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Special Collection: Drone Ecologies

INTERVENTIONS: POLICY AND PRACTICE

Protecting people and wildlife from the potential harms of drone use in biodiversity conservation: interdisciplinary dialogues

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In this policy intervention, we recount the process of producing a policy briefing targeting researchers and practitioners who use drones in biodiversity conservation. We use the writing process as a springboard to think through the ways that interdisciplinary exchange has and might further inform the ethical use of new technologies, such as drones. This approach is vital, we argue, because while drones may be deployed as tools that enable or empower forest, wildlife or habitat monitoring practices, so too can they be variously disruptive, repurposed and/or exceed these applications in significant ways. From questions of surveillance and capture, data ownership and security, to noise disruption, drone use requires careful and critical reflection, particularly in sensitive contexts. Yet, interdisciplinary exchange attentive to the ethical, social and experiential dimensions of drone use remains patchy and thin. To this end, this intervention reflects

on the process of a group of scholars from ecological, environmental and social science backgrounds coming together in an interdisciplinary project grappling with diverse issues around responsible conservation drone use. After recounting our methodology, including the surprises and learning that emerged in practice, we contextualise the key themes we chose to foreground in our published policy briefing. We conclude by connecting our collaboration with wider actions and energies in the context of existing (conservation) drone policy and practice, while underscoring our contributions to existing work.

Key words drones • UAVs • conservation ethics • interdisciplinarity • dialogue

Key messages

- Drones are increasingly popular tools in conservation, enabling the capture of airborne imagery and sensor data.
- The use of drones in conservation is also associated with a range of potential harms to humans and wildlife.
- This intervention reflects on the development of policy guidelines on responsible and considerate drone use.
- Group members reflect on (the challenges of) creating a shared language across disciplinary differences.

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Introduction

Digital technologies are an increasingly established feature of conservation, 'reshaping' conservation practice in notable ways (Simlai and Sandbrook, 2021: 239). As the papers in this *Drone Ecologies* Special Collection demonstrate, drones offer significant potential in the tackling of current challenges in biodiversity conservation, while raising important issues both for people and wildlife in their vicinity. As comparatively accessible and cost-effective geospatial tools that capture fine spatio-temporal resolution airborne imagery and sensor data (López and Mulero-Pázmány, 2019), drones may assist in the democratisation of conservation practice and the pursuit of 'environmental and social justice' more widely (Radjawali and Pye, 2017: 17; Choi-Fitzpatrick, 2020). This is particularly evident in the use of drones as tools 'empowering' Indigenous communities to create and own 'new environmental and geographic knowledge' on community issues (Simlai and Sandbrook, 2021: 247; see also Paneque-Gálvez et al, 2017; Macdonald et al, 2021). Yet, from adverse impacts on wildlife to concerns about privacy and the drone's potential to amplify broader conflict dynamics, drones also raise and pose new ethical, social and political questions.

The call for greater interdisciplinary attention to these concerns formed the premise of the interdisciplinary workshop *Drone Ecologies: Exploring the opportunities and risks of aerial monitoring for biodiversity conservation* (henceforth Drone Ecologies), held on 5 and 6 July 2021 (University of Bristol, 2021), and of this special collection more generally. The workshop, which explored both the opportunities and potential risks of new

monitoring technologies, welcomed over 60 participants, including academics from the social and natural sciences, and practitioners from arts, industry and non-governmental organisations. As is evident in the event recordings (available here), the workshop was animated and thought-provoking, in part because of encounters and exchanges between diverse expertise and perspectives on and around drones. Several participants noted this was the first time they had thought about drone impacts on wildlife, while others noted they had not previously considered that drones might be deliberately deployed in conservation spaces to incite fear. Amid these exchanges, new questions emerged. What might best practice for conservation drone use look like, especially in conflict-affected areas? How might conservation drone use be facilitated while limiting potential harms to humans and wildlife in their midst?

In response, a group of researchers from across the natural and social sciences opted to continue these conversations, gathering over the period of a year to work together to develop a policy briefing on responsible drone use, designed for a conservation practitioner audience (available here). This intervention reflects on this collaborative process of interdisciplinary dialogue. After detailing our methodology, it documents the experience of virtually coming and working together, highlighting areas of learning and surprise, tension and challenge, before contextualising the key themes foregrounded in our published briefing. We conclude by connecting our collaboration within wider actions and energies in the context of existing drone policy and practice, drawing particular attention to the scope of our interdisciplinary contribution.

Methodology: facilitating interdisciplinary encounters

A core aspect of both the *Drone Ecologies* workshop and wider dialogue that followed was the facilitation of interdisciplinary exchange. Debate has flourished around the limitations of single-discipline research to 'address complex societal challenges' and conversations have thus centred on the role of 'cross-disciplinary engagement' and the 'blending of knowledge' in developing new solutions (Felt et al, 2016: 733). Interdisciplinarity can be understood as the coming together of 'two or more academic fields of knowledge' (Raento, 2020: 357) with the aim of 'integrating' perspectives to 'deliver richer outcomes' exceeding the 'capability' of a single disciplinary perspective (Pye, 2018: 40, 35). In defining interdisciplinarity, scholars turn attention to the word's constituent parts, with the inter- referring to a 'togetherness, mutuality, and reciprocity', 'between', and disciplinary referring to a particular 'field of study' and its 'rules, boundaries, and order' (Repko and Szostak, 2017: 43; Raento, 2020: 357). Bringing different disciplines into dialogue on a 'common problem', interdisciplinary work often occurs in shared spaces and involves the 'definition of problems', identification of 'key concepts' and 'exchange of expertise', with the aim of developing a 'shared language' (Lury, 2018: 9). Thus, while we were a multidisciplinary team (from different disciplines), our aim was to produce interdisciplinary knowledge through our exchanges, which exceeded the sum of our individual disciplinary contributions.

Interdisciplinary exchange began before the workshop as the organisers consulted experts in the field and established four cross-cutting themes: (1) *Technicalities* (what drones can do in forest/wildlife conservation); (2) *Rights and communities* (how drones could be used to support the rights of communities); (3) *Drones and green securitisation* (where and when monitoring becomes surveillance); and (4) *Ethics and protocols* (discussion and sharing of best practices for drone use fostering environmental

justice). These themes were explored through plenaries, roundtable discussions and workshops, and, importantly, in the chat function of the workshop, which took place virtually via Zoom. This was an important dimension of the online conferencing modality made essential by the workshop's historical situatedness: in June 2021, the ongoing COVID-19 pandemic made in-person events challenging. However, both at the event and in post-event feedback forms, participants noted that this format had *enriched* discussions, facilitating constant dialogue via chat features without interrupting presentations, and reportedly enabling PhD students and postdocs to more easily enter conversation with senior academics and experienced practitioners.

The workshop saw particularly lively discussions in the 'Ethics and Protocols' session, where attendees exchanged experiences in the field and best practice on drone use in conservation through small group activities. Here, as in other sessions, a range of digital tools were deployed in order to enable exchange, reflecting the event's broader ethos to explore the use of technologies to see problems differently. In this case 'Jamboard', a digital whiteboard software enabling real-time idea-sharing, was used. Each small group, comprising individuals from a range of backgrounds and nationalities, shared ethical issues arising from their own use of drones, and if and how they felt these were resolved. The use of Jamboard enabled the collaborative collation and visual notation of diverse issues and responses: those which spanned concerns around physical safety and operator harassment; local resident concerns and fears of drone use; and the running of community workshops and the collaborative development of flight operations in response.

Inspired by this fruitful exchange across multiple forms of expertise, a group of attendees gathered online to continue discussions in the months afterward. This led to the formation of a policy briefing working group comprising nine researchers from across the natural and social sciences, who opted to create guidelines on responsible drone use for conservation practitioners. The resulting briefing *Responsible Drone Use in Biodiversity Conservation: Guidelines for environmental and conservation organisations who use drones*, was published with CIFOR in 2023 and can be accessed here.

In developing the policy briefing, further digital tools facilitated knowledge exchange, with all meetings taking place online via video conferencing software (Zoom), and through the use of collaborative online documents (Google Docs). While there are challenges associated with meeting online, from accommodating diverse time zones, to energy burnout, to turn-taking, we found that these tools helped develop and deepen our exchange, assisting with both the levelling out of voices of various types and seniorities, and the widening of the temporalities of exchange. For example, the use of Google Docs during and after meetings enabled both live and simultaneous sharing and contribution of ideas by multiple users in real time, while also extending the afterlife of meetings and digestion of materials. Rather than fuelling frustrations of 'chaotic meetings' where collaborators may appear rushed or distracted, need to 'abruptly leave for another meeting' (Michael, 2018: 281), or be operating on different time zones introducing different timings/needs, this offered options for people to later return to the document and to contribute iteratively. The nature of this digital contribution was also important. Alongside simple interventions such as choosing our own different writing colours which helped make both different contributions and difference in contributions visible, the comment box feature proved valuable in enabling each of us to respond to and pose questions of different contributions, as well as to amplify and signal support of the same (for example, through a thumbs up or 'I agree'). Such digital functionalities aided us as we proceeded to group, expand and sculpt ideas into a coherent structure for the briefing.

Such approaches were also employed with the aim of enabling each participant's voice to be featured and represented throughout the development of the policy briefing. As scholarship on interdisciplinarity aptly demonstrates, 'power can manifest in many ways' within interdisciplinary collaboration, from 'individual status' and perceptions of the 'most accepted account' of an issue, to the 'inclusion and exclusion' of views and assumptions about 'relevance' (MacMynowski, 2007), the effects of which can unevenly impact scholars at different career stages and/or in 'precarious' employment (Purvis et al, 2023). Echoing literature describing both the 'valuing' work of disciplines (Schoenberger, 2001: 372) and the (legacies of a) 'deep normative current' that can act to 'valorize' the natural sciences as 'the objective scientific ideal' and the social sciences as 'trailing behind' in terms of 'rigor' (MacMynowski, 2007), one of the paper's authors noted that social scientists were often 'brought in' to do 'impact work' and 'seen as (merely) supporting the seemingly more rigorous and central biophysical scientific work'. In recognition of the potential significance of how 'different types of knowledge' are 'positioned toward one another' (Felt et al, 2016: 738), this interdisciplinary collaboration sought to intentionally undermine such perceptions. The funding for the workshop and subsequent collaborations was led and facilitated by social scientist Naomi Millner's 'Drones in the Forest: Exploring the political ecologies of emerging environmental monitoring technologies in conflicted conservation areas (Colombia and Guatemala)' grant (SRG20\200574), one underpinned by the recognition that given the nature of drones and their social, ecological and socio-ecological promises and potential harms, a democratic interdisciplinary conversation was necessary. While recognising the multiple forms of negotiation and (re)prioritisation punctuating interdisciplinary collaboration (see, for example, Balmer et al, 2015), through both the discussion of such issues and the implementing of such (digital) techniques and practices, the collaboration pursued what one social science author described as a 'horizontal' rather than hierarchical process. As is explored further later, while different options were discussed regarding how our interdisciplinary collaboration might proceed (involving discussions of both desired audience and the pros and cons of different information formats), we opted to prioritise developing guidelines for conservation drone practitioners, with the aim of translating academic ideas to/for a practitioner audience and urging responsible and considerate drone use on the ground. Further, this collaborative process led us to identify particular actors (both human and non-human) that may be impacted by conservation drone use, as well as to discern particular themes (from privacy and noise disturbance to the importance of engaging local communities) that we felt were most pertinent to include in our briefing.

Alongside writing the policy briefing, the briefing's nine co-authors were approached and asked if they would like and/or had capacity to engage in a separate reflective process, leading the development of this policy and practice piece. The purpose of this process was to both document and reflect our own experiences of this interdisciplinary exchange, and share learnings from this wider impacted-oriented collaboration. Seven of the nine co-authors opted to participate, comprising three natural scientists (Andrew, Yves, Serge) and four social scientists (Anna, Naomi, Elizabeth, Jaime). As is represented in the paper's author contribution statement included at the end of the paper (utilising the CRediT taxonomy, https://credit.niso.org/), each co-author led on, undertook and/or held various roles and responsibilities. However, in seeking to best facilitate balanced and critical reflections

on the interdisciplinary exchange, the process of learning, and the development of a shared language that underpinned the policy briefing, each co-author participated in several core activities. These began with all co-authors individually responding to the following questions: (1) Describe a key moment where your understanding about drones changed, or you learnt something new; (2) Share any moments of surprise where you noticed that two people weren't talking about the same thing or weren't on the 'same page' about a particular issue; (3) Describe something that has been important for you to communicate to the group, from your disciplinary standpoint (for example, a particular issue, topic, theme or practice); and (4) Describe anything that stands out in your experience of interdisciplinary working, as we worked together on preparing the policy briefing, or on drones/drone ecologies more widely. These questions were designed to facilitate reflection on both the (process of) interdisciplinary dialogue and particular learning opportunities and tensions, to draw out in this article's analysis. While the writing of this piece was led by two social scientists (volunteers for the role), all co-authors contributed to the writing through both ongoing participation in team conversations, and commenting upon drafts of and revisions to the piece. The next section presents the key themes that emerged within this reflective exercise and process, sharing our emergent insights into both the *how* of doing interdisciplinarity, and the *what* of the content that came to drive our policy briefing.

Collaborative learning and moments of surprise

Several key themes emerged through our reflections on the policy-writing process. These included: a deepening in understanding of the relationships and relations that drones participate in; the challenges of creating a shared language across differences; and unresolved tensions. We unpack each with the aim of informing and prompting further discussion around interdisciplinary drone dialogues.

Deepening and problematising understandings

Our reflective exercise opened with a question urging group members to share a key moment where their understandings about drones changed, or they learnt something new. A central theme within the responses was a widening of the group's awareness of the drone's potential effects and harms on communities with attachments to areas of drone flight. Two group members with an ecological or environmental background recalled group discussions of Trishant Simlai's plenary talk at the *Drone Ecologies* workshop that demonstrated how conservation drones had been used as part of a deliberate system of surveillance and harassment of humans in forest communities in India. Reflecting on this, one group member explained that while they had not been aware of such issues within their own drone research, their understandings of the potential 'misuse of drones' by conservation practitioners and the potential 'psychological impacts on local communities' had shifted. Another group member described this case as deepening their understanding of the drone's potential to be appropriated for control, opening '[their] eyes to a set of risks they were only previously peripherally aware of'. They continued that they had since opted to 'terminate' a proposal they were working on due to concerns around the potential 'risk of misuse' of drones in a particular context. Similarly, another group member

recounted viewing a video of scientists testing their drones in southern Africa and paying renewed attention to the 'general fear of citizens' witnessing the 'drone coming towards them'. Such exchanges demonstrate the capacity of interdisciplinary dialogue to both deepen and problematise the ways in which we think about technological devices and their impacts.

A core aspect of collaborative communication lies in the 'creation of common ground' (Repko and Szostak, 2017: 447). In our case, Trishant's presentation emerged as such a ground, assisting with communication across different understandings and acting as a 'tool to help get people closer to a similar page' (group member). Alongside underscoring the idea that 'being made more legible is not always desirable' (Greenwood, 2020: 100), such discussions also widened perspectives in other ways. For example, some social scientists recalled unlearning 'simplistic' assumptions that 'drones would just be tools of dispossession and militarization'. In discussion of both how community-led drone mapping could lead to justice claims, and the embodied materiality of scientific drone use, existing understandings of the aerial view were, for some members, 'destabilised' and 'refreshed'. Governance was an important emergent theme here, with one group member asking: 'who do (conservation) governance structures benefit? How do existing governance structures facilitate the use of drones and for what ends? How might these governance structures need to be changed?' How might we imagine them otherwise?

Our group's discussions underscored the drone's 'ambiguity', one enabling different dispositions and capacities, and whose 'political function is not yet fully decided' (Millner, 2020: 2). In this vein, some group members with an ecological or environmental background described being struck by learning of the close connections that can exist between the military, industry and conservation groups, while some social scientists recalled instead learning of the diverse impacts of drones upon non-humans and the 'strong emphasis' on care in seeking to minimise these disturbances. These discussions linked back to a central theme that emerged in the *Drone Ecologies* workshop, namely the importance of decentring the drone itself and turning attention to the wider 'networks, assemblages, and ecosystems' (Amador et al, 2021) of which it is both a part and impacts.

The challenge of creating a shared language

While designed to share and 'adjust' diverse expertise 'to serve a common goal' (Raento, 2020: 357), achieving interdisciplinarity is not necessarily straightforward. In this vein, through our processes, several areas of 'friction' emerged where we either could not agree, or found we were not all speaking about the same thing. Following the idea that conflict is not simply an 'inconvenience' but rather an 'inevitable and central interdisciplinary enterprise' (Repko and Szostak, 2017: 416), we were interested in the insights emerging in these frictions.

A central source of conflict was the differential use and interpretation of language across the group. After all, language remains central to how a research issue may be defined and how the questions we ask of it may be 'framed' (Bracken and Oughton, 2006: 375), recognising that disciplinary language can be understood as a 'tacit process' through which academics 'demarcate their field of expertise or knowledge' (Purvis et al, 2023). One group member gave the example of the phrase 'types of data' captured with drones, explaining how they felt confused until they realised that

someone was referring to 'data on different issues of concern (e.g., fires, logging)', rather than 'data types (i.e. imagery or sensor data types)', as they had typically used and understood the term. Another group member highlighted the word 'surveillance' as an example of where language use diverged: where social science colleagues focused on the political and privacy dimensions and implications of the drone's overwatch, ecology and environmental colleagues focused on the 'ecological/biophysical sense of the term, indicating to look and gather data systematically'. They added that while an interesting difference, it remained 'hard to communicate' across this 'linguistic issue'.

Nevertheless, one of the results of the collaborative process was the collective forging of the articulations of concerns surrounding drone use, and a shared sense of ways to mitigate these challenges. Enacting a 'technology of entanglement' (Felt et al, 2016: 734), we paused to unpack and study 'each other's language' (Schoenberger, 2001: 366). We saw these differences in perspective not as 'roadblocks' but as opportunities for discussion (Kelly et al, 2019: 152) and sought to acknowledge that, while valuable, at times our communications remained 'partial' and 'inexact' (Schoenberger, 2001: 366). While by no means straightforward, there was a shared feeling of satisfaction in this process, as comment boxes were resolved, recommendations reached consensus and everyone contributed expertise and reflections to the final briefing (available here). Having time and (virtual) space to share introductions and experiences, and to iteratively build on and up conversations, was vital in this process, as already discussed. Utilising measures such as choosing writing colours to ensure the visibility of different contributions and using comment boxes to raise questions and support particular contributions, aimed at once to value all voices and to pursue 'compromise' in and through its constituent parts, namely 'mise' (putting), 'pro' (forward) and 'com' (together) or 'a putting forward together' (Michael, 2018: 279), in order to evolve a language that reflected everyone's experiences and insights.

Unresolved tensions

While we put in place a range of tools and tactics that enabled concrete interdisciplinary achievements, there nonetheless remained instances where the group was 'not on the same page' – not understanding each other and not agreeing on an issue. For example, one group member described an 'as yet unresolved tension' between 'the value in linking real world perceptions of drone use in conservation activities with military use'. They continued that while they recognise the importance of discussing 'these connections' when discussing the drone's 'historical origins', they felt that for 'many operators, operations and applications, these links are tangential and not part of the experience in any tangible way'. Conversely, social science colleagues repeated concerns around, with and through questions of political economy and militarisation. Such tensions, visible in lengthy comment exchanges on shared documents, highlight both the ongoing nature of interdisciplinary discussion, and the challenges around (ongoing) consensus-building. That said, the aim of our exchange and collaboration was not to relinquish or erase these differences. Rather, it was about learning and coming together to find balance in our approaches and languages, to represent a variety of concerns and insights within (and beyond) the formation of the research and experience-led policy briefing (available here).

Writing the policy briefing

When it came to progressing plans for the policy brief, the question of *who was at the centre of our accounts of the drone* came to the fore. Here, discussions spanned the diverse ways drones were used (how and by whom), as well as how drone use across diverse contexts might differently impact the communities and wildlife below. Group members highlighted both the potential risks of drone use in areas inhabited by, or of cultural significance to, rural communities and Indigenous groups, and the importance of considering and consulting local people in the capture and ownership of drone data. Further, they stressed that potential conservation drone harms were not confined to humans. As such, in informing our briefing we reviewed a growing body of research detailing the effects – both behavioural and psychological – of drones on wildlife, that which varies by species, drone type and flight pattern, as well as flight environment or context (see for example Mulero-Pázmány et al, 2017). Throughout our discussions, a range of themes cross-cutting these actors emerged, from access, power and empowerment; data capture, ownership and security; reactions and responses to drones, to inclusion and decision making. In developing the policy briefing we reflected across these conversations to identify both particular actors (human communities and wildlife) and key recommendations at different temporalities (before you fly, during flight and after your flight). We also wanted to make them inclusive of a range of practices through which to operate drones responsibly, ethically and considerately (for example, around visibility, communication and collaboration; data capture, ownership and decision making; safety and awareness of the potential impacts of drone flight), those which acted as scaffolds to structure the final briefing (available here).

Lastly, while the policy briefing is a predominantly textual document, the group recognised the importance of visual forms of information (Lukinbeal, 2014). Given both the proportion of 'human communication that is non-verbal', and that many 'process visual information faster than textual information', those undertaking policy-relevant research are increasingly urged to 'consider the use of visuals' (Pearson and Dare, 2016). As a core aim of our interdisciplinary collaboration was to translate and communicate our and wider research into responsible and considerate guidelines, we embraced visual materials as at once accessible forms of communication in the wider 'construction of knowledges' (Rose, 2003: 212), and materials that can facilitate the 'empowerment of voices and peoples' (Tolia-Kelly, 2012: 138). The discussion of the development of visuals formed an important aspect of the project's wider interdisciplinary dialogue. For example, group members described the stereotypical presentation of the drone operator as a Western, White male. As such, in developing visual materials for the policy briefing we were eager to reflect the gender, ethnic and contextual diversity of drone operators and operating environments, with images in our briefing depicting drone flights, operators and wildlife in Africa, Indonesian Borneo and Latin America. In reflecting upon the 'politics of visual media' (Tolia-Kelly, 2012: 138), the group was eager to develop visual materials that both rescript commonplace depictions of drone operators and operational contexts, and to also encourage best practice in its revised depictions. Figure 1 depicts a female drone operator demonstrating their drone to local communities in the area of flight, prior to drone operations taking place.

Figure 1 also features different facial expressions and responses to drones, a design decision linking back to the group's own discussion and learning in this area, as

Figure 1: Demonstrating drones and engaging with communities before you fly drone operations.

Credit: Komarudin

Figure 2: Drones can elicit a range of responses.

Credit: Komarudin

discussed earlier. In this vein, the group were also eager to highlight that alongside eliciting multiple psychological, physiological and emotional responses from humans, so too could drones differently impact wildlife.

The development of Figure 2 echoed the group's recognition of the potential for drones to cause a range of reactions and responses in humans and non-humans alike, with the aim of prompting and urging practitioners to follow the policy briefing guidelines around consulting local communities and adopting considerate flight practice (for example, through considering proximity to wildlife, direction and pattern of flight, and the potential impacts of drone noise on different species).

Policy and practice

As we have seen across this special collection, drones are increasingly trialled and embraced as data-gathering tools in a growing range of activities. To this end, our group identified and engaged with a range of existing literatures, energies and actions in the area of responsible and considerate (conservation) drone use. Contributions of note that variously informed our own discussions included both organisation-led guidelines and academic-outlined best practice. For example, organisations such as the global Humanitarian UAV network 'UAViators' have developed 'best practice' drone guidelines (UAViators, n.d.). Available as an open Google Doc wherein users can propose suggestions to amend or extend the content, this online handbook 'informs the safe, responsible and effective use of civilian' drones in 'humanitarian settings' (UAViators, n.d.). While focused specifically on humanitarian settings, the handbook valuably provides both the opportunity for geographically and culturally diverse input, and 'an operational checklist divided into Pre-flight, In-flight and Post-flight sections' (UAViators, n.d. : 1), each of which acted to inspire our group's own dialogue and discussion of the responsible and considerate conservation drone use across different contexts and temporalities.

We also drew inspiration from scientific and social science best practice guidance. This included Crouch and Chandler's (2021) lengthy guidance on the use of drones for 'peatland monitoring and conservation', which highlights both preparatory considerations (for example, regulations, pilot experience, preflight surveys) and practical questions of process, inclusive of data considerations (for example, data privacy, storage and processing), as well as Hodgson and Koh's (2016: R405) best practice guidance around the use of drones 'in the vicinity of animals or for the purpose of animal research'. Hodgson and Koh (2016: R405) draw on wider 'guidelines for ensuring the ethical treatment of animals in research' with the aim of developing principles, such as a consideration of equipment selection and pursuing minimum disturbance, to mitigate the potential risks drones pose. In addition, social science–led guidance was informative. For example, Sandbrook et al's (2021: 1) guidelines urge the foregrounding of 'ethical questions' surrounding the use of 'conservation surveillance technologies' including drones (for example, spanning their 'social impacts', 'necessity and proportionality', potential impacts on people, and the importance of data protection). Further, premised around the 'co-development of protocols to guide Indigenous-led innovation', Macdonald et al (2021: 300, 301) assert the importance of recognising and inclusively engaging 'Indigenous ethics and stewardship' in the deployment of drones in the production of 'new knowledge to adaptively co-manage Indigenous people's lands and seas'. The authors develop a series

of protocols, including empowering Indigenous governance, developing ethical and trusted research relationships, and enabling ongoing Indigenous-led technological innovation (Macdonald et al, 2021: 306–10). Importantly, our interdisciplinary collaboration encouraged us to read across different guidelines, and to reflect on their presences, absences and tensions in between.

As a group we also reflected on such existing guidance in relation to our own best practice around considerate and responsible flight, drawing on our diverse research contexts and experiences to discuss wide-ranging practical, applied, ethical and political concerns. Yet, while existing literature and guidance proved variously inspiring, so too did our group's dialogue both differ from and extend such work in important ways. It remains that contributions in the area of responsible and considerate (conservation) drone use largely do not extend beyond and across particular disciplinary domains. As this piece has demonstrated, our group's interdisciplinary dialogue brought together varied expertise, approaches and work in different geographical, operational and cultural contexts. This coming together facilitated a deeper and more multifaceted understanding of the potential utilities, disruptions and harms accompanying drones in conservation contexts. As we have already discussed, this interdisciplinary dialogue at once pushed each of us outside our disciplinary comfort zones and was essential in stimulating critical thinking, reflection and learning. Social scientists urged a widening of conversations around ethics, politics and governance, while natural scientists urged social scientists concerned with problematising towards more practical mitigations and solutions. This development of constructive yet critical dialogue is valuable, as Paneque-Gálvez et al (2022: 665) demonstrate, because the use of drones cannot be separated from social and political questions of equity and governance (for example, land rights) more widely. In and through these conversations we collectively developed distinct and holistic recommendations at once exceeding and extending disciplinary conversations and specifically designed and authored for a practitioner audience, meaning that its content is succinct, stepped and accessible for wider presentation, with the aim of reaching a wider audience and being of direct use in the field and beyond.

Conclusion

This intervention has reflected on the process of collaboratively developing a briefing on responsible drone use for conservation practitioners (accessible here). The development of the guidelines both responded to calls for further work across diverse disciplines and contexts to explore the 'operational and analytical' challenges surrounding conservation drone use (López and Mulero-Pázmány, 2019: 1), and recognised the need for conservation practitioners to develop and employ 'best practice' (Markowitz et al, 2017: 384), particularly when working in territories inhabited by Indigenous and other local communities (Vargas-Ramírez and Paneque-Gálvez, 2019).

Building upon the exchanges of the Drone Ecologies workshop and the group development of the conservation drone guidelines, this intervention has synthesised learnings from this collaborative process. We have asserted the value of the development of interdisciplinary networks, those which can 'illuminate' different perspectives around potential drone 'damages or disturbances' (Amador et al, 2021). We have highlighted moments and increments of learning, and shared details of the

process we pursued to enable and enact this. While cognisant of the consideration that went into the coordination of meetings and communications, we also recognised the challenges encountered. These included making and maintaining meaningful time for exchange, and learning and deploying techniques designed to develop 'shared vocabularies and understandings' (Bracken and Oughton, 2006: 371). Research on interdisciplinary practice centrally stresses the challenges of sharing and untangling our 'own, nuanced vocabularies' in collaborative settings, wherein even 'one word can mean different things to different people' (Raento, 2020: 363).

In recognition that collaborative working is iterative, we close our intervention by outlining several potential next steps. We would first like to dedicate further time to discuss the 'how' of interdisciplinary research, that is, both how we can be better 'understood' (Lury, 2018: 2) and how we can work collaboratively to share, learn and forge new common languages (Kelly et al, 2019). This involves further attention to the practices of interdisciplinary working, and the ways in which we might 'map each author's insights' (Repko and Szostak, 2017: 419) as well as relations and divergences between them. One option might be to undertake work in more defined phases, beginning with a conservation drone case study/application (shared familiarity), followed by collectively formulating key questions and concerns we feel this instance raises and prompts (with space for different approaches, while seeking compromise across these), and ending by collaboratively mapping our responses, with the aim of developing a shared vocabulary and viewpoint.

This approach might also be extended to dedicate further attention to different drone temporalities and phases. For example, much existing drone research foregrounds the drone as it flies, focusing attention to capabilities and implications alike (Klauser and Pedrozo, 2015). However, as Fish and Richardson (2022: 18) remind us, across the drone's 'diverse applications', its core 'operation is the generation of data for effective action'. While attention to the (implications of the) drone in flight remains critical, as group members observed, less attention is paid to the aftermath of the drone's flight and to the (ethics of the) processes and practices of managing 'the massive volume of data' that drones collect (López and Mulero-Pázmány, 2019: 10). Concerns with data storage and post hoc uses are echoed in recent discussions of 'data sovereignty' in the context of 'Indigenous data governance' (Walter and Suina, 2019: 237). Herein, in 'asserting Indigenous interests in relation to data', questions are raised about the role of 'Indigenous decision-making across the data ecosystem', from data 'conception' to capture, and 'control of access' to the 'usage of data' (Walter and Suina, 2019: 237). In this vein, the group might productively reflect further on issues, at once practical and political, at the intersection of drone users, drone data and processing, and data analysis.

CRediT taxonomy: https://credit.niso.org/
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Conflict of interest
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