibility of taking

[3] Ecologist, interview conducted by author through skype, April 6, 2019.
[4] Conservation NGO employee, interview by author, October 7 2019.

advantage of the mandate for rural property owners to set aside forested land, and to use their data to coordinate biodiversity corridors.

While GPS collars track the movement of animals, camera traps also provide useful information for legitimizing the expansion of protected area by providing animal distribution data. The same researcher explained that in a previous project in the Paranapiacaba Continuum, she evaluated how an area's management affected the occupancy of jaguars. She did this by setting up camera traps in both a private and a publicly protected area. Surprisingly, whilst there were only few registers of jaguars in the public park, they captured 62 pictures of jaguars in the private areas:

> When we worked in this area, this wasn't a park yet. It was just private ranches and stuff. [pointing] … And here's a state park. This wasn't even a park. This was horrible. You know, it was like several properties, and people coming from all over the place. When we did this work there, we worked with a team of people… And then I went into this area and worked with one guy, the owner of this ranch, and two of us went into the bush every day and he knew exactly where to go and everything and we did this work. I placed cameras here in private ranches, and they place cameras there, in the state park, in areas that were similar in size. This is very important for conservation. And we were able to photograph in this area private reserve, we took 62 pictures of jaguars. And in the state park we only got one picture of a jaguar.[5]

This researcher explained how the significant presence of jaguars in the privately owned area contributed to the area being turned into an officially protected park. This also demonstrates how data gathered through digital technologies can be used in evaluating the efficacy of different management systems. For example, this same researcher attributed the highly unequal jaguar distribution to the fact that the private area had a more funds to spend on security to keep palm poachers and hunters out. Conversely, the state park lacked a budget or enough park guard personnel to carry out adequate surveillance. A government employee working with protected areas also spoke enthusiastically of how camera trap data could be used with programs such as the Green List of Protected and Conserved Areas. This is an International Union for Conservation of Nature (IUCN) program to create an evidence-based certificate to set the standard of best practice for protected areas (IUCN 2020). Monitoring devices will be utilized in the evaluation process to make sure parks are complying with the strict criteria, and expert guidance will be given on how parks can "improve their performance and impacts" (IUCN 2020). This move towards 'evidence-based' conservation is very much emblematic of biopolitical conservation, and would not be as effective without widespread use of new technologies. However, an over-emphasis on 'data-centric' conservation can potentially have an 'anti-political' effect, where there is an elimination of political participation, debate or contestation (Sadowski and Levenda 2020). This can prove especially dangerous given that conservation must also deal with human populations.

*'Sumidouros' – Sources and sinks of species*

As well as intensifying the prioritization of territories for conservation, new technologies also intensify community engagement and law enforcement. According to some researchers palm poaching, and hunting have negative effects on the occupancy of some mammals like the jaguar in protected areas (da Silva *et al.* 2018: 55). The presence or absence of certain species proves to be an especially important aspect for conservation in the Atlantic Forest. As mentioned earlier, under the effects of defaunation, the Atlantic Forest has been labelled a 'half empty' forest (Bogoni *et al*. 2018). The remaining fauna is unevenly distributed throughout the biome and between fragments. Some areas, such as Foz do Iguaçu National Park in Paraná state, are larger fragments that have a relatively healthy population of jaguars, and better connectivity with other biomes like the Pantanal. However, this was not always the case and in the 1990s, the jaguar population in Foz do Iguaçu National Park was dangerously low. That being said, censuses carried out since have shown a steady rise in the population of

[5] Conservation NGO employee, interview by author, October 7 2019.

jaguars. In contrast to the rest of the Atlantic Forest, where jaguar populations are highly threatened, its growing population makes Foz do Iguaçu a source for jaguar populations. The hope is that if sufficient connectivity is created with other fragments, the Foz do Iguaçu jaguars can help to repopulate other regions in the biome.[6] Equally, due to hunting and other reasons, there are areas empty of certain species. These 'empty spaces', or *sinks*, signal to biopolitical conservation that something is preventing a species from inhabiting those areas. As a tapir ecologist explains:

> With this [camera trap] information we know where they avoid. Not only where they inhabit, but where they avoid [sic]… So, in this monitoring project we are trying to do in this region, we have big gaps of forest without animals. Even though there is a big forest, we have a gap. And we need to understand why that is. Is it because of hunting, or maybe is it because of fruit production? We don't know exactly. Just because there is a forest, doesn't mean there is animal occurrence there. But we need to understand deeper, why they are in some areas and not in others… with this information, we can make some decisions. And, with the human dimensions we can even reach the communities surrounding where we have these gaps. So, we have a gap here, where we have no tapirs, we have no peccaries, and probably no jaguars, and we know that there are a lot of communities around there. We would like to maybe reintroduce or reforest the animal population in this area. So how will the community perceive this?[7]

From the interviews I conducted, these *sinks*, or empty holes, seem to be attributed by conservation actors primarily to the presence of hunting activities in the regions, sometimes exacerbated by insufficient law enforcement and surveillance. Some researchers, such as Mendes *et al.* (2020), have used camera traps to argue that human activities like hunting cause 'landscapes of fear' for animals, leaving them to be more active at night, or avoid certain areas altogether. For locally endangered species like the jaguars, maintaining movement between fragments is key for their survival in the biome. By avoiding particular routes, they may be forced to traverse areas more densely populated by humans – thereby increasing the chance for conflict or predation. When a jaguar was collared close to the Carlos Botelho State Park, the researcher said that the track indicated they couldn't cross a certain section close to the park: "one animal couldn't cross this. so, it is probably a village of hunters, or palm harvesters. So, I think this is a *sumidouro*. But jaguars are animals that need to cross big distances to survive."[8] These *sinks* indicate to the researcher that they should prioritize efforts in that area. Depending on the case, this could be in the form of an environmental education program, or stricter law enforcement around the region. This reaffirms the case that new technologies are used to exercise biopower over human communities, in order to *make charismatic species live* (Cavanagh and Benjaminsen 2015, Sandbrook *et al*. 2018). This is a particularly sensitive issue, as the Paranapiacaba Continuum is within the Vale do Ribeira, the region of São Paulo with the most vulnerable communities. This makes it clear that although monitoring devices are able to show the environmental conditions a species population needs to be *made to live*, the spatial implications of this, especially when it comes to dynamics with neighboring human communities, need to be considered.

*Camera traps, palm poachers and hunters*

There are some hunters and palm poachers traversing the forest that encounter camera traps and resist biopolitical surveillance in various ways. Most of the researchers working with camera traps that I spoke to confirmed recording footage of palm poachers or hunters:

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[6] Conservation NGO employee, interview by author, October 7 2019.
[7] Ecologist, interview by author, March 22 2019.
[8] Ecologist, interview by author, March 22 2019.

> One of our cameras disappeared. In another campaign, the hunters took the SD card out, turned it off and left the camera there. So, they knew how to use it. In another park, they stole two cameras, and in another protected area they stole two more. I remember there were certain locations we got video of some men with rifles. There was also another location where they took the batteries for their flashlights. Another clip that had a guy with a huge machete.[9]

These researchers have a close relationship with protected area management, and this data, alongside information on palm poacher and hunter's camps and tracks, are usually relayed to them. Undoubtably, the ecological research conducted in protected areas ends up becoming an extension of park surveillance against wildlife crime. However, instead of actively trying to gather information on palm poachers or hunters, researchers I spoke to try to conceal camera traps to avoid damages or losses:

> We know that people walk in some trails. Those are areas where they can steal the cameras, so we try to avoid setting them up in those places. We set them up about 20 meters from the main path and note down the GPS coordinates. We try to not make any trail (*picada*). We also hide the cameras so people cannot see. If we feel secure that the camera won't be stolen, then we can make it more visible. Because otherwise, the people kick, shoot at, or open and take the cards from the camera.[10]

Although technologies like camera traps have become more affordable, each camera can cost as much as US$500. Especially considering recent drastic cuts to environmental funding and research, losing even one camera can be very detrimental for a laboratory or organization. However, some private reserves, particularly those owned by large extractive companies, do have surplus money to spend on monitoring technology. Referring to one of these private reserves, the same field ecologists said: "they bought camouflaged cameras that do not trigger a flash. And they bought three of those cameras specifically to try to catch people. They left them in strategic places, and because it doesn't flash the chances of catching people is better, right?" This is to say that although camera trapping technology in the Atlantic Forest is not widely used directly in the surveillance against wildlife crime, there is a possibility of its adoption becoming a more common occurrence in the future. Beyond the potential for digital technologies to be used in the surveillance of human subjects, they also have other effects on the researchers and practitioners, and how they carry out data collection.

*Remote data and separation from the field*

Another important theme worth exploring is how the use of digital devices is shaping the subjectivities of the ecologists themselves (Asiyanbi *et al.* 2019). The nature of fieldwork itself is now markedly different, and this alters the relation the researcher has with the ecosystems and species they study. With camera traps, GPS collars and other remote sensing devices, a distinction emerges between field ecologists that carry out campaigns and collect data, and scientists that are primarily laboratory-based and run analysis through models and algorithms on datasets. Those that twenty years ago spent a vast amount of their time tracking animals via radio telemetry, now see a new generation of ecologists that have a wholly different experience of fieldwork. One of the veterans in jaguar research reflects on this:

> In between computers, cell phones, satellites, GPS, telemetry color, and so many other gadgets that today have transformed fieldwork into something much more impersonal aiming much more at efficiency than the pleasure of being in the field. Amongst so much technology, modern technology, I consider myself privileged to have been working with one of the people that made fieldwork as a result of our connection with nature through the heart.[11]

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[9] Ecologist, interview by author, April 6 2019.
[10] *Ibid.*
[11] Ecologist, interview by author over Skype, April 6 2019.

This suggests that the experience of fieldwork may have changed, and that it may have also shifted the connection to nature away from one of the 'heart', towards being increasingly mediated by more complex technology. The same researcher speaks of this phenomenon by relating it to an advertisement he had come across:

> I quote an advertisement I had seen: You have a picture of a biologist who is all sweaty and tired, and dirty. Coming back from the field, and after a hard day in the field gathering locations the hard way. Like I used to. I used to work my entire life in the field. And then there was another picture, and it said: "Do it the right way." and then there is a biologist with an air-conditioned office, with both feet on the table, receiving all the information on the computer. So, it is more or less that…The field biologist is not in the field anymore. He stays in the office and receives the information, and I think that takes away the romanticism, and all that brought the scientists together with nature. And I think that is a great loss. I would never like to lose that.[12]

This critique of increasing reliance on technology to conduct remote conservation research could be viewed as an expression of what Foucault calls 'counter-conduct', which is "a subtle and sly attempt to subvert and 'escape direction by others'" (Asiyanbi *et al.* 2019: 129). There is a sentiment expressed here that something, a 'romanticism', has been lost through the integration of technology in ecology. Some of the ecologists I interviewed mentioned that some of their most important epiphanies they have had, occurred during fieldwork. Whilst accompanying a camera trapping expedition, the two biologists I was with discussed the distinction between field biologists, and those that stay in the lab. They often get field ecologist apprentices to accompany them in campaigns, and many of them are not used to the long days walking on 'unpaved' hilly forest paths. Apparently, there were many occasions where those apprentices gave up and decided to stay behind instead of helping set up camera traps.[13] The same jaguar researcher earlier shared his perspectives on this:

> I think people don't want the hardship anymore of life in the field. They won't go into the field if there is no internet connection, or if they don't have a four-wheel drive. Or they won't go if the roads aren't bad. Nature is not like that – whenever you can get to nature like that, with internet connection and asphalted roads, it just isn't nature anymore.[14]

Of course, this does not comprise the ecologist's experience across the board. However, this does highlight a potential emergent trend in modern ecology, and certainly calls to question how the change in the way fieldwork is conducted affects ecologist's subjectivity and relationship with nature and the object of their research. Further, it could also be influencing the type of person that is attracted to the field of ecology in the first place. Moreover, it touches on the discussions of the nature/culture dichotomy in the literature, anxieties of wild nature becoming too domesticated (Whitney 2014), and recent conservation approaches seeking to minimize the impact of human interventions through 'rewilding' (Lorimer *et al.* 2015).

*Data limitations*

As powerful as new technologies at the hand of biopolitical conservation may seem, life itself resists being fully integrated into the biopolitical knowledge production. Foucault himself stated that "it is not that life has been totally integrated into techniques that govern and administer it; it constantly escapes them" (Biermann and Mansfield 2014: 260; Foucault 1990: 143). Despite the game-changing role that new technologies have in biodiversity monitoring, there are circumstances where they run into limitations. This is especially the case

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[12] *Ibid.*
[13] Ecologist, interview by author, February 28 2018.
[14] Ecologist, interview by author over skype, April 6 2019

when they are confronted with the challenging topography and vegetation of the Atlantic Forest. Biopolitics relies on the rationalization of 'life', which is steered based on knowledge production. Yet, a question that emerges is what happens within biopolitical regimes when there is insufficient knowledge to direct and prioritize action? When it comes to collecting data, the steep hills and dense vegetation of the Atlantic Forest make navigating the forest terrain a grueling endeavor. According to an interviewee, the scientific method calls for 90 days of footage collection, spread over 60 locations with two cameras each, all running simultaneously. Realistically, two field ecologists are able to set up 20 locations in seven days, meaning it would take up to three weeks to set up all 60 locations: "we would need a big team to be able to do this all at once. Today we have 120 cameras, but we are also trying to monitor different regions at the same time. So, we break the grids up into sections, and do 20 locations at a time."[15] This demonstrates that having access to the technology is not enough, but there are also budgetary constraints in terms of labor, time, and numbers of camera traps available.

GPS collaring also comes with its own complications. Besides the fact that capturing and tagging an animal can be difficult and expensive to orchestrate, the topography and climate of the Atlantic Forest can prove taxing to the equipment. A researcher working with pumas and jaguars explained the complications of using the GPS collars:

> The collars have to read the sky. But with these gullies, sometimes they can't read all the satellites in the sky. So, the connection is pretty bad. The collars are programmed to connect with the satellite every day, in a particular time of the day. If the cat is sleeping with the head down pointing to a rock or tree, or if he is in a very deep area, he doesn't have a connection with the satellite long enough to send the information. So, it keeps back logging.[16]

When the collar cannot connect with the satellite after a given number of days, it goes into a power saving mode. Once it enters this mode, instead of sending one signal per hour, it sends one *per day* – significantly diminishing the efficacy of the study.

These complications have made getting data on animals like the jaguar and puma particularly difficult. With digital technologies, much more is known about species than before. Nonetheless, after much effort, scientists have not had as much success with collaring jaguars as they would have hoped. When considering how defaunation affects these animals in the Atlantic Forest, the science is not yet conclusive:

> Because of the issues with the collars, we don't know if the jaguars behave differently in the Atlantic Forest. We don't know if because food is scarce, and they normally have to walk more, and individuals have to overlap their home ranges [territory] more. We don't know if that is just their normal way of living in the Atlantic Forest. In this case, we can't be certain if they need larger protected areas and reserves.[17]

In saying this, this scientist was referring to a young jaguar which moved across an abnormally large distance whilst being tracked, in comparison to jaguars in other biomes. If this is a pattern repeated across other individuals, they would need to account for that when advocating and creating new protected areas. The problem is that they have not been able to collar enough jaguars in their project to state show this is the case.

This uncertainty when it comes to defaunation was also voiced by a government employee working with carnivorous species:

[15] Ecologist, interview by author, April 6 2019.

[16] Conservation NGO employee, interview by author, April 12 2019.

[17] Ibid.

> We don't work much on the effects of defaunation. We have been trying to work on this with some other groups. This research has been conducted by some university groups, that gather information on the fragments throughout the Atlantic Forest. But we're still at stage of gathering information... So, we're not even bringing this to the action plans because we don't know where to act, where to prioritize the resources. But we still are looking at lots of other information that is being published... We are trying to work together with other researchers to generate information. But I also see that [defaunation] is being talked about much more broadly nowadays.[18]

This nicely exemplifies the biopolitical nature of conservation and its relationship with knowledge production. Yet, especially in a dense and hilly environment like the Atlantic Forest, collecting data on some species still remains a challenge. Without adequate scientific knowledge, conservation actors do not have solid grounds on how to direct their biopolitical interventions. Though, with an increase of attention to defaunation in the scientific, governmental, and non-governmental arena, this may begin to change.

## 4. Discussion

Taking into consideration the empirical material above, what follows will be a discussion of how the camera traps and GPS collars relate to the biopolitics of conservation. Drawing from Jeffrey Nealon and Byung-Chul Han's engagement with Foucault's work, I argue that the use of remote sensing technologies contribute to the intensification of biopower in conservation. As corroborated by other studies, this intensification aids in the argument for new conservation territories and the commodification of nature (Verma *et al.* 2016). Simultaneously, the data collected also highlights problem areas where biopolitical intervention should be prioritized – potentially playing into coercive conservation. The remote collection of data distances the researcher from the object of study, which may also have consequences for conservation's relation with local communities.

Emerging technologies play the role of intensification of knowledge production within a biopolitical conservation regime. This is primarily because remote and automated data collection hyper-accelerates the flow of information. As such, this intensified pace of data collection, coupled with increased capacity for analysis, means that digital devices are bringing the effects of biopolitical conservation into their *maximum intensity* and *extending them as far as possible* (Nealon 2008: 39). As Verma *et al.* point out, the data collected is processed and rendered into wildlife cartographies, which are used to shift public narrative and policy towards conservation ends (2016). In an example above, I demonstrated how camera trap and tracking data is used to advocate for the expansion of protected areas. Hence, the use of these technologies is also harnessed to spatially extend the reach of conservation governance as far as possible. With ongoing technological developments, information flows in the biopolitical regime of power are constantly streamlined, leading to a lowering of 'cost', and what Foucault calls "economic" growth (Nealon 2008: 39). Nealon argues that in Foucault's work, the dynamic of intensification is the catalyst to social change: "I'd argue that the logic of intensification *is* Foucault's primary mechanism for explaining historical change: the emergence of new modes of power happens through the lightening, saturation, becoming-more-efficient, and transversal linkage of existing practices" (Nealon 2008: 38). It appears that the culmination of the use of different technologies has reached a tipping point where some scholars diagnose that conservation's mode of power may be shifting from biopolitics towards 'ontopolitics' (Büscher 2018) or 'conservation by algorithm' (Adams 2017).

The risk of extinction in the Atlantic Forest brought by defaunation and fragmentation increases the pressure surrounding conservation in the region. Yet, tracking technologies make for a finer-grained understanding of how animals behave, move, and are distributed throughout the biome. As large-bodied mammal populations continue to decline in the Atlantic Forest, the biodiversity monitoring technology has become increasingly complex, focusing on the minutiae of the remaining life. Biopolitical authority justifies its governance because it acts by prioritizing the health of its target population (Foucault 2003). In the case of this

[18] Governmental conservation employee, interview by author, October 7 2019.

defaunated forest, the target populations continue to die off despite conservation efforts. Logically, it then follows that conservation actors will intensify their efforts to hamper extinction threats. For Braverman, since surveillance and biopolitics are symbiotically tied, an intensification of biopolitical efforts is accompanied by increased surveillance and knowledge production (2014). In the Atlantic Forest, scientists are reacting to the threat of species extinction precisely by intensifying their monitoring efforts in order to have clearer knowledge on which to ground future conservation interventions. With the Atlantic Forest being 'half-emptied' of its fauna (Bogoni 2019), conservation's gaze and attention increasingly focuses on dwindling animal populations. This dynamic *de facto* increases the intensity of biopolitical conservation on its subjects, as the maxed-out apparatus and focus of digital power is funneled into smaller populations. Simultaneously, as trophic cascading within fragments continues, the forest further empty of larger mammals, making the urgency to safeguard individuals and populations increase exponentially. These dynamics come into confluence, increasing the pressures in crisis conservation scenarios, and will lead to unpredictable outcomes.

Current global conservation strategy is built around protecting charismatic umbrella species like the jaguar. Being large mammals, they necessitate a complex ecosystem to sustain them. The thought is that by conserving these charismatic species, other species living within the same area are protected by proxy. Consequently, significant occupancy of jaguars in a region may justify claims for territorial expansion or an increase in financial resources for already-existing protected areas. Species distribution data is also used to calculate the population viability numbers for different fragments within the biome. Due to defaunation and extinction debt in the Atlantic Forest, the population viability for the jaguar shows that if new protected areas and biodiversity corridors are not established, jaguars may not have a future in the biome further than 2050 (Paviolo *et al.* 2016). Given this, the monitoring carried out by these digital technologies effectively dictates where conservation actors should prioritize their actions and makes appeals to donors for where they should direct funds and attention. This affirms Verma *et al.*'s argument that wildlife cartographies are utilized to secure funding and to marketize conservation (2016; Igoe 2010). In these instances, digital instruments are employed as a mechanism for attracting capital, because "values accrues only insofar as objects are seen" (Han 2015: 9). In this instance, recording the presence of charismatic species gives conservation capital to a protected area or property owner. Likewise, calculating potential desirable areas to 'make certain species live' also creates value, and depoliticizes the expansion of conservation territory (Sadowski and Levenda 2020).

The presence of species is not the only notable characteristic that conservationists look for in a landscape. Within conditions of defaunation, emptiness reveals which human settlements are unfavorable to fostering charismatic life. In this case, wildlife cartographies also spatially represent regions where animals do not feel safe inhabiting. In doing so, they allow conservationists to calculate and categorize how favorable specific human communities are to making wildlife 'live', and assessing whether they are engaging in hunting, poaching or deforestation. As stated earlier, Byung-Chul Han contends that a data-centric system has a compulsion to conform and eliminate 'the Other', or 'the Deviant' (Han 2015: 76). Individuals and communities that transgress biopolitical conservation's norms are antagonistic to its core goals, and thus need to be 'calibrated' (Han 2015: 2). For this reason, biopolitical conservation extends its governance beyond nonhumans and must engage with human communities in order to *make charismatic life live* (Cavanagh and Benjaminsen 2015). Further, although it is not commonplace in Brazil yet, the prospects of camera trap and tracking technologies being used more explicitly against human populations is a real possibility (Sandbrook *et al.* 2018). This is especially the case given that algorithms are now being used to counter illegal poaching in other regions (Adams 2018). As stated earlier, palm poaching and hunting levels in the biome already make ecologists refer to parts of the Atlantic Forest as "war zones" (Galetti *et al.* 2017). If the pressures from defaunation persist in the biome, conservation could skew towards 'neoprotectionism' – an intensified return to 'fortress conservation' models (Büscher and Fletcher 2020). In this scenario, digital technologies could be progressively adopted within coercive and militarized modes of conservation, as actors intensify their efforts to save species from extinction (Büscher and Ramutsindela 2016). Given the recent approval of Law 16.260/2016, which allows the franchising of public use services in state parks in São Paulo to private companies, coercive measures could be progressively enforced in the Atlantic Forest in order to protect 'natural capital' (Lopes *et al.* 2019; Fletcher *et al.* 2019).

Byung-Chul Han also argues that "data-driven quantification of reality is driving *Spirit* from the realm of knowledge" (2017: 68). As stated earlier, here he is referring to the way technology and Big Data are changing knowledge from being based on *causality* to *correlation*. Extending this idea, I argue that this loss of *Spirit* is also expressed by ecologists when they say there is a loss of romanticism in contemporary ecology and fieldwork. Framed in this way, I posit that 'Dataism' is driving *Spirit* away from biopolitical conservation (Han 2017). Fieldwork used to be an integral part of being an ecologist. Yet, automated data collection and Big Data are decoupling fieldwork and ecology, physically separating (some) researchers from their object of study. Indeed, the number of fieldwork-based publications since the 1980s has decreased by roughly 20%, "with modelling and data analysis studies increasing by 600% and 800%, respectively" (Ríos-Saldaña *et al*. 2018: 2).

Much of the current work in ecology comprises of applying models and analysis to extensive datasets. The effects of the distancing of researchers from the embodied subjectivity in the ecosystem they study is currently under-explored. How, and if, their perspective and relation to nature is affected through this transformation in ecology labor should be researched. In relation to the potential for 'neoprotectionism' (Büscher and Fletcher 2020), I would argue that the distancing of the researcher from the ecosystem may have implications for their relations and perspective of rural communities living close to nature. Similar to the use of drones in warfare, distancing may make it easier to advocate for more coercive conservation approaches (Espinoza and Afxentiou 2018; Gregory 2017). Without field immersion and interaction with neighboring communities, conservationists may more readily advocate for sovereign environmentalities (Fletcher 2010) applied to human populations to curb rising extinction threats.

With all the knowledge generated by camera traps, GPS collars, and other devices, ecologists still run into limitations. Despite ongoing research on defaunation, this knowledge is not yet being translated into concrete action plans in the Atlantic Forest. Even as biopolitical conservation collects unprecedented amounts of data with highly complex technology, it does not mean sound conservation policy automatically follows. This is made apparent by the rise of "authoritarian neoliberalism", such as is the case in Bolsonaro's Brazil (Deutsch 2021; Saad-Filho and Boffo 2021). In these contexts, the authority of technocratic, biopolitical conservation is challenged. Although conservation knowledge and actors calling for certain priorities and agendas, environmental policy seems to be steering directly counter to this (e.g. environmental budget cuts [Magnusson *et al.* 2018]). Future research should examine this dynamic closer, and its implications for the biopolitics of conservation. Further, even with the use of new technologies, life resists being fully incorporated into biopolitics, and there are elements of defaunation in the Atlantic Forest that remain unknown to conservation biology. At the same time, with the future survival of species at stake, conservation actors must take some form of action to address defaunation. Since biopolitics is a data-centric mode of governance, another avenue of inquiry could understand how conservation regimes act in the absence of concrete knowledge. This would not only be useful in the context of the Atlantic Forest, but also in other regions where data on certain species or ecosystems is sparse but biodiversity is in a state of crisis.

## 5. Conclusion

This article has brought together literature on new technologies and biopolitics in order to analyze the consequences of digital technologies in biodiversity conservation. This was addressed via a case study of conservation in the Atlantic Forest, a biome undergoing a critical biodiversity crisis where animal populations are suffering from the effects of fragmentation and defaunation. If current conditions in the Atlantic Forest remain unchanged, extinctions at the biome level are sure to follow. As such, a foundational element in the response by conservation actors has been to monitor wildlife closely. New technologies like camera traps and GPS collars play a key role in understanding how to prioritize and direct biopolitical action. There are several implications of this for the biopolitics of conservation.

I have argued that by dramatically increasing the quality of data flow of information, these technologies are maximizing the intensity of biopolitical conservation (Nealon 2008). This transformation in information flow, alongside the automated analysis through algorithms, also provides fodder for claims to new conservation territories and funding. When species occurrence and movement data are rendered into wildlife cartographies, they highlight problem areas where conservation intervention should be deployed (Verma *et al.* 2016). The approaches to neutralize and 'calibrate' extinction threats from human subjects may come in the form of disciplinary, sovereign, or neoliberal environmentalities (Fletcher 2010, Han 2015). Thus, digital technologies categorize local communities according to their level of environmental conformity or transgression, and mediates biopolitical governance over human populations. Moreover, remote sensing technologies are distancing researchers from their field site and object of study, which I argue signifies a loss of *Spirit* in the realm of ecological science (Han 2017). I have argued that this distancing shapes the subjectivity of ecologists and means that some are potentially less exposed to interactions with local communities. I hypothesize that with mounting pressures on wildlife, this could facilitate the implementation of increasingly sovereign tactics against local communities, in efforts to prevent species extinction (Büscher and Fletcher 2020).

My aim is not to be deterministic with the arguments presented in this article. Rather, I follow Kranzberg's first law of technology, that "technology is neither good nor bad; nor is it neutral" (Kranzberg 1986: 545). Depending on the underlying 'mission' behind the use of the technology, it can have outcomes on either end on the spectrum of emancipation and coercion (van der Wal *et al.* 2015). Nature conservation has had a mixed record concerning its social impacts, and it is important to be conscious of the power dynamics between stakeholders in the implementation of digital technologies (Sandbrook *et al*. 2018). Ultimately, for conservation to be effective, it must have the backing of local communities around protected areas. Big Data and complex technologies are excellent at analyzing the *how*, but they are less equipped at understanding *why* phenomenon occur (Han 2017: 68). Conservationists should not, then, abandon causal and theoretical ways of knowing in their scramble to technologically develop their methodologies and practices. Consequently, to ensure long-term success in conservation goals, new technologies should be used in amplifying genuine inclusion and tackling the roots of environmental problems, rather than perpetuating structural, or physical, violence amongst local communities – who face the brunt of conservation responsibility and impacts.

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