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Address
Canopy c/o Vincent Nijman
School of Law and Social Sciences
Oxford Brookes University
Oxford
OX3 0BP
UK

Website
MSc Primate Conservation:
http://www.brookes.ac.uk/primates

Front Cover
Sumatran orangutan (*Pongo abelii*) in the Buffer Zone of the Gunung Leuser National Park, North Sumatra ©Louisa Watson

Table of contents

Letter from the Editors

Welcome to the Winter 2024 issue of Canopy, the in-house journal for the MSc and MRes in Primate Conservation at Oxford Brookes University. The theme of this issue, "New Directions in Primatology", celebrates emerging methods, approaches, and research questions within our discipline. Our selection of articles from past MSc and MRes students reflects the breadth of interests and the wide range of topics explored within our program.

With the growing threat of anthropogenic pressures on primates and their habitats, the need for innovation is greater than ever. Challenges associated with tourism and increased contact between humans and primates have escalated and introduced new conservation dilemmas. As conservation efforts evolve to address contemporary issues, researchers must continuously innovate and adapt their approaches to protect habitats and species in light of the increasing challenges of a 21st-century landscape.

This issue explores a number of relevant topics, including environmental education, ecotourism, and the impact of the COVID-19 pandemic, offering a fresh perspective on primate conservation. These articles highlight the importance of interdisciplinary approaches and the utilisation of technology to address specific conservation threats and extend the capabilities of researchers when studying highly endangered and elusive species.

We want to thank all of the staff on this course for their excellent teaching and guidance throughout this semester, as well as the PhD students and staff in other departments who have offered their support through guest lectures and advice sessions at the pub every Monday. We hope that you enjoy reading this issue of Canopy and find inspiration in the creative and innovative works produced by previous students during their time in the program.

Best Wishes,

Emma, Andrew, Louisa, and Christian

Letter from the Course Leader

I'm very pleased to write this letter in a time when we are preparing to celebrate the 25h anniversary of the MSc in Primate Conservation, which makes this course the first and longest-running programme in this field. Having a programme that has lasted this long is not a coincidence but is the result of the extraordinary motivation and resilience shared by both students and staff members of this course. This resilience can only be driven by a full understanding of the importance and impact of our work. The way our programme managed to get through the difficulties caused by first the pandemic and more recently by the financial pressure on UK universities last year serves as the best proof of this resilience. During this challenging phase, we received an incredible amount of support from students, alumni, and colleagues who have loudly voiced the uniqueness of our programme and the reasons why it should continue - a touching response that demonstrates the strong, life-lasting network that our course has built over the years. This has helped us move forward, think of alternative solutions and, ultimately, save the programme.

I also want to take this opportunity to acknowledge two people who have been fundamental in this programme. The first is Prof. Simon Bearder, who created the MSc in Primate Conservation and launched the course in 2000. We recently celebrated the 50th anniversary of Simon's career with a special event in Oxford, where both colleagues and former students were invited. Many of those who could not attend in person sent a short video to thank Simon. Among them were individuals who now lead NGOs, work as academics or consultants, and contribute to wildlife conservation in a variety of ways. The result was a long and moving tribute to a person who has had a substantial impact on their lives and on primate conservation. The other person I want to thank here is Prof. Anna Nekaris, who led the MSc in Primate Conservation for many years. Her contribution to the success and global impact of this course has been gigantic. Anna has been an influential and inspirational lecturer and a model researcher with her World-leading work on nocturnal primates, particularly Asian lorises. She has always been able to understand the evolving requirements of the discipline and the growing need for interdisciplinarity in conservation. A few months ago, Anna began an exciting new role at Anglia Ruskin. We wish her all the best in this next phase of her career.

The student projects featured in this issue of Canopy largely reflect the interdisciplinarity of our field, as emphasized above. Some of the contributions are from alumni who had to cope with the difficulties of studying during the pandemic. Several studies highlight the necessity of understanding the benefits and costs of nature-based tourism, especially now that we can assess the effects of the pandemic. Lawrance surveyed several NGOs in Madagascar to understand the impact of the pandemic on their operations. This revealed a remarkable resilience due to the diversification of their activities, with over half of organisations

reporting no change to their operations. Laurin-Lalonde discussed how nature's legal personality and nature's rights offer an interesting model for the protection of non-human primates, especially in their role of ecosystem maintenance as seed dispersers. Giammarco stressed the need for more cooperation between wild and zoo-based studies to improve our understanding of welfare in both settings and allow for more comparative research to occur. She concluded that understanding and protecting the well-being of wild individuals can lead to improved conservation. Schrieber highlighted the importance of interdisciplinary collaboration as a core component of environmental education for the development of a holistic approach. Parry discussed the need for a more conciliatory view of human-primate interactions rather than the demonization of primates and perpetuating the idea of constant conflict with human communities. This is crucial, Parry concluded, if affected communities are to embrace conservation efforts and help preserve endangered species. Woolloff found that most tour companies did not enforce IUCN guidelines when viewing Sumatran Orangutans in Indonesia. The frequency with which tourists uploaded photos showing close contact with orangutans has not markedly changed over the last decade. Finally, Hathaway combined direct behavioural observation and accelerometer data of wild Javan slow lorises to identify behaviours and movement/postures. Her work demonstrated the power of bio-logging devices to extend the capacity of our senses and reveal a previously inaccessible view into the activities of cryptic animals.

As in previous years, the new cohort is formed by a group of inspired students who want to make a difference despite the enormous challenges of conservation. This motivation has already been demonstrated in these first months with their exceptional contribution to the promotion of the programme via social media and to the production of this volume. Helping these students will be extremely rewarding and fulfilling for us. We will continue to support them with all our motivation and enthusiasm. I wish all students of this year's cohort the best of luck in making a significant contribution to the human and non-human primates on which their work will focus, and for their future.

Giuseppe Donati
Professor in Biological Anthropology and Course Leader

The impact of COVID-19 on conservation and organisational resilience in Madagascar

Susan Lawrance
Cohort 2020 - 2021
sdlawrance@gmail.com

By August 2021, a newly identified virus, COVID-19, had infected nearly 217 million people with 4.5 million recorded deaths (WHO, 2021). Governments, guided by the WHO, took control, implementing policies to close borders, restrict domestic movement, enforce social distancing and quarantine travellers (Bates *et al.*, 2020). The impact of COVID-19 on human society has been substantial and its effects on the environment and conservation widely reported (Gibbons *et al.*, 2021). The restrictions are expected to have far-reaching effects on the global economy and environment into the future, with the impact felt far more acutely in developing countries (Kideghesho *et al.*, 2021). The increasing overuse of ecosystem services to sustain rural livelihoods and commercial activities, causing severe environmental degradation, is said to underpin the causes of the COVID-19 pandemic (Waithaka, 2021). Pandemics and environmental degradation present similar problem structures but the political response to each is very different. Similarities include global interdependence, disproportionate impacts, and scientific uncertainty. Many governments do not have coordinated policies to tackle the interrelated aspects of these problems, and environmental abuse through illegal wildlife poaching was a key contributor to the COVID-19 pandemic (Morin *et al.*, 2021).

This exploratory study investigated the resilience of conservation organisations operating in Madagascar to determine the extent of the impact from the pandemic. The results form a basis for further research and are intended to support strategies for post-pandemic recovery.

Ecotourism revenue has long been relied upon to support conservation work and local livelihoods, and the global travel ban due to the pandemic severely impacted this thriving industry. The UN World Tourism Organisation suggested that African countries lost around 75% of tourism revenue as of 2021, a value projected to increase as the pandemic continued (CCSA, 2021). All areas of conservation, from research to employment, were disrupted both on a global and local level.

Situated in the southwest Indian Ocean, Madagascar is the fourth largest island in the world and is described by conservationists as having unique biodiversity with a high level of endemism (Gardner *et al.*, 2018). However, with a mainly rural population relying on agriculture and natural resources to survive,

biodiversity is severely threatened by human encroachment. At the time of this study, 96% of lemur species faced extinction (IUCN, 2020) and nearly 50% of remaining forest was less than 100 m from an edge (Jones *et al.*, 2019). For decades, NGOs involved in conservation in Madagascar have operated under challenging conditions marked by food insecurity, weak governance, and poor or non-existent infrastructure. To determine the impact of the pandemic on conservation work in Madagascar, I invited over 50 organisations, many members of Lemur Conservation Network, to complete an anonymous online survey to report how the pandemic had affected their operations. A response rate of 44% (n=25) was achieved. Responding organisations operated geographically across Madagascar including protected and unprotected areas (Table 1). Organisations were a mix of international and national NGOs and all employed Malagasy staff and volunteers. Organisations generally self-reported high resilience, perhaps helped by the fact that most employed local community members, which enabled some conservation work to continue. Although those involved in tourism became unemployed, jobs were created through diversification into providing COVID-19 products such as facemasks, health services and humanitarian aid.

Table 1. List of conservation areas covered by organisations responding to the survey.

Protected area (PA)	Region	Km^2
Analamanga, Itasy, and Melaky Regions	North	62,756
Andasibe-Mantadia National Park with Mitsubishi Park and Torotorofotsy	North	155
Ankarafantsika National Park	North	1,350
AP Tsimembo Manambolomaty	North	62,745
AP Mandrozo	North	15145
Anosy region: Sainte Luce Littoral Forest fragments	South	1
Betampona Special Reserve	North	29
COFAV and Tapia forest of Amoron'i Mania	North	4,500
Eastern forest of Kianjavato	South	400
Lavavolo	South	100
Montagne des Francais	North	61
Ranomafana National Park	South	416
SAVA region incl. Marojejy, Masoala and Makira National Parks	North	25,518
Sofia Region	North	50,100

Globally it was reported that the pandemic had negatively impacted wildlife protection and surveillance due to the shortfall in ecotourism revenue to pay rangers and anti-poaching teams. However, in this study, over half of organisations responsible for protection reported no change to their operations with others reducing operations but not completely halting all surveillance. It was clear that the local communities were very much involved in conservation work playing an essential part in the custodianship of protected areas.

Over-reliance on ecotourism as an income source in Madagascar was not as prominent as in other countries because tourism is still very much in development in the country. It is also because political instability, which has deterred tourists sporadically over the past 15 years or so, has ensured that tourism is not the only revenue stream. Most organisations identified a range of revenue sources, which enabled them to be more resilient to the shock of the pandemic. In this respect, the pandemic provided more of a warning that income diversification is essential to build future resilience against global shocks. The impact was felt more sharply in countries such as Namibia (Lendelvo *et al.*, 2020) and Costa Rica (Quesada-Rodríguez *et al*., 2021), where ecotourism has been well established for many years and forms a substantial part of gross domestic product.

Organisations selected lemur conservation as the top recovery funding priority, followed by reforestation. Other wildlife conservation, conservation education and community projects were jointly ranked third most important.

Based on feedback from the responding organisations and studies in other countries relating to the pandemic's impact on conservation, it became clear that governments, NGOs and others responsible for conservation should focus on three key areas in order to develop a post-COVID-19 strategy to withstand future pandemics. These are 1) diversifying revenue-generation, 2) setting a robust environmental strategy, and 3) establishing crisis management measures. Researchers argue that returning to business as usual is not a sustainable strategy and that the pandemic has provided an opportunity to improve environmental strategies and to take advantage of new opportunities.

More insight into the financial impact on conservation and the pressure on organisations to divert resources to providing humanitarian aid is needed to develop a business case for priority funding for post-pandemic recovery in Madagascar. This can only be achieved through collaboration between the government, organisations, communities, and researchers to ensure the response is grounded in national rather than international strategy.

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Analysis of accelerometer data using Random Forest models to classify the behaviour of a wild nocturnal primate: Javan slow loris (*Nycticebus javanicus*)

Amanda L. N. Hathaway
Cohort 2021-2022
ahathaway2014@gmail.com

Understanding the behaviour, physiology, and activity budgets of animals in their natural environments is fundamental to ecology (Cooke *et al.,* 2004). The use of bio-loggers, animal-borne devices such as GPS trackers, cameras, and physiological loggers, provide data on animal movement, behaviour, and physiology without the need for direct observation (Yoda, 2019). Animal-borne accelerometers, devices that provide data on movement, are particularly powerful tools that aid in the study of animal behaviour (Brown *et al.,* 2013; Nams, 2014; Fehlmann *et al*., 2017; Nekaris *et al.,* 2022). They have enabled animal behaviour researchers to study species remotely that may otherwise be very difficult or impossible to observe directly (Allaby, 2009). Only a small number of studies

have used accelerometers to study primate behaviour (e.g. Fernandez-Duque & Ekert, 2006; Fehlmann *et al.,* 2017; Reinhardt et al., 2019; Nekaris *et al.,* 2022) and the majority of these sought to identify broad activity categories rather than specific behaviours. Even fewer studies have focused on nocturnal primates. The data derived from accelerometers can be used to identify specific animal behaviours but are complex and often very large, so they require sophisticated analysis methods to infer behavioural contexts (Jonsen *et al.,* 2013). Additionally, the raw accelerometer dataset only provides acceleration and orientation information so various models can be used to infer context. Machine-learning models are used to develop an algorithm that will automatically identify patterns within the dataset.

This study uses a random forest model, a supervised approach to machine learning, to identify behaviours in a set of accelerometer data acquired from an adult male wild Javan slow loris (*Nycticebus javanicus*) using direct behavioural observations for validation. Javan slow lorises are nocturnal prosimian primates of the family Lorisidae. The study site is in Western Java outside the village of Cipaganti on the Gunung Puntang Mountain in an agroforestry landscape. The loris subject is a member of a wild population of Javan slow lorises that have been consistently monitored and studied for over ten years by the Little Fireface Project (LFP). As part of the LFP program, members of this wild loris population are regularly captured and fitted with collars that are affixed with GPS transmitters and accelerometers. The accelerometer used in this study was the model Technosmart Axy 5s (Fig. 1). The accelerometer recorded movement data at an interval of 25 Hz. The battery can last up to 60 days at this rate.

Behavioural data were acquired by field assistants between the hours of 18:30 and 23:00 on March 10, 15, and 18, 2022. Behaviour and position were recorded using a scan sampling method at five-minute intervals plus *ad libitum* observations using an ethogram developed by LFP.

Figure 1. Javan slow loris wearing a collar with affixed accelerometer (white box). Photo courtesy of LFP

All data processing was conducted in Microsoft Excel and data analysis was conducted using R and RStudio to run the Random Forest model. We extracted accelerometer data that correspond to direct observations. Aligning the timestamps from

both datasets, we added labels to the raw dataset with behaviours from the direct observations. The labelled subset of accelerometer data consists of a total of 2,900 data points. We divided the data into three parts based on broad behavioural categories, locomotion, feeding, and resting, then we ran the random forest model three times, once for each subset. We ran a random forest script derived from the one used by Nekaris *et al.* (2022). First, 70% of the labelled dataset was randomly selected as a training subset while the remaining 30% was used as a validation dataset, which tests the accuracy of the model's predictions. The random forest model identified 21 separate modified behaviours, wherein the raw accelerometer variables yielded a mean overall prediction accuracy of 91.6% for the training dataset and 94.6% for the validation dataset across all three behaviour categories. The behaviour identified with the lowest accuracy in the training dataset was Tr_wa (travel_walk) at 74.08% and the behaviour identified with the lowest accuracy in the validation dataset was Ex_bg (explore_bridge) at 80%. Resting behaviours were identified with the greatest accuracy – 99.16% from the resting training dataset. Locomotive behaviours were identified with the least accuracy – 85.54% from the locomotive training dataset. Static_DorsoVentral, Static_Lateral, and acceleration on the Z axis (accZ) were the 1st, 2nd and 3rd most important variables, respectively, to identify behaviours (Table 1).

The aim of this study was to validate an analysis methodology. By combining direct behavioural observation data and accelerometer data within a random forest model framework, we have successfully identified 21 combinations of six behaviours and 18 movement/position modifiers from a wild Javan slow loris with a mean accuracy of 91.6% in the training datasets and 94.6% in the validation datasets. The random forest model identified resting behaviours with the greatest accuracy (99.16%) and locomotive behaviours with the lowest accuracy (85.54%), which is consistent with the results of similar studies in other species (Fehlmann *et al.,* 2017; Nekaris *et al.,* 2022). Across all behaviour categories, the most important variables were static_DorsoVentral, static_Lateral, and accZ. This somewhat reflects the results of Nekaris *et al*. (2022), which was a study of accelerometer data of a captive individual of a different species of loris, *Nycticebus bengalensis*. They found Static_Lateral and Static_DorsoVentral to be the first and second most important variables respectively to predict behaviours while accZ was the third most important variable for just one behaviour. Boyd *et al.* (2004) pose a definition of bio-logging as the "investigation of phenomena in or around free-ranging organisms that are beyond the boundary of our visibility or experience". Animals such as

the Javan slow loris are few in number, small, arboreal, and nocturnal - all conditions that make them difficult for humans to observe in the wild. Bio-logging devices such as accelerometers effectively extend the capacity of our senses to allow us a previously inaccessible view into the activities and behaviours of animals like the Javan slow loris, deep diving sunfish (Nakamura et al., 2015), flying and diving seabirds (Chimienti *et al.,* 2016), or migrating arctic muskox (Chimienti *et al.,* 2021). The information gleaned from such studies is important in understanding wildlife responses and resistance to global climate change, anthropogenic environmental modification and destruction, and other pressures (Boyd *et al*., 2004). Complementarily, we can use bio-logging data to reconstruct environmental state and fluctuations because animal behaviour is affected by the surrounding environment and therefore contains environmental information (Yoda, 2019). These insights can be integrated into ecosystem management programs to resist the negative effects of climate change and environmental degradation (Bograd *et al.,* 2010).

Table 1. Results of the Random Forest classification to assess the predictive power of the variables retrieved from a three-axis accelerometer in assessing the behaviours of a wild Javan slow loris. Prediction accuracy, main confusing behaviours, and the importance of variables in the Random Forest classifier were based on the training datasets.

Behaviour		Prediction accuracy (%)	Main confusing behaviour(s) (% error)	Most important variables in Random Forest classifier		
				1st variable	2nd variable	3rd variable
Locomotive Behaviours	ex_bg	85.72	ex_cd (11.9)	Static_Lateral	Static_DorsoVentral	accY
	ex_cd	94.4	tr_cu; tr_wa (1.3)	Static_DorsoVentral	Static_Lateral	accZ
	ex_ch	77.42	tr_cd (12.9)	Static_DorsoVentral	Static_Lateral	accY
	ex_cu	94.32	tr_bg (1.9)	Static_DorsoVentral	Static_Lateral	accZ
	ex_wa	81.63	ex_cd; ex_cu (9.18)	Static_DorsoVentral	accZ	accY
	tr_bg	82.44	ex_cd (9.16)	Static_Lateral	Static_DorsoVentral	Pitch
	tr_cd	86.86	ex_cd; tr_cu (2.85)	Static_Lateral	Static_DorsoVentral	Pitch
	tr_cu	94.12	ex_cu; tr_bg (1.96)	Static_DorsoVentral	Static_Lateral	accZ
	tr_rw	83.34	ex_cd (16.6)	Static_DorsoVentral	Static_Lateral	Pitch
	tr_sw	86.57	ex_cu (8.95)	Static_Lateral	Static_DorsoVentral	Pitch
	tr_wa	74.08	ex_cd (19.75)	Static_DorsoVentral	Static_Lateral	Pitch
Feed-ing	Fe_h3	100	Na	accZ	Static_DorsoVentral	accX
	Fe_h4	90.9	Fe_v2 (9.09)	accX	Static_BackForward	Pitch
	Fe_v2	93.75	Fe_h4	accZ	accX	Static_DorsoVentral
Resting Behaviours	Al_h2	100	Na	accZ	Static_DorsoVentral	Static_Lateral
	Al_h4	94.12	AlV4d (5.88)	Static_DorsoVentral	accZ	Amplitude_Lateral
	Al_si	100	Na	Static_DorsoVentral	accZ	Static_Lateral
	Al_st	100	Na	Static_DorsoVentral	accZ	Static_Lateral
	Al_V4d	100	Na	Static_DorsoVentral	accZ	Static_BackForward
	Gr_si	100	Na	Static_DorsoVentral	Static_Lateral	accZ
	Re_sb	100	Na	Static_Lateral	Static_DorsoVentral	accY

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Primates: Angels or Demons: Are conflicts between primates and humans all a matter of perspective?

"Imprinting human values onto primates/wildlife can promote misconception of their motivations"
(adapted from Jürgens, 2022 p2)

Graham Parry
Cohort 2023-2024
grahamp113@gmail.com

Primate interactions with humans are often portrayed within a negative context. Literature especially emphasizes the 'conflict' of such encounters, often focusing on the negative rather than the positives of coexistence. This negative emphasis, which promotes ideas of competition for resources, destructive ability, and dangers to human communities - both economically and in terms of safety - adds credence to the movement

towards eradication of a nuisance species. Here, I identify the focus of academic literature and review the weight of evidence which promotes a negative attitude towards human-primate encounters. I suggest it is time to take a more conciliatory tone, move away from negative concepts, and provide a more balanced perspective of our closest cousins in the evolutionary chain.

Primate behaviours have attracted a great deal of focus in academic literature, especially when in conflict with humans. But is it all down to perception, with literature biased towards negative interactions (Bhatia *et al*., 2020)? Should we adopt a more conciliatory tone, moving away from the negative connotation of 'Human-Primate Conflict' and toward more balanced terminology such as 'Human-Primate Interactions or 'Human-Primate Coexistence' (Redpath *et al*., 2015)? Perhaps it's all a matter of perspective, or do we really believe that primates are intentionally antagonistic towards humans (Peterson *et al.*, 2010)? Are there truly angels and demons lurking behind their behaviours when interacting with humans?

Wildlife, in general, receive an equally negative response in articles reflecting encounters with humans, with minimal attention paid to mitigating factors (Hockings, 2016; Kithi *et al*., 2017; Jürgens, 2022). Here, I take a general definition of conflict from Madden (2004) as: "interactions between

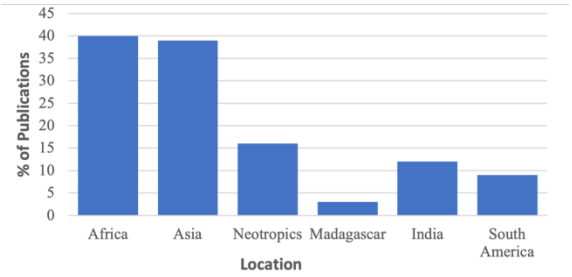

Figure 1. The % of publications across major regions which use 'human-wildlife conflict' as their lead headline. Adapted from a Web of Science search (McLennan *et al.,* 2017) and updated to reflect the period 2010-2022

wildlife and humans with a negative outcome". I suggest that perspectives of primate and wildlife interactions with human populations are influenced by the negative connotation of using the term 'conflict', creating a bias in how these interactions are understood (Madden, 2004). I propose that a more neutral reference is needed to avoid demonizing these interactions, with a greater emphasis placed on conciliatory language to remove bias and allow for a more objective view of human-wildlife, and specifically human-primate interactions (Lee & Pritson, 2005).

A literature review of human-primate encounters was undertaken using Google Scholar and Web of Science databases (Gómez-Luna *et al*., 2014; Snyder, 2019). Keyword searches were carried out for the period 2010-2022 using the terms "Human-Primate Conflict", "Human-Primate Interactions", and "Human-primate Coexistence". This review period was selected to represent the last two decades of

literature. Older papers were referenced for clarification but were not included in the analysis period. A comparative study was carried out using" Human-Wildlife Conflict", "Human-Wildlife Interactions" and "Human-Wildlife Coexistence" word searches. A distribution of publications was also used to identify geographical regions where reference to 'Human-primate conflict' dominated the literature. Results from these searches of human-primate interactions produced 42,000 entries. Refining this search to specific "Human-primate conflict" headlines resulted in 240 journals, with 113 headlining with "Human-primate coexistence". The percentage of peer-reviewed journals using 'conflict' terminology when referring to Human-primate encounters was highest in Africa and Asia (Fig. 1), averaging 40% of those reviewed. The reoccurring theme within an increasing number of Human-primate Interactions showed that on average, 72% of journals referred to "human-primate conflict" (Fig. 2)., whereas only 6.7% of journals used "coexistence" in their references when discussing human-primate interactions. A comparative review of journals focusing more generally on 'Wildlife' reflected an even greater skew towards negative connotations, with 'Human-wildlife conflict' far exceeding other interactions or coexistence (Fig. 3).

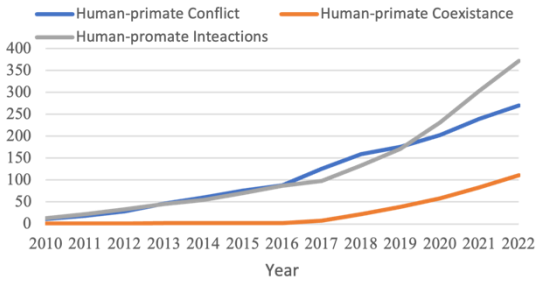

Figure 2. Graphical results of literature search using key words: 'human-primate conflict', human-primate coexistence', 'human-primate interaction' by year.

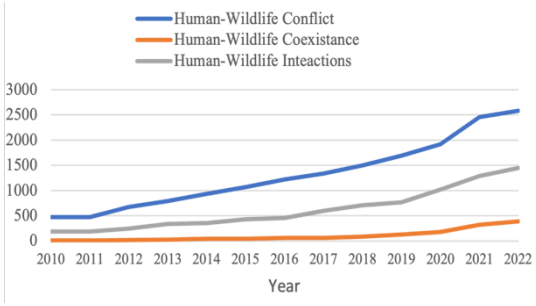

Figure 3. Graphical results of a literature search using key words: 'human- wildlife conflict', human-wildlife coexistence', 'human- wildlife interaction' by year.

It was evident from the academic literature reviewed that the perception of conflict and negative patterns of coexistence have dominated, leading to the decimation of perceived dangerous species (van Schail *et al*., 2016). These fears are exacerbated by media and social groups promoting the negative aspects of primate and wildlife interactions (Lee & Priston, 2005). Humans base their perceptions and attitudes not only on facts and personal experiences, but also on a myriad of factors such as wider social experiences, cultural norms, expectations, and beliefs - the majority of which are derived from the literature we read (Dickman, 2010; Jürgens, 2022).

Human willingness to tolerate primates is therefore often governed by elements of social and cultural practices, levels of education, community perception, and economic impacts (Hill, 1999). In certain cultures (e.g., the Hindus of Bhutan, India and Nepal) primates are seen as deities, while in others (e.g., China and Japan), they may be viewed as mystical creatures, both deceitful and devious. To the world's subsistence farmers, they may be perceived as pests and a significant threat to their livelihoods and personal safety (Hill, 1999). A fundamental aspect of human perception towards primates appears to be rooted in the practice of attributing human values to primate behaviours (Whiten & Van de Waal, 2017; Jürgens, 2022). Applying these principles implies a deliberate act by primates to steal, cause harm or seek confrontation with humans. However, the reality lies in a need for food and the need to forage (Dickman, 2010; Peterson *et al.*, 2010). As subsistence farmers become reliant on crop yields, any loss is considered detrimental. Therefore, a loss due to primate crop feeding turns tolerance to intolerance and confrontation (Fuentes, 2002).

Educational programs that promote awareness, increase knowledge of primate species, and foster an interest of primates within the local or impacted community has been shown to increase tolerance and reduce conflict (King & Lee, 1987; Whiten & Van de Waal, 2017). That said, the results of greater educational awareness have yet to be fully explored. While education has a large part to play in wildlife tolerance and understanding, the medium through which it is delivered is also crucial (Hill 1999; Lee & Priston, 2005). Literature portraying negative interactions between humans and primates has dominated the academic press. This has led to the demonization of primates and a perception of constant conflict between human communities and primates. Although in recent years, the emphasis has begun to move away from these negative connotations, a lot more needs to be done. A more conciliatory view needs to be taken if affected communities are to embrace conservation efforts and help preserve endangered species. Education will play a major role in this swing away from confrontation, as will the use of more conciliatory language within research journals. Reducing the use of the term 'conflict' and adopting a less biased promotion of human-primate encounters to highlight greater coexistence will require increased understanding, education, and a new paradigm that reflects collaboration in addressing a new global conservation challenge. More research is needed to address these perceptions, as primates are neither angels nor demons, but a range of species - like ourselves - looking to survive in a changing world of evolving habitats

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Interdisciplinary cooperation as a key to holistic environmental education

Michelle Schreiber
Cohort 2022-2023
stolz.michi@web.de

Environmental education generally describes 'an educational approach that addresses human intervention in the natural balance and the resulting problems' (Bahr, 2013). The central focus is on promoting the willingness to act and empowering people to treat natural resources with respect, especially in the context of the conflict between individual and social interests, as well as economic and ecological interests. Some studies show that

environmental education is an essential component of environmental and species protection (Knudson *et al.*, 2003; Jacobson, 2009; “Fridays for Future”, 2023). It promotes sustainable use of the environment and resources, improves local and global attitudes towards sustainability, reduces vandalism, illegal trade, and poaching, supports compliance with environmental protection laws, and even positively influences political decisions. Hence, it is important that environmental education projects are constantly optimised and adapted to current standards. While projects have to date often been created by mono-disciplinary teams, research in the last decade (Hähner, 2012; Röhlich, 2018) emphasised that interdisciplinary cooperation is essential in many areas of environmental protection to achieve holistic solutions. Therefore, this article deals with the relevance of interdisciplinary cooperation in the field of environmental education and sheds light on the extent to which it is key to a holistic environmental approach.

Interdisciplinary refers to the cooperative use and further development of approaches, ways of thinking, or methods applied in different scientific disciplines (Schneider & Toyka-Seid, 2013). An interdisciplinary way of working encompasses several individual scientists who are independent of each other to investigate a topic using their respective methods. This is a relevant approach, as research questions can often not be answered by a single discipline. Therefore, cooperation between disciplines is necessary. Environmental education consists of two aspects of education: promoting a person’s independence and self-determination, on the one hand, and the topic of the environment, on the other hand. This promotes a person's understanding of his or her environment and includes aspects of environmental protection with all measures that contribute to the preservation and protection of people's natural environment.

To shed light on the relevance of interdisciplinary cooperation in the field of environmental education, four semi-structured interviews (length: 45–90 minutes, online) were conducted with both expert groups (teachers, environmentalists) to evaluate their respective needs, focus topics, and strengths. The teachers had been in their profession for four to thirteen years, while the environmentalists had worked actively for eight to thirty years. Coding was achieved by categorising the statements. A comment on the pedagogical task was categorised as ‘pedagogically inclusive’ so that core needs resulted from this. In the context of this work, the focus was on the overlapping of the needs and the consideration of other expert fields.

The results showed that teachers identified six core needs and ideas, while environmentalists articulated three core needs and ideas (Table 1). None of the stated needs overlapped completely. On the contrary, two needs even

contradicted each other. For example, environmentalists emphasised the sustainable production of all materials, while teachers particularly emphasised a free or low-cost option.

Table 1. Core needs and ideas of interviewed teachers and environmentalists

Group	Need
Teacher	Target-group orientated
Teacher	Didactic
Teacher	Inclusive pedagogical
Teacher	Child-friendly
Teacher	Cross-curricular
Teacher	Realisable
Environmentalist	Self-efficiency
Environmentalist	Correct knowledge
Environmentalist	Sustainability

The survey showed that none of the needs and focus topics of the two expert groups overlapped. Rather, it showed that the experts would work past each other and possibly even in opposition to each other. As a result, environmental education projects neglect either the environmental protection aspect or the educational component. It is therefore essential to move from mono-disciplinary teams of experts consisting of either teachers or environmentalists to interdisciplinary teams that work hand in hand, integrate all important aspects of both disciplines, and find appropriate compromises for conflicts to create a holistic environmental education project.

This article briefly highlighted the relevance of interdisciplinary collaboration in the field of environmental education for the development of holistic materials. It shows that without such collaboration, important aspects of the core concept of environmental education will always remain unaddressed, making a holistic approach impossible. Interdisciplinary cooperation is thus the key to holistic environmental education projects. Initially, the focus was on the two obvious teams of experts (teachers and environmentalists). It remains to be seen whether the team could be optimized by including other subject matter experts, such as media designers or marketing experts. These could be particularly important in the development and marketing of a project.

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Conservation welfare- understanding and protecting the wellbeing of wild individuals

Hannah Giammarco
Cohort 2022-2023
hannah.e.giammarco@gmail.com

An animal with good welfare experiences comfort, good health, safety, and the ability to exhibit a wide variety of behaviours, display cognitive abilities, and develop and express species-typical relationships and behaviours. This highlights the interconnectedness welfare has with the physical, mental and emotional states of animals. While welfare is commonly accepted as a vital part of *ex situ* animal health like zoo-housed animals, it has not been found as important in wild animal health.

This has led to the creation of conservation welfare science, a new field that explores methods to minimise harm to wildlife and prioritise welfare when possible (Beausoleil, 2020). The aims of conservation welfare include the improvement of the well-being of animals impacted by conservation methods and the design of policy through direct consultation with conservation scientists (Beausoleil, 2020). This approach prioritises the use of the scientific method to understand and improve these methods and policies and the inclusion of welfare experts in planning conservation management strategies, something that is often not done (Beausoleil, 2020). However, it is still a growing field and reviewing its current status is vital to finding where conservation welfare is lacking and where focus must be placed on. This reasoning is why I focused on presenting the state of research on wild animal welfare research for my dissertation in the form of a narrative-based literature review, which has been summarised below.

Due to the creation of conservation welfare as a scientific focus, there has been a push by scientists to better understand the welfare of wild animals. This push has led to an almost exponential increase in the research of topics like urban animal welfare (Magle *et al*., 2012). However, conservation welfare is a relatively new field still in its nascent stages (Soryl *et al.*, 2021).

Wild animal welfare research uses a large variety of methods, including surveys, reported injuries, and behavioural observations, much like captive research (Animal Ethics, 2019). Behaviour, conservation and landscape ecology tend to be some of the most studied topics in wild animal welfare (Magle *et al*., 2012). Wild animal welfare research also differs slightly from zoo research in that it tends to be performed to create solutions to conservation problems, versus solving only individual-level welfare problems like in captivity. For

example, in the case of urban animal welfare, it was found that streets in highly populated areas are more likely to cause animal limb mutilations. This research was conducted to find what may decrease the number of mutilations, which was found to be done through frequent street cleanings and repavings (Animal Ethics *et al*., 2019).

One issue with the field is the lack of use of the word welfare. Based on the definition of welfare, studies that investigate health and normative behaviours of animals are looking at parts of an animal's welfare (Fraser *et al*., 1997). An example of this is Levy *et al*. (2023) who investigates long term impacts of drought on young female baboons. They found that if an adolescent female baboon experienced a drought, they were more likely to have shorter limbs, showing that an early stressful event can cause long-term impact. These findings could also be seen as research into how poor welfare impacts the growth of a female baboon. The animal's freedom of access to water was restricted, leading to poor welfare and subsequent impacts on its growth. This slight change in terminology may be part of the reason wild animal welfare research appears so far behind compared to captive animal welfare research.

Another trend found in wild animal well-being research is a focus on invasive or "pest" animals and our methods of managing them (Harvey *et al*., 2020). This trend focuses on whether the methods used are humane based on the impact they have on the pest animal's welfare. This type of research is vital to improving the methods that can directly decrease an animal population while also supporting the efficiency and importance of these management methods (Littin *et al*., 2014). Clear assessment strategies for these management methods are outlined in literature and can be universally applied to pest management of different species (Littin *et al*., 2014).

It is common for recommendations in wild animal welfare literature to include concern for the lack of standardised methods for evaluating welfare. In the case of chimpanzees (*Pan troglodytes*), it was found that there was a lack of uniform measurements in literature to score their health and nutrition (Gerstner & Pruetz, 2022). This degrades our ability to compare results between scientific literature in different settings, such as zoos and the wild, and between non-published scientific data, such as from rehabilitation centres. In Harvey *et al.* (2020), a ten-step process was outlined that systematically evaluates the welfare status of non-captive individuals. This process gives a starting point to assessing welfare of wild animals, while also giving guidelines on how to adapt this procedure to more specific situations and taxa (Harvey *et al*., 2020). In the original publication, free-roaming horses were used as an example to show how the protocol works. Since its publication, other

research articles have used the method to verify its effectiveness and to develop its methods further (Harvey *et al.*, 2021; Harvey *et al*., 2023). While this methodology is relatively new, it implies a future where more uniform welfare observations can be made for wild populations and can be used to improve management practices on a larger scale.

Using methods such as the 'Ten Stage Protocol' may help further cooperation between zoos and wild animal conservation (Harvey *et al*., 2020). Despite the wealth of knowledge that the captive field has discovered about the welfare of the animals they house, the majority of the information and techniques cannot be applied to wild animal research (Gerstner & Pruetz, 2022). Cooperation between wild and zoo-based studies of conspecifics can improve the understanding of welfare in both settings and allow for more comparative research to occur (Gerstner & Pruetz, 2022). This can be done using similar indicators and scales of measurement for welfare for evaluating that species in different contexts (Harvey *et al*., 2020).

In conclusion, the field of conservation welfare has been growing our understanding of wild animal welfare and can lead to improved conservation methods. Further research efforts must be done so that the field can be more useful and impact the lives of individual animals that are threatened by human actions.

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An analysis of the extent to which tourists adhere to IUCN guidelines when viewing Sumatran orangutans *Pongo abelii* in Bukit Lawang, Indonesia

Amy Woolloff
Cohort 2020 - 2021
aewoolloff@gmail.com

Close contact between humans and apes can have negative consequences for wild populations, with apes particularly vulnerable to zoonoses from humans due to our close phylogenetic relationship (Wallis & Rick Lee, 1999; Davis *et al.,* 2005). Suspected outbreaks resulting from transmission of zoonoses from humans have previously led to deaths in great ape populations (Woodford *et al.,* 2002; Sandbrook & Semple, 2006) and the International Union for Conservation of Nature (IUCN) species specialist group for non-human primates currently states that we should assume COVID-19 can be transmitted from humans to apes (IUCN Primate SSC, 2020).

This study focuses on the site of Bukit Lawang within Gunung Leuser National Park, Indonesia (Fig. 1). This is a popular tourist destination for seeing Sumatran orangutans (*Pongo abelii*) which are currently categorised as Critically Endangered by IUCN Red Listings, with population numbers decreasing (Singleton *et al.,* 2017). Bukit Lawang's Sumatran orangutan population is predominantly made up of rehabilitated orangutans, where tourists were previously allowed to directly interact with and feed the orangutans (Dellatore *et al.,* 2014).

Although it is now banned to touch, feed or disturb the orangutans, Dellatore *et al.* observed in 2014 that these tourist behaviours still occurred, concluding that tourism was having a direct negative impact on the Sumatran orangutan population's behaviour and health. They made several recommendations for improvements, including following the IUCN best practice guidelines for Great Ape tourism. These guidelines state that for visitors not wearing masks, the minimum distance permitted between tourists and apes is 10 m (Macfie & Williamson, 2010). There is currently little global research on compliance with these guidelines, with the majority focused on mountain gorillas *Gorilla beringei* (Sandbrook & Semple, 2006; Stevens *et al.,* 2020) Most recently, an analysis of Instagram posts from tourists visiting mountain gorillas between 2013-2019 found that 86% of tourists were within 4 m of the gorillas and only 3% at 7 m or more, with distances between tourists and mountain gorillas decreasing over time (Van Hamme *et al*., 2021).

To evaluate the prevalence with which IUCN guidelines are adhered to during wildlife tours of Sumatran orangutans in Bukit Lawang since recommendations in 2014, I analysed photos uploaded by tourists on Trip Advisor galleries for the top ten most popular wildlife tour companies in this region, with three key questions:

1) What percentage of tour companies have at least one photo involving close contact or touching of orangutans?

2) Has there been a decline in the number of photos involving close contact since recommendations by Dellatore *et al.* in 2014?

3) Does the presence of a policy detailing safe distances on a tour agency website have an impact on the average number of most recent photos including close contact?

A trip advisor search for the term 'wildlife tour' was carried out under the section 'Things to do' with the location set as 'Bukit Lawang, North Sumatra' and all pages of results viewed, with the ten most popular tour companies according to number of reviews selected. To analyse the prevalence with which close contact occurred between humans and Sumatran Orangutans and compare this over time, the oldest and most recent 100 photos uploaded by tourists in each tour company's Trip Advisor photo galleries were viewed.

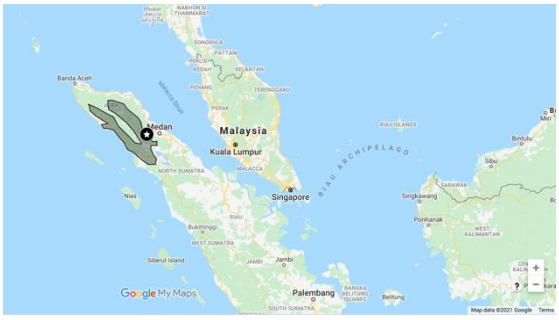

Figure 1. The estimated range of the Sumatran Orangutan is shaded in grey, with the star indicating the popular tourist site of Bukit Lawang, Indonesia

Any photo in which both humans and orangutans were in the frame was determined to be below the IUCN 10 m guidelines and recorded as 'close contact'. During initial research, it was noted that a fairly high proportion of close contact photos involved touching so this was recorded as a second category of interest. Corresponding dates of the oldest and most recent photos were noted to calculate the average time span covered in the study. Tour company websites were accessed through their Trip Advisor company profiles and checked for a policy regarding minimum distances. Companies were recorded as having a policy that matched IUCN guidelines, a policy which mentioned distancing in some context and no policy at all. All data were analysed in Excel with descriptive statistics used to answer each research question.

The photo galleries covered an average time span of 4.8 years (range 2.6-8.1) from 2015-2020. The vast majority (90%) of tour companies had at least one incident of a photo involving close contact between

tourists and orangutans in their most recent 100 photos. This had not changed from the oldest 100 photos, although the percentage of companies that had at least one incident involving touching had dropped from 70 to 40% (Fig. 2). There was only a very minor reduction in the average number of close contact photos uploaded by tourists, although the average number of photos involving tourists touching orangutans fell markedly from an average of 1.9 to 0.4 per 100 photos (Fig. 3).

Only one out of ten tour company websites had a policy that matched IUCN guidelines, with a further three having a policy that mentioned the need to keep a distance in some context. The remaining six had no visible policy on their websites. For companies with no policy, there was an average of 5 photos uploaded by tourists involving close contact out of the most recent 100. There was a marked reduction in the average number of close contact photos for companies with a policy, with an average of 3.5 photos per 100 involving close contact between tourists and orangutans for companies with a policy mentioning distance in some context and none for the company with a policy that matched IUCN guidelines. Similar to findings from studies on tourists viewing mountain gorillas (Sandbrook & Semple, 2006; Stevens *et al..,* 2020; Van Hamme *et al..,* 2021), my study found that the majority of tour companies did not enforce IUCN guidelines.

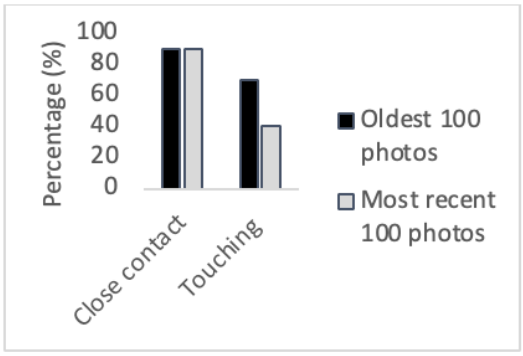

Figure 2. The % of top ten tour companies in Bukit Lawang in which at least one tourist uploaded a photo demonstrating close contact or touching of Sumatran orangutans over an average time span of 4.8 years between 2015-2020.

The frequency with which tourists uploaded photos demonstrating close contact with orangutans has not markedly changed since recommendations were made by Dellatore *et al.* in 2014, although a marked decrease in the average number of photos uploaded involving touching indicates that behavioural change may be possible. The results indicate that the presence of a policy matching IUCN guidelines may have an impact on reducing the number of photos involving close contact between tourists and Sumatran orangutans.

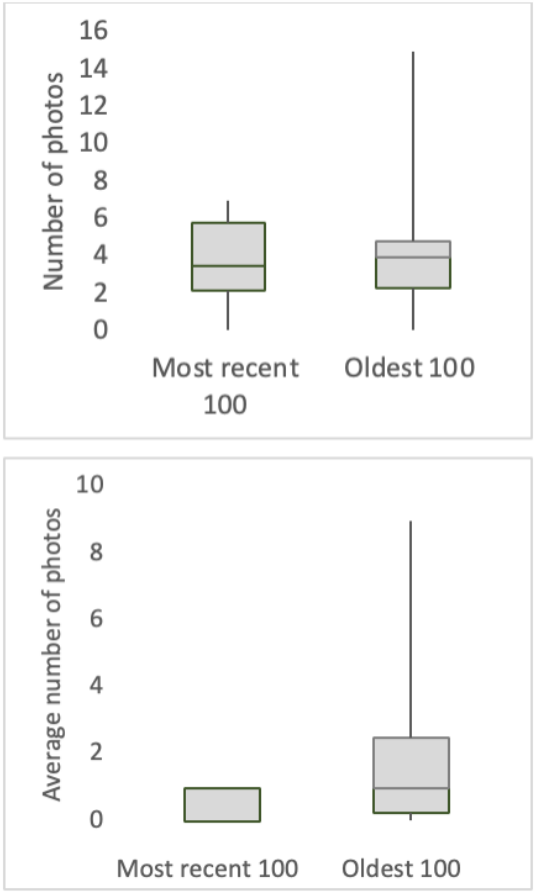

Figure 3. The average number of photos uploaded by tourists for the top ten tour companies in Bukit Lawang in which close contact between tourists and Sumatran orangutans occurred (top) or touching of Sumatran orangutans (bottom) over an average time span of 4.8 years between 2015-2020.

My study has several limitations and is therefore only intended to provide a snapshot of the overall prevalence with which close contact and touching are still occurring. Only photos uploaded could be analysed and it was not possible to gauge distances in photos with no people in the frame. Without ground observations, it is not possible to know the extent to which the 10 m rule is verbally enforced to tourists, although the presence of a policy online may indicate that a company is more likely to do this. Further research is needed in person to verify the findings here and identify potential causes of non-compliance.

Wich *et al.* (2016) predicted that Sumatran orangutans may be the first great ape species to become extinct. Although recent estimates place the population at higher numbers than first thought, they remain threatened, and it is essential to ensure the continuing health and survival of wild populations remaining (Wich *et al*., 2016). If IUCN recommendations continue to be ignored the already vulnerable population in Bukit Lawang has the potential to have their numbers threatened by zoonotic transmission; the park authorities must act now in the interest of their own economic sustainability and the conservation of this important species. I make the following recommendations based on these findings:

1. A previous study found that tourists are largely unaware of the disease risk they may pose to orangutans (Muehlenbein *et al.,* 2008). Educational campaigns are needed to inform tourists of why the 10 m rule is important

2. Policies that match IUCN guidelines need to be more clearly enforced and communicated

3. Trip Advisor banned sales to attractions allowing contact with wild animals in 2016. They could also refuse to endorse companies that still allow it

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Implications and impacts of nature's legal personality on stakeholders and its possible applications to primate conservation

Marianne Laurin-Lalonde
Cohort 2021-2022
m.laurin.lalonde@outlook.com

Nature's legal personality (NLP) has gained in popularity in the past 20 years as an alternative to conservation that articulates itself within the western legal system, protects nature, and gives higher visibility to indigenous groups. Considering its worldwide adoption and relative novelty, I ask if its principles and mechanisms could be used for primate conservation based on a literature review.

NLP is the result of an ontological shift born from a growing sense of urgency in a context of environmental "crisis" accompanied by a rising recognition of Indigenous rights and a need for decolonisation (Walsh, 2010; Barcan, 2020). The failure of the current neoliberal system of consumerism and the nature-culture dichotomy has led environmental and human-rights activists to look for alternatives, exploring concepts of post-neoliberalism,

ecocentrism, and indigenous traditional knowledge and ontologies (Walsh, 2010; Barcan, 2020). Thus, in 1972, Christopher Stone published his article "Should Trees Have Standing", triggering an environmental law movement and setting the foundations of NLP. The article stated that "forests, oceans, rivers, and other so-called 'natural objects' in the environment – indeed, […] the natural environment as a whole" should have rights and standing (Stone, 2010). Coupled with local indigenous ontologies concerning human relationships with nature, NLP has been adopted and adapted according to the countries' contexts, interests, and natural features. Since Stone's publication, multiple countries like the United States, Bolivia, Colombia, and Bangladesh have granted rights to nature. At the same time, other nations, like Ecuador, New Zealand-Aotearoa, and India, went further and gave rights, duties and standing to nature, recognising it as a legal entity. Canada is the newest addition to the list, recognising the Magpie River, or Muteshekau Shipu River in Innu, as a legal 'person' in 2021. Thus, the River was granted nine fundamental rights:

"The right to live, exist and flow;

The right to respect of its natural cycles;

The right to evolve naturally, to be preserved and protected;

The right to maintain its natural biodiversity;

The right to maintain its integrity;

The right to fulfil essential functions within its ecosystem;

The right to be protected against pollution;

The right to regenerate and be restored;

The right to sue;" (Noël et al., 2021) (Personal translation from French)

The rights and legal personality of the river are to be recognised and considered for any decision or action concerning it by the government and any private entity (Noël *et al.*, 2021). The guardians are nominated by the Municipalité Régional de Compté (MRC) of Minganie and the Ekuanitshit Innu First Nation (Noël *et al.*, 2021). They will represent, act, and protect the rights and interests of the Muteshekau Shipu River (Noël *et al.*, 2021). The guardians will be able to undertake legal proceedings in the name of the natural feature and claim reparations and compensation (Noël *et al.*, 2021). The guardians' responsibility to protect the river includes the obligation to undertake research, surveillance, integration of Innu traditional knowledge, conservation management and education, among others (Noël *et al.*, 2021). This would reflect Innu traditional law and allow them to maintain their relationship with their ancestral land (Noël *et al.*, 2021).

The Muteshekau Shipu River is only one example, but NLP can be recognised through constitutional ratifications, specific legislation, and judiciaries (Fischer-Lescano, 2020). Similarly, the rights and duties accorded to nature and its features can vary depending on the cultural, social, and political needs and intentions behind its creation. NLP has been

adapted to the local indigenous ontologies, political demands, aspirations, and the need for action toward climate change and environmental degradation.

My research led me to think that NLP and nature's rights have significant potential as alternatives to dominant paradigms of anthropocentrism and neoliberalism and offer an interesting model for the protection of nature and indigenous interests. Therefore, I wondered how primate conservation articulated itself within NLP. One of the ways I imagined primates could be protected under NLP is through principles of ecological services. Indeed, primates are significant actors in forests' seed dispersal cycle: consuming, defecating, and spitting large amounts of viable seeds across long distances (Chapman *et al.*, 2012; Estrada *et al.*, 2017). They can influence the composition of forests by influencing the growth, productivity, and abundance of plants, thus modifying the forest's nutrient cycling, and ensuring the environment's resilience and adaptation (Chapman *et al.*, 2012; Estrada *et al.*, 2017). Considering primates' important role in the maintenance of ecosystem health and the diverse rights of nature, I think primates, and other animals of similar ecological importance, could benefit from, or be integrated into, NLP as vital actors that allow nature to practise its rights.

I believe that NLP could be a viable alternative to hegemonic paradigms enacting systemic changes influenced by, and influencing, human behaviour toward better conservation and environmental practices (Estrada *et al.*, 2017). Meaningful primate conservation requires policy changes and commitment from the stakeholders to alleviate pressure and decrease industrial and resource demands on primate habitats (Díaz *et al.,* 2006; Estrada *et al.,* 2017).

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