Page 307 - 327 **DOI:** *https://doij.org/10.10000/IJLMH.117520*

INTERNATIONAL JOURNAL OF LAW MANAGEMENT & HUMANITIES

[ISSN 2581-5369]

Volume 7 | Issue 3

2024

Drone Surveillance in Protecting Endangered Species: Regulatory Challenges and Opportunities in India

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ABSTRACT

The use of drone technology is a turning point for novel and improved methods of wildlife conservation in India. This article examines the multi-faceted roles that drones play in wildlife monitoring and conservation, and the potential for adoption of drones in augmenting current efforts. The article begins by providing an overview of the legal regime surrounding drone use in India by examining the Civil Aviation Requirements for Remotely Piloted Aircraft Systems, 2021 and other Acts protecting wild animals. It then confronts the legal and operational barriers to their use. Further, the article casts a glance back, by explaining how and why drones have been used in conservation. Case studies, illustrating the use of drone technology for Project Tiger and for conservation of elephants (examining cases of poaching using drones and use of drones for real-time monitoring and surveillance) set the pace for technological advancement. The article also considers how predictive analytics and artificial intelligence can aid in aligning conservation efforts with the real world and in engaging local communities who share their territory with rare and protected wildlife. Finally, through case studies, the article envisions public-private partnerships for wildlife conservation and leading strategies for the effective organisation of elected representatives. The article concludes by providing concrete policy recommendations to improve legal frameworks and to create standard operating procedures necessary for wildlife conservation through technologies like drones.

Keywords: *Drone Technology, Wildlife Conservation, Endangered Species, Anti-Poaching Initiatives, India.*

I. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), or drones, have become a powerful tool in the effort to conserve some of the planet's most endangered species. Fitted with thermographic cameras and high-resolution lenses, drones penetrate deep into inaccessible landscapes, giving conservationists near real-time access to information they could never have gathered otherwise.

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But beyond documenting wildlife and habitats, drones are being used for much more than mere sightseeing: they also analyse populations of animals, help map habitats, aid anti-poaching missions, and even directly intervene by delivering aid packages to hard-to-reach areas.

Drones have rapidly become an essential tool in the conservation arsenal: fitted with cameras, a UAV can be set to follow a pre-programmed flight path over a national park or wildlife preserve, automatically collecting images and videos to monitor movements and health of endangered species, even where access by human beings is difficult or downright dangerous to undertake, either because of challenging terrain or because the area is home to threatening species.

Additionally, because drones can collect data over time, they should be able to track how wildlife populations and habitats change through time. Tracking changes overtime in the population of an endangered species and in its habitats would be useful for understanding the effects of changes in the environment, human incursions or climate change on animals and their habitats. Thus, drone-collected data can play a role not only in monitoring wildlife's and protecting them from poachers and other dangers, but could plausibly also be used to answer empirical questions about how animals respond to human encroachment, helping advance our conservation efforts.

II. SIGNIFICANCE AND POTENTIAL IMPACT ON ENDANGERED SPECIES IN INDIA

These species range from the Himalayan ranges to the coast of the Indian Ocean. They include as many as 90 per cent of species that are endangered or critically endangered. India's conservation challenges are massive, beginning with iconic species such as the Bengal Tiger, Asian Elephant, One-horned Rhinoceros and the Snow Leopard. All of them require technical solutions but mostly, they need to be protected from habitat loss, poaching and conflict with humans. It is this last requirement where drone technology can truly make an impact.

Drones could substantially transform the ability of conservationists to monitor India's threatened species. Firstly, they could provide an added layer of oversight to the work of wildlife authorities on the ground. Real-time monitoring through UAVs would help quickly identify poachers and take action against them. Drones can now be fitted with night-vision cameras, which could identify poaching activity at night — the preferred time of poachers.

Second, they can help us to study and protect habitats by mapping ground cover and changes in land use and sometimes the creep of human settlement into protected areas. This detailed habitat analysis allows us to see how endangered species 'need' space.

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More importantly, drones can also be used for the direct protection of wildlife. Vaccines or medications can be delivered to animals in otherwise inaccessible areas; health conditions can be monitored; and if necessary, predators or threatening humans can be deterred in a non-lethal way. The ability of drones to intervene directly in the lives of threatened animals speaks to what's truly novel about the application of drone technology to conservation.

Yet, there are a few regulatory, privacy public-acceptability, ethical, and technical hurdles to overcome in using drones for the protection of endangered species in India. Still, the potential benefits of drones for biodiversity conservation in the country are immense. As India establishes the judicial and legal regime for the governance of aero-technologies including drones and symbolizes its commitment to a human priority for aerial mobility, a new horizon for effective conservation of threatened species is clearly on the path.

(A) Technological Overview

The basic pinpointing idea goes back approximately to the start of the 20th century, beginning as mainly military technology, with the earliest drone models a type of target practice remote-controlled plane. But the use of remote unmanned aerial surveillance didn't really catch on until the Vietnam War, with the US military utilizing drones for reconnaissance. Only since the 1990s, with the advancement of the technologies of electronics, computing and imaging, has the technology developed rapidly and become more dual-use, with commercial and military applications in mind.

This democratization owes its origins to the miniaturization, dropping costs and advanced navigation systems of the 21st century, such as GPS. Drones are now used in a wide range of fields today, from agriculture and mapping to real estate and filmmaking. And increasingly, wildlife conservation is among the most important aspects of their use. Using technology which evolves from hulking, expensive and difficult to operate systems to lighter, easier and cheaper ones can empower conservationists in India and around the world to perform many of the most important tasks of environmental monitoring and protection.

(B) Types of Drones Used in Wildlife Conservation

Selection of drone type for wildlife conservation missions will be guided by the monitoring tasks involved, the habitat and terrain of the conservation protected area, as well as specific mission requirements. Broadly, they can be divided into UAVs with fixed-wing designs, multi-rotor drones and hybrid systems:

- Fixed-Wing Drones: resemble normal airplanes, and are valued for their long range and wide area coverage. They're especially well-suited for habitat mapping, landscape

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surveys and wildlife censuses of wide national parks or reserves; also, for routine patrols against poaching activities. Because they fly more efficiently than helicopters, they lend themselves to long missions. However, because they need a runway or launcher, they have to be deployed with one.

- Multi-Rotor Drones: The most common type of UAVs used in conservation is a multi-rotor drone such as a quadcopter. This type of aerial device is capable of hovering, vertical takeoff and landing, and of flying at low levels in a confined space, making it easily applicable for detailed wildlife monitoring, particularly in dense forests and other habitats or rugged land where a fixed-wing drone cannot fly. These are paired with high-resolution cameras and thermal sensors to take detailed images of wildlife and their habitats more than 20 times a day.
- Hybrid Systems: Hybrid drones combine the range and speed of a fixed-wing model with the redundancy and vertical takeoff and landing capabilities of a multi-rotor model. Hybrid systems are less common than the others because of their complexity and higher cost, but are beginning to be used for conservation tasks that require both extensive range and precision control.

(C) Advancements in Drone Technology Relevant to Conservation Efforts

The rapid technological progress in drone technology has added several more boxes to a conservationists' wish list, such as:

Enhanced imageability: equipped with high-resolution cameras, infra-red technology and night vision gauges, most drones are able to detect and record wildlife visibility in low light or in permanent darkness. As a result, conservationists can monitor the movements of wildlife and poachers, and feed into reducing the poaching of threatened species.

Artificial intelligence and machine learning: AI and machine learning algorithms are now incorporated into the systems of drones in order to expedite the analysis of the copious amounts of data that are collected. Using these technologies, individual species of animals can be detected, herd size can be estimated, and habitat conditions can be assessed. In concert with automation, this leads to reduced time and labor in terms of data analysis; in effect, on-site decision-making can take place during drone flights.

Greater endurance and range: better battery capacity, plus slicker airframes and more fine-tuned aerodynamics, translate into drones that can fly farther and for longer periods of time, which is important when dealing with large or hard-to-reach conservation landscapes where ground-

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based survey sessions are simply not feasible.

Remote Sensing and Geospatial Analysis: Drones equipped with remote sensing cameras that image in the visible, infrared, thermal and ultraviolet (UV) spectrums can collect data to enable detailed, geospatial analysis of habitats – an important ingredient for an understanding of the dynamics of an ecosystem; it also helps to inform our assessment of human impacts on wildlife, and net weave detailed mitigation strategies for conservation.

These devices' integration into drone hardware has enabled real-time, groundbreaking insights into endangered species and their habitat and, with drones, vast, inaccessible areas of land and those inhabiting them can be monitored in high-resolution detail – and these areas would have otherwise remained unprotected. As India is as diverse in the ways in which it degrades its environment as in its ecology, the targeted application of drone technology has the potential to contribute to species preservation in the country if the regulatory norms allow the humane and proper utilization of such tooling.

III. LEGISLATIVE FRAMEWORK GOVERNING DRONES IN INDIA

(A) Civil Aviation Requirements (CAR) for Remotely Piloted Aircraft Systems

Given that the number of drones being used for various activities, including in wildlife conservation, is increasing rapidly, the Directorate General of Civil Aviation (DGCA) issued CAR (civil aviation requirement) for Remotely Piloted Aircraft System (RPAS) in 2018 which is the legal framework for the use of drones for various purposes across India in the Indian airspace ensuring safety, security and international norms and standards.

It outlines the operational requirements, certification and maintenance approach for RPAS, compartmentalizes drones per their weight and operational class for operations conducted by this category of drones, and provides conservation access upon the receipt of the requisite approvals from the competent authority. For conservation, the CAR provides some salient provisions specifically on nature-centric uses of drones. First, when used in proximity to sensitive noise zones like in the vicinity of an airport or an international border, and also access for approvals like the UAOP, and other clearances that are conditional upon specific operations of RPAS.

Key provisions under the CAR relevant to conservation efforts include:

- No Permission-No Takeoff (NPNT): all drones must obey the NPNT protocol, allowing the regulatory body to track and monitor that flights are mapped. Without NPNT, wildlife conservation drones will likely not be used Near to wildlife. This NPNT process

will be critical to ensuring that wildlife conservation drones will not interfere with other airspace users and with larger planes, as well as flight areas that are not suitable for drone flights.

- Geo-fencing: The CAR requires drones to be equipped with geo-fencing technology that prevents drones from entering prohibited zones. For conservation drones, this would ensure that their flight doesn't unintentionally trespass into a military zone such as a no-fly area, or an international border that forms the edge of a wildlife reserve.
- Maximum height and Distance limits: the limit for height and distance depends upon the category of the drone. Conservation drones may be granted exemption from maximum height and distance limits by DGCA with the purpose of panoramic wildlife surveillance and monitoring.
- Insurance: Any drone deployment for wildlife conservation must carry insurance to cover the cost of third-party damage, in line with the principle of safety and liability enforced in the CAR.

The CAR framework has a wide ambit, but it makes exceptions when drone use could play a crucial role. The DGCA can offer such exceptions in the case of conservation, including wildlife conservation, where drones can be useful in detecting poachers and monitoring endangered wild animals and their habitats. These kinds of conservation-related drone operations require special permissions from the DGCA.

(B) The Wildlife (Protection) Act, 1972: Relevance to Drone Surveillance

The Wildlife (Protection) Act, 1972, is foundational to India's environmental legislation on wildlife, and 'to ensure preservation of wildlife including its habitat'. The Act prohibits the hunting, poaching and trading of wildlife, and establishes a legal mechanism for the creation and management of protected areas (PAs) such as national parks and wildlife sanctuaries, as well as conservation reserves.

In relation to drone surveillance, no specific mention is made in the Act about UAVs. But several of its related mandates prescribe conditions for activity within wildlife habitats. These typically require permissions for certain kinds of activities by requiring clearances from the appropriate forest and wildlife authorities, and could well apply to drone operations for monitoring and conservation.

Typically, when a drone operator applies for permission to fly within a protected area, authorities will deliberate based on the potential effects on the wildlife and habitats within:

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- Disturbances to Wildlife: Potential impacts from drone flights, such as noise or disruptions to animal behaviour, is one of the more prominent considerations. Applications for drone use must outline how such impacts can be mitigated.
- Conflicts of Interest: Permissions can be tricky but can be far easier than you might think where the intended use for drones is directly linked to conservation in a way that important numbers of people can see. Examples might include supporting anti-poaching efforts, the measurement of habitat extent or shape, or monitoring rare species. Proposals need to include a Specific Statement of Aims and Methods and Results Expected.
- Privacy and security: Any drone use must be done in a manner that is compatible with privacy and security protocols – surveillance for protection should not encroach upon the rights of people living in or near the areas that they are protecting.

This tension between the CAR and the Wildlife (Protection) Act, 1972 is the simultaneous obligation to create aviation safety norms and to protect wildlife habitats. While the DGCA regulates the technical and safety requirements of drone operations, the permissions and restrictions under the Wildlife (Protection) Act make sure that drone operations are also aligned with conservation efforts where these species occur. The CAR is the starting point of the conservation arm of the cascade: a critical first step to protect some of the most endangered species in the country, while ensuring they are not harmed as collateral damage.

Conservation missions, including the use of drones for the protection of endangered species in India, are framed by environmental legislation. Two important legislations, the Forest Conservation Act (FCA), 1980, and the Environmental Protection Act (EPA), 1986, form the legal context within which drone use in conservation is being carried out. These acts not only define the scope of what is allowed and what is prohibited in forest areas and ecologically-sensitive areas, they also implicitly inform the use of drones for conservation purposes.

(C) The Forest Conservation Act, 1980

This act is referred to as Forest Conservation Act, 1980 and it was passed for the 'Conservation of Forests and regulation of De-reservation of Forests and for matters connected therewith'. The FCA prohibits the conversion and diversion of forest areas, which needs prior permission of the Central Government prior to using a forest area for any purpose other than a forest (Note that Navi Mumbai falls under the Central Government). Unlike the Forest Act, the FCA relates to conversion of forest lands, but at the same time, it sheds lights on drone application in forest conservation.

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Implications for Drone Use in Forest Conservation Efforts

Permissions required: Since the Act specifies that no person shall, unless granted permission, endeavor to 'enter upon or take away or damage any wood, timber for the purposes of sale or for any other commercial purpose' from forest land, drone-assisted surveillance for conservation purposes from, in, or on any forest land likely to involve the Central Government or its agency are required to be permitted. This is especially so in large-scale forays such as assessment of forest health, illegal logging or wildlife censuses.

However, drones have the potential to offer key information needed to achieve the aims of the FCA Sequencing the genome of crested guiro: a tree that could play a role in tropical ecosystem recovery Drone data can support the FCA's objectives by monitoring forest cover change from year-to-year, tracking reforestation projects and measuring the effects of different conservation policies. Any of these uses would serve the Act's aims to preserve the forest ecosystems – if they are done without damaging the environment.

Regulatory Compliance: The FCA regulatory framework applies to drone operations conducted in or over forest areas. Thus, flights must remain 'without harm to people or our environment' by avoiding contributing to deforestation and not interfering with the natural behaviour of wildlife. Drones cannot disturb ecosystems. Flight plans and equipment must be adapted in real time to the ecological sensitivity of the area with the objective of preventing 'an adverse impact from the operation (drone) on the environment', including wildlife, soils and vegetation.

(D) The Environmental Protection Act, 1986

This is a well-designed act for the conservation of environment.it entitles the central government to take all proper measures for the protection of environment and can provide the standard of emissions and effluent ;must determines the location of the industries; management and control of houmous materials.

How Environmental Legislation Affects Drone Operations

Regulatory Oversight: The Environmental Protection Agency (EPA) provides a general framework for environmental protection, and drone operations for conservation must take place within this framework. It might be inferred from the text that any drone use that could potentially negatively affect the environment – either directly by disturbance or indirectly by the collected data leading to policy decisions – must be carefully managed. Drones used in conservation must align with general directives that strive to minimize ecological disturbance.

- Environmental Impact Assessments (EIAs): For drone projects that are part of a broader

conservation or development initiative that can trigger an EIA under the EPA, the use of drones must also be evaluated for its potential environmental impact and the observations captured with the drone must form part of a broader EIA screening and assessment.

- New Opportunities for Environmental Governance: Because the EPA statute requires the agency to use 'all practicable measures' for environmental protection, using drones would create new opportunities to apply these innovative technologies to environmental management, monitoring, inspection, or enforcement. A use of drones by the EPA might allow organisations to collect more precise data in greater frequency than is currently possible, by automating the collection and analysis of that data with less human involvement. This is precisely what the EPA is mandated to do.

IV. CASE STUDIES: DRONES IN ACTION FOR WILDLIFE CONSERVATION

(A) Project Tiger

India's commitment to saving the Bengal tiger has led to a highly successful wildlife conservation programme: Project Tiger, launched in 1973 by the Government of India, is now one of the most successful schemes of its kind in the world, increasing the tiger population within India. Expanding Project Tiger's role to include drones is a further synergy between conservation and technology.

Use of Drones for Monitoring Tiger Populations and Habitats

Improved Surveillance and Patrolling: Unmanned aerial vehicles are helping conservationists working inside Project Tiger to increase their surveillance and patrolling capabilities. The drones fitted with high-definition cameras and thermal image sensors are giving bird's-eye views of the forested areas and rugged terrain where tigers roam. Such an aerial perspective has the potential to keep track of tiger movements, poaching activities, and the integrity of tiger habitats.

Data capturing and mapping: Obviously, drones surveil. But droning had a much wider role in the conservation of tigers than just catching them on film. The images and video captured by the drones also allowed for the collection of huge amounts of data on tiger numbers, migration and wider habitat use – all crucial for scientific analyses needed to inform decisions in conservation, so that the way the tigers were being managed could switch strategy when an emerging threat was identified, or the tigers changed their behaviour.

Habitat Mapping and Conservation: It was also used to map the habitat within the PT reserves.

Mosaics were created using images taken by the drone. Each PT reserve is flown over, and the images produced are amalgamated together to create a mosaic that has a high level of detail showing the area covered by the reserve. This mapping includes coding of features such as forest cover and distribution of water bodies and other sources of water, along with any other human-related disturbances that might be witnessed in the habitat of tigers. The purpose behind habitat mapping is to aid the conservation of tigers because it outlines the kind of resources that tigers need and helps provide them with the necessities required for their existence.

The Complexity of Compliance: Deployment of drones in Project Tiger would have been commendable in its own way but would not have been that easy. It would have needed to be in compliance with existing regulatory orders. Civil Aviation Requirements (CAR) No 21 Section 3 of the Draft CAR for Remotely Piloted Aircraft Systems issued by the Directorate General of Civil Aviation (DGCA) stated that to fly a drone for any purpose in the protected areas as per the Wildlife (Protection) Act, 1972, a permission would be required from and records from drone operations have to be furnished to the following authorities:

1) The Chief Wildlife Warden, Government of the concerned States,
2) The Director, Project Tiger, Ministry of Environment, Forest and Climate Change, and
3) The Chief Warden of Reserve Forest, Sanctuary and National Park of concerned States.

Conservationists could have to work beyond written orders to ensure that the drone activity does not affect the sanctity of protected areas, which is essential to carry on the conservation effort. Project Tiger should consider the technical challenges to conservation. With limited availability of drone battery that could keep them in the air for 30 minutes; possibility of the landing of the drone crashing given difficult terrain and lack of aviation experience of drone operators are some of its challenges.

Now then, what's in store for the future – and what's potentially possible? The possibilities include developing more targeted conservation plans, and thus saving more lives, both wild (and more cows on fures). Drones can also help better target the efficient use of conservation funds. As drone technology improves – with better battery life, higher resolutions and more powerful software for data analysis – so too will the possibilities for their use, both for Project Tiger and beyond.

(B) Elephant Conservation Efforts

It is no wonder that elephants, being revered as Ganesha (the Hindu god with the head of an elephant), capture so many conservationists' imaginations: elephants are endangered

throughout India by habitat loss, human-elephant conflict and intense poaching for meat and body parts. Wildlife-viewing parks, once havens for elephants alongside other wild animals, are now faced with severe cryptic habitat loss that threatens elephants throughout their range. In response to these pressing threats, drones have become indispensable to monitoring elephant movements and preventing human-elephant conflict.

(C) Drones for Tracking and Managing Human-Elephant Conflicts

Real-time monitoring and tracking: Using off-the-shelf unmanned aerial vehicles (UAVs), also known as drones, with built-in high-resolution cameras and thermal imagery, it is easy to track the movements of elephant herds in real time, particularly in forested terrains and areas where people frequently move around and where it is difficult to undertake elephant tracking. Once the movements of elephant herds are identified, it is easy to pre-empt conflict prone areas where conflict mitigation is projected ahead of time.

- Conflict Mitigation: Conserve drones also aid in developing and implementing effective conflict mitigation strategies. One of the key ways is by offering an aerial perspective to document important elephant corridors and water sources, as well as, document increases in habitat fragmentation. This information is vital to plan human activities away from elephant movements to further help reduce conflict. In addition to identifying such movements, drones can be used to deploy deterrents such as noise or light to gently guide elephants away from villages without causing physical harm.
- Implementation problems: Conservation applications using drones has its own set of problems. Approval process for launching a flying machine in protected areas is not a simple one, especially when we are talking about flying drones as per the CAR rule and the regulations introduced under the Wildlife (Protection) Act, 1972. Drone flights itself disturbs the wildlife and the noise created during the flight is likely to trigger responses that warrants creating a protocol of the launch and the period for which it will remain air-born to minimize the impact.

(D) Anti-Poaching Initiatives

The blood hold of dinner plates such as rhino, elephants, and deer on to poachers is a major pressure point for biodiversity. Adding high-tech vigilance with the use of drones is just one-way anti-poaching patrols are being heightened to cover vast, inaccessible territories.

Success Stories and Challenges

- Drone surveillance and rapid response: Drones fitted with infra-red and thermal imaging

cameras have also been used in anti-poaching operations. The fact that the entire protected area can now be monitored 24 hours a day helps to deter poachers, while wildlife officials can be directed to the exact location of poachers within minutes after detection by drones. The apprehension of only a few poachers will disrupt entire poaching networks.

- Intelligence Gathering: Drones are collecting aerial intelligence Data isn't being gathered by drones to be used only in real time. Post-collection analysis can reveal important information about poaching patterns, preferred poacher entry points, and hotspots for illegal activities. This intelligence is then used to pre-empt poaching attempts by enhancing conservation strategies.
- Operational and regulatory challenges: Now that drones have started to be deployed in the anti-poaching context, they're facing a series of operational challenges, such as technical issues concerning battery life, limited range and need for specialized training among operators; as well as regulatory challenges, such as permitting the deployment of drones in protected areas (especially when it comes to sensitive areas), as well as issues of respecting privacy and ethical boundaries, ensuring that drones are operating without interfering in the natural behaviour of wildlife or infringing on the rights of local communities.

V. REGULATORY CHALLENGES

Drones have a bright future for wildlife protection in India — but it's not without its regulatory hurdles – privacy issues with drones are being watched closely as are bigger surveillance questions. Like all surveillance tools, drones need to proceed carefully in conservation research and surveillance – both for wildlife and for those tracking lawbreakers. Drones used for wildlife conservation have the capacity to carry high-resolution cameras and sensors that can collect detailed information on large areas. Obviously, if done indiscriminately, such observations can easily lead to an invasion of privacy.

(A) Privacy and Surveillance Concerns

- Invasion of privacy: The high-resolution image and video resolution of drones can result in potential invasion of privacy in private lands and homes. Especially in India, where there exist communities with diverse caste and ethnic groups often living in close proximity to wildlife habitats and protected areas, the likelihood of invasion of privacy of local populations is a significant risk. The legal framework of drone operations must therefore ensure that conservation-related operations through drones do not

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inadvertently intrude into the right to private life.

- Storage, management and protection of data: Data can also be an important by-product of drone surveillance for conservation purposes. However, the storage, management and protection of these data, which can be both sensitive and valuable, are not straightforward. Prevention of unauthorized access to such data, and also safeguarding them from security breaches, are important. Depending on how these biometric data are used, India already has an infant legal system struggling with the complexities of data protection in the absence of a piece of legislature that is similar to the GDPR in the EU and has the potential to provide appropriate standards of governance to the management of data gathered through conservation drones, especially because we can already see that the principles of consent, data minimization, and the purpose limitation principle might be relevant. With the release of the Personal Data Protection Bill, which is still in the consideration stage, these standards may be more closely aligned with the management of conservation drone data.

(B) Balancing Conservation Efforts with Privacy Laws

- Regulatory Structure for Drone Operations: While the Directorate General of Civil Aviation (DGCA) has put in place the Civil Aviation Requirements (CAR) for the safe operation of Remotely Piloted Aircraft Systems (RPAS), including privacy and security concerns, the guidelines ensuring its conservation safety and ensuring the balance between conservation effort and privacy invasion are still at a nascent stage. This includes open and holistic discussions with conservationists, legal jurispers, and policymakers to bring about the ethical use of drone surveillance for conservation.
- Ethical guidelines and best practices: supplementary to the legal frameworks cited above, best practices – such as community engagement and informed consent (where feasible) – should accompany drone use in conservation. This has particular relevance in cases where surveillance operations are carried out near human settlements. Ensuring transparency and communicating the objectives of drone operations are crucial to allaying privacy concerns; as well as providing assurance on the non-secretive nature of the information gathered, and in ensuring that the data collected can be utilized solely for conservation purposes.
- Technological fixes: one of the more promising technological fixes would be the use of technological advancement to limit privacy intrusions. For example, techniques ‘by design’ – such as automatically blacking out, in images or videos, humans and private

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property at the time of capture by drones – can be developed and included in the drone architecture. Another approach, to ensure the right of privacy, would be to add strong access controls and to encrypt storage and transmission of surveillance data.

(C) Interference with Wildlife

The wildlife can be disturbed by the presence of drones in natural habitats. UAVs operating in the air could lead to the avoidance by wildlife of monitored areas, trigger stress responses or alter the behaviour of animals, which could all have long-term implications and perhaps even lead to animals becoming extinct. For example, if the stress response of a monitored species is such that it hinders its ability to survive or reproduce, then continued use of drones in that location could be fatal for the species. Ultimately, the conservation community must find a way to leverage the remarkable wildlife monitoring potential of UAVs, without exacerbating any such problems.

These challenges were countered by the fact that India's regulatory framework governing drone operations includes DGCA guidelines that outline how disturbances to wildlife ought to be minimized. Additionally, India's Wildlife (Protection) Act, 1972, and the Forest Conservation Act, 1980, though they are silent on drones, lay a legal foundation to regulate activities that are likely to harm wildlife or affect their habitats. Any drone surveillance for conservation must ensure that the wellbeing of the animals and the integrity of their habitats are not jeopardized.

Conservationists and drone operators can help to reduce the risk of interference by following best practices. These include staying at a safe and respectful distance from wildlife, avoiding critical times such as mating or nesting seasons, using a drone equipped with noise-reduction technology, and choosing the time of flight of the drone appropriately so that it does not conflict with general activity surges. For example, it is good practice to avoid operating drones during dawn or dusk, when most animals are at their most active.

(D) Studies on the Impact of Drones on Animal Behavior

Anticipating this kind of impact on animal behaviour, various studies across the world, including India, have been conducted to assess and learn about these effects. Such studies are the basis to formulate guidelines for drone use in wildlife research that can be used to prevent surveillance hurting the very species it aims to protect.

Research on drones and wildlife response has generated mixed results, depending on the species studied, the type of drone and flight altitude, and including how loud or quiet the drone sound is. Some studies have found only slight stress responses in some species of wildlife, resulting in researchers concluding that for well-operated drones, wildlife monitoring can be a

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low-impact method of observing the way the world works. Other research has documented increased disturbance where wildlife shows changes in behaviour, elevated stress levels, or even injury or death of an animal due to the drone flying through the area.

For example, recent research in India looked at various animal (including elephant, tiger and many avian) species' responses to drones. The response was shown to depend not just on speed, altitude and noise, but also on the drone's approach. Higher altitudes and quieter drone flights seemed to result in lower stress responses. Such research suggests that flying a drone 'to spec' will depend a lot on the species (and habitat) of a given approach.

The lessons learnt from these studies have important ramifications for the design of guidelines and policies for drone use in the context of conservation activities. More specifically, these studies underscore the importance of species-specific protocols that account for the characteristics and sensitivities of different species of wildlife, and for a research programme (and adaptive management regimes) that engages in continuous improvements of drone surveillance practices based on the latest scientific findings and technological advancements as they become available.

(E) Role of Drones in Promoting Conservation Awareness

Wildlife and their habitats look astoundingly beautiful from the air; drones reveal landscapes in a way impossible for human eyes. Stunning and evocative, the resulting images and footage attract a wide audience, and are a powerful, highly effective way to raise awareness about conservation. The more immersed the public can be in the lives of wild species – the closer the human eye can bring us to the wild – the more likely we are to generate empathy and solidarity with conservation initiatives. By sharing drone-captured images and videos on social networks, documentaries (parsing and replicating the footage), as well as the mainstream news media, species and their habitats can entice and engage the public in conservation efforts like never before.

Educational institutions bringing drone technology into the classroom to teach ecology, biodiversity and conservation. With the help of drone footage, teachers can take students into real-world situations where endangered wildlife exist. For students, this helps create a sense of stewardship and care for a planet in peril.

Drones also enable crowdsourced or citizen science projects, in which members of the public can participate in conservation initiatives. Drones enable people to monitor restoration projects – for instance, by gathering public input and observations of the success of reforestation efforts. Participatory approaches like this are crucial for raising awareness of conservation issues and

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enabling communities to become active participants.

As drones can provide continuous data from the field, they add an unprecedented layer of transparency to institutional conservation projects and the status of wildlife habitat. Greater openness about what is being done and achieved, and easier data-sharing, could go a long way toward improving the accountability of conservation organisations to the general public and major donors, which will ultimately enhance public trust.

Though overall, drones can be beneficial in promoting awareness of conservation solutions and approaches, there are still some potential problems. People's privacy could be violated while wildlife could be disturbed by drone use, and regulatory authority could restrict possibilities for drone operation. However, the challenges that could arise from using drones for promoting awareness can be addressed through approaching the use of drones ethically and legally, with respect to the measures imposed by societies.

What's next? In the years to come, I think that the potential role of drones in promoting conservation awareness will increase. With advances in drone-mounted hardware and data analytics, the capacity for more dynamic and interactive storytelling methods will also increase. AR and VR experiences, currently in their infancy, could make widespread and immersive use of drone-captured content to potentially further narrow the gap between the public and conservation.

VI. SUGGESTIONS

A way forward involves embedding the use of drone surveillance for wildlife conservation in India within an integrated set of measures to strengthen legal frameworks and standard operating procedures, and build public-private partnerships and a strong ecosystem of conservation research and innovation. It includes actions to build robust regulatory, operational and collaborative ecosystems to optimize the use of drone technology for conservation.

(A) Enhancing Legal Frameworks

The first incremental step towards incorporating drone surveillance into wildlife conservation can be found in the improvement and modification of the existing legal frameworks to adapt to the ever-changing capabilities of drone technology. This improvement, for example, is achieved through a multi-faceted approach.

The legal basis of drone operations in India needs to be clarified and extended to include conservation-related drone operations clearly within the boundaries of existing regulatory frameworks/Civil Aviation Requirements (CAR) for Remotely Piloted Aircraft Systems. This

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will provide a clear and unambiguous legal basis for conservation drone operations for wildlife protection and habitat management.

Enhance the inter-agency coordination between the Directorate General of Civil Aviation (DGCA) and the Ministry of Environment, Forest and Climate Change (MoEFCC) to develop draft and final drone regulations that promote the cause of conservation, and ensure simplified processes for securing clearances for flying drones in protected areas.

(B) Developing Standard Operating Procedures (SOPs)

The establishment of detailed SOPs for drone operations in the context of wildlife conservation ensures standard operating procedures are followed in the use of drone technology to maximize benefit for conservation, people and Great Apes, and that proper risk assessments are conducted to minimize harm. SOPs must cover every step of drone operations, from pre-flight, flight operations and post-flight, to data management and analysis, with a particular focus on minimizing disturbance of wildlife and disturbance to the habitats they live in.

(C) For the Deployment of Drones in Wildlife Conservation Efforts

SOPs for the use of drones in wildlife conservation must also include clear protocols for extreme situations – such as when drones come across poachers, or there is immediate danger posed to the wildlife. This will trigger an emergency protocol for immediate response, taking advantage of drone's capabilities..

(D) Fostering Public-Private Partnerships

The development of public-private partnerships is essential to harness the complementary strengths and assets of the private and public sectors to conserve IUCN Red List endangered species. These partnerships can help to:

- Accelerating the transfer of private-sector drone and surveillance technologies to humanitarian agencies and law-enforcement organisations.
- Pooling resources – funding from wealthy countries for poorer ones, technical and other additional resources, access to equipment – to back up conservation efforts.
- Joint projects aimed to develop new drone technologies and analytical tools to purpose-build them for conservation efforts, including artificial intelligence-based systems for image analysis and species identification.

(E) Encouraging Innovation and Investment in Conservation Technologies

Most importantly, we need to foster an ecosystem that promotes investment in innovation and

conservation technologies, and provides incentives for long-term sustainability of drone surveillance practices. This means:

- Government and private sector incentive programs for startups and technology companies developing innovative conservation technologies.
- Essentially anything related to grant programmes in the following areas: technology and conservation, conservation research for academics, natural history research, or environmental science for non-profits.
- Enhancing the likelihood of success of new technologies in the conservation context through supported demonstration projects.

VII. CONCLUSION

The vast potential of the drone technology in wildlife conservation in India particularly to combat human-animal conflicts, act as a game changer in the protection of endangered species and in the long war against poaching. Drones offer a new avenue to ramp up the conservation sector that is plagued by inadequate resources, reframing the potential by providing detailed information and real-time surveillance of landscapes, giving range and depth to areas that are otherwise remote and difficult to monitor. It has been deployed successfully to aid wildlife conservation initiatives in projects like Project Tiger and even in the local endeavors aimed at elephant conservation. Drones have been shown to have potential in improving surveillance and data collection, thereby helping to determine focused conservation strategies.

Though the benefits are clear, the use of drones in conservation is accompanied by many challenges, especially related to regulation, privacy and technology. Many existing laws such as the Civil Aviation Requirements (CAR) for Remotely Piloted Aircraft Systems and national level environmental acts such as the Wildlife (Protection) Act1972 provide a base for lethal use but require better definition to adapt to the needs of conservation. Grey areas in law, the risk of trespassing on privacy laws and the possibility of disturbing wildlife are some of the key factors behind the need for careful and considered use of drones for conservation.

The calls for improvements to laws so that they can better specifically allow conservation-focused drone operations, while also allowing for flexibility, specifically of regulatory bodies and conservation authorities working together. Building full Standard Operating Procedures (SOPs) which apply to drone operations in wildlife conservation is an important factor in the ethical and appropriate use of this technology across the board; these allow for all operations to be managed from pre-operation preparations to the final post-operation analysis. These SOPs

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need to outline a plan for minimizing disturbances to wildlife and ethics in data collection.

Public-private partnerships could thus be key to advancing conservation, by sharing technologies, expertise and resources. This could help to accelerate the development and deployment of drone systems tailored to conservation needs; promote technology transfer; and leverage private sector investment in and innovation for conservation technologies.

Without a means to sustain and scale conservation drones, the article concludes, the new technology may never see the widespread conservation uses intended. The article suggests building 'a vibrant ecosystem of startups, academic research, and new technologies into the conservation technology sector through pilot incentive programmes, research grants, and demonstration projects', that encourages the kind of innovation and investment that will sustain and build upon drone technologies in conservation over the long term. Overall, while drone technologies have the potential to be a game-changer in wildlife conservation in India, they need a robust public-private partnership comprising not only of governments, academics and civil society, but also non-profits and the business community to overcome regulatory hurdles, formulate best practices for ethical and practical uses, and guide ethical applications. With an effort to improve legal provisions, incentivize technological innovation and encourage multilateral collaborations, India can leverage drone technologies to make substantial strides in the maintenance of its endangered fauna, secure their habitats, and ensure the continuity of its vibrant diversity of animals and plants for future generations.

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VIII. REFERENCES

1. Wildlife Trust of India. (2018). Drones for wildlife conservation. Retrieved May 19, 2023, from https://www.wti.org.in/news/drones-for-wildlife-conservation/
2. Wildlife Drones. (2022). Improving conservation outcomes, one species at a time. Retrieved from https://wildlifedrones.net/conservation/
3. ZenaDrone. (2022). The Ethics of Using Drones for Wildlife Conservation. Retrieved from https://www.zenadrone.com/the-ethics-of-using-drones-for-wildlife-conservation/
4. Event 38 Unmanned Systems. (2022). Drones for Conservation of Endangered Species. Retrieved from https://event38.com/case-studies/conservation-of-the-endangered-spider-monkey/
5. Globhe. (2022). Wildlife conservation. Retrieved from https://www.globhe.com/wildlife-conservation
6. Consortiq. (2022). How drones are used in conservation efforts. Retrieved from https://consortiq.com/uas-resources/how-drones-are-used-in-conservation-efforts
7. Jiménez López, J., & Mulero-Pázmány, M. (2019). Drones for Conservation in Protected Areas: Present and Future. *Drones*, 3(1), 10. https://doi.org/10.3390/drones3010010
8. Nature. (2019). Drones and AI are top of the tree for wildlife surveillance. Retrieved from https://www.nature.com/articles/d42473-019-00304-3
9. Petso, T., & Jamisola, R. S., Jr. (2023). Wildlife conservation using drones and artificial intelligence in Africa. *Science Robotics*, 8, eadm7008. DOI:10.1126/scirobotics.adm7008
10. Rathi, P.K. (2017). A legal Evaluation of Protection of Wildlife Vis. A Vis. Scientific and Technological Development. *Delhi Law Review*, 9(1).
11. Pant, A., & Kumar, S. (2018). Environmental Law Enforcement and Need for Reforming the Liability Regime in India: An Agenda to Revisit. *Delhi Law Review*, 10(1).
12. Murison, M. (2019, February 13). How Drones Are Protecting Endangered Species. *Zeitview*. https://blog.zeitview.com/how-drones-are-protecting-endangered-species
13. Wade, A. (2019, March 19). How drones and AI are protecting endangered wildlife.

https://iotechworld.com/how-drones-are-used-for-better-surveillance-security/

14. Edmond, C. (2022, December 15). How the 'SnotBot' and 2 other drones are helping us save endangered species. *World Economic Forum.* https://www.weforum.org/agenda/2022/12/endangered-species-drones-conservation-ai-technology/
15. Alpha Swift Drones. (2023, May 9). Drones and Wildlife Conservation: A New Tool for Researchers. https://alphaswift.com/blog/drones-and-wildlife-conservation
16. Parker, J.R. (2023, May 31). AI in Wildlife Conservation: Protecting Endangered Species with Technology. *Medium.* https://medium.com/@jrparker07/ai-in-wildlife-conservation-protecting-endangered-species-with-technology-8655faff3546
17. Chakraborty, S. (2023, July 1). Ethical Use of Drone Technology for People and Wildlife. *Analytics Insight.* https://www.analyticsinsight.net/ethical-use-of-drone-technology-for-people-and-wildlife/
18. XDynamics. (2023, August 10). Drones for Wildlife Conservation: Monitoring and Protecting Endangered Species. https://www.xdynamics.com/blog/drones-for-wildlife-conservation-monitoring-and-protecting-endangered-species/
19. Sieve Aeronautical Imaging. (2023, September 3). The Growing Role of Drones in Wildlife Conservation. *LinkedIn.* https://www.linkedin.com/pulse/growing-role-drones-wildlife-conservation-sieve-aeronautic-imaging/
20. ClearSpot.ai. (2023, October 6). Drones for Wildlife Conservation: Monitoring and Protecting Endangered Species. *LinkedIn.* https://www.linkedin.com/pulse/how-drone-pilots-shaping-fight-against-environmental-challenges/
21. JOUAV. (2023, November 10). Wildlife Drones | How to Use Drones for Wildlife Conservation? https://www.jouav.com/blog/wildlife-drone.html
22. IO Tech World. (2024, February 19). How Drones Are Used for Better Surveillance & Security? https://iotechworld.com/how-drones-are-used-for-better-surveillance-security/
23. Drones Deli. (2024, March 15). The Role of Drones in Protecting Endangered Species. https://dronesdeli.com/blogs/news/the-role-of-drones-in-protecting-endangered-species

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