Aeroconservation – Challenges for Law and Policy

Pip Wallace and Jennifer Holman*

Airspace conservation (aeroconservation) is a relative latecomer to ecosystem management, despite intensifying threats to birds, bats and invertebrates in the habitat. This article demonstrates the geographies of threats and examines gaps in law and policy responses. Commonly treated at law, and in fact, as an extension of terrestrial or marine spaces, recognition of air as habitat and related conservation protection is rare. In addition, management is confounded by the dynamic, three-dimensional and indivisible nature of airspace, by wildlife and aircraft mobility, and by temporal features. Regulation of airspace and patterns of spatial activity are dominated by aircraft traffic control and related transport imperatives to the exclusion of wildlife protection. Where strategic planning mechanisms are applied, they are often tied to amorphous definitions of habitat, rely upon terrestrial habitat protection for their expression or are reflected as two-dimensional notations on a map. Recommendations to enhance protection for co-existence include transforming the approach to airspace and adopting integrated, strategic and three-dimensional approaches.

I. Introduction

The term "freedom of the air" implies a lack of human presence and dominion over the wide-open skies. In the 20th century, an alternate meaning emerged, with the term being co-opted to define specific, air-traffic rights or privileges[1] for free movement of aircraft and people through airspace. At the same time the freedom of wildlife to exist in airspace has been significantly circumscribed by intensifying human activity and development.

Although hunting threats in airspace were an early focus for wildlife conservation,[2] more comprehensive management of airspace in response to anthropogenic threats to wildlife is a late arrival to ecosystem management.[3] As use of airspace and related pressures intensify so too does recognition of congestion of the space and incumbent threats to airborne animals. Scientists – employing both traditional and new technology – are documenting the nature of airspace use by wildlife, collating the threats and driving recognition of the need to apply protective measures.

Despite emerging understanding of the threats, development of effective responses is challenging. Commonly treated at law, and in fact, as an extension of terrestrial or marine spaces, specific recognition of air as habitat and related protection is rare. In addition, management is confounded by the dynamic, three-dimensional and indivisible nature of airspace and by both wildlife and aircraft mobility and

* Pip Wallace: LLB Auck, LLM Waikato, PhD Waikato, Senior Lecturer, Environmental Planning Programme, Faculty of Arts and Social Sciences, Waikato University, New Zealand, Private Bag 3104 Hamilton 3240, New Zealand. Jennifer Holman: BA, Univ of Texas, JD, Univ of California, Davis, LLM Waikato, Research Assistant, Environmental Planning Programme, Faculty of Arts and Social Sciences, Waikato University, New Zealand, Private Bag 3104 Hamilton 3240, New Zealand. Our grateful thanks to Iain White and Silvia Serrao-Neumann for valuable comments on an earlier draft.

[1] Sarah Jane Fox, "Borderless Skies! Sovereign Dominance, Regionalism: Lessons from Europe" (2017) 34 *International Journal on World Peace* 19, 25.

[2] Robert Boardman, *The International Politics of Bird Conservation: Biodiversity, Regionalism and Global Governance* (Edward Elgar, 2006) 34.

[3] Christina M Davy, Adam T Ford and Kevin C Fraser, "Aeroconservation for the Fragmented Skies" (2017) 10 *Conservation Letters* 773; Robert H Diehl, "The Airspace Is Habitat" (2013) 28 *Trends in Ecology & Evolution* 377; Pip Wallace, "The Nature of Habitat" (2007) 12 *New Zealand Journal of Environmental Law* 211.

temporality. Furthermore, wildlife loss in airspace sits low on the ladder of public concern, overshadowed by other looming environmental crises, lack of awareness and a certain disregard fostered by the inevitability of wildlife conflict with humans and overriding anthropocentric concerns including safety and convenience.[4] The purpose of this article is to examine how aerial-wildlife habitat and its species are impacted by anthropogenic modification and to analyse related legal and planning measures. A focal point will be the extent to which the law, and associated planning tools, contemplate the third and fourth dimensions (space and time) and the opportunities to respond with greater spatial and temporal specificity to the problems documented.

First, the article will – through literature review – examine the nature of airspace, its key characteristics and its function as wildlife habitat. Following this is an analysis of threats encountered by wildlife in airspace. Attention will then turn to the historical treatment of airspace at law. From there the article will move to analyse legal and policy measures commonly applied for wildlife conservation purposes in airspace and consider fitness for purpose. Finally, the article will address gaps and opportunities to enhance protective legal mechanisms and approaches.

The method for this investigation comprised several targeted searches and analyses. Building upon existing knowledge and publications, it commenced with a scan of international and national literature. From there the focus was narrowed by a systematic literature review and inventory of spatial techniques applied through regulation to protect wildlife and habitat with particular focus on techniques that contemplated the volumetric nature of the space to be protected. The original search was not limited to airspace but included water columns and the subterranean. The purpose of the search was to identify existing techniques which extended protection beyond the two-dimensional. At the same time, research was undertaken in Canada examining regulatory and non-regulatory methods applied to protect aerial habitat, focusing upon migratory species. This was then followed by an analysis of international agreements to assess provision for wildlife protection in airspace, using key search terms such as air/airspace/flight path/migration/corridor/area, producing an additional inventory. Finally, to help contextualise international agreements in a national context, the New Zealand and Australian law and literature was surveyed in connection with airspace use and protection for wildlife. A systematic analysis of the case law was undertaken and key words included aerial/habitat/connections/migration/connectivity/airspace. Targeted survey of resource management plans was also conducted. From this work emerged the following picture of the treatment of airspace and the extent of legal protection for wildlife. Five key messages are identified in conclusion which broadly suggest the need to rethink the way airspace is visualised and regulated, greater integration between regulatory silos and application of planning mechanisms that extend beyond two-dimensional approaches to capture the third- and fourth-dimensions.

II. Airspace

To Māori, the sky is Ranginui who with Papa-tu-ā-nuku (the earth) are the primordial parents from whom “every species, every place, every type of rock and stone, every person (living or dead), every god, and every other element of creation” originates and is united through common descent.[5] In Māori cosmology many of the offspring of Ranginui and Papa-tu-ā-nuku “are personified as climatic entities”[6] and the interconnections of the environment are demonstrated through these relationships.[7]

[4] Bradley F Blackwell et al, “Wildlife Collisions with Aircraft: A Missing Component of Land-use Planning for Airports” (2009) 93 *Landscape and Urban Planning* 1, 2; Crawford Neelam, C Poudyal, and John C Maerz, “When Drivers and Terrapins Collide: Assessing Stakeholder Attitudes toward Wildlife Management on the Jekyll Island Causeway” (2015) 20 *Human Dimensions of Wildlife* 1, 11.

[5] Waitangi Tribunal, *Ko Aotearoa Tēnei: A Report into Claims Concerning New Zealand Law and Policy Affecting Māori Culture and Identity* (2010)17.

[6] DNT King, A Skipper and WB Tawhai, “Māori Environmental Knowledge of Local Weather and Climate Change in Aotearoa–New Zealand” (2008) 90 *Climatic Change* 286, 390.

[7] Waitangi Tribunal, *Te Urewera* (2017) 3107 fn 29 – adopting the statement of Counsel for Nga Rauru o Nga Potiki.

Association of the sky with deities is common to other cultures and religions, and from the cosmos has emerged a rich vein of human belief and legend. In contrast, contemporary Western perspectives are anthropocentric, tending to treat the area as a resource rendering services[8] for human purposes,[9] attaching terms such as "air" or "airspace", absenting reference to person and obscuring reference to place. This sharp perspectival division is now eroding in the New Zealand context as the law – reshaped by Treaty of Waitangi settlement agreements – moves forward to acknowledge legal personhood in rivers, mountains and forests.[10]

Contemporary scientific literature describes the phenomenon of "atmosphere", defining properties, place and relationships with other phenomena. Defined as "a layer of gaseous elements that surrounds the earth and differentiates the environment of the earth from outer space", these gases envelope and protect the surface of the earth from both solar and cosmic radiation.[11] The atmosphere is characterised from the ground up, through vertical layers defined by height and composition, each layer having different gaseous properties with only the first two layers capable of supporting life:

FIGURE 1. Atmospheric layers

Atmospheric layers	
0–10 km	**Troposphere**: the lowest level of Earth's atmosphere extending to approximately 10 kilometres above sea level
10–50 km	**Stratosphere**: uppermost region of the atmosphere able to support life; extends from 10 to 50 kilometres above Earth's surface
50–80 km	**Mesosphere**: the extremely rarefied atmospheric layer at altitudes from 50 to 80 kilometres above the surface, characterised by rapid decreases in temperature
80–800 km	**Thermosphere**: outer region of the atmosphere between 80 and 800 kilometres from the surface where temperature increases with increasing altitude because of bombardment by solar radiation

Source: Adapted from *Earth Science: Earth's Weather, Water, and Atmosphere*.[12]

The reference to "sphere" indicates the volumetric nature of atmospheric space, and classifications based on height and gaseous composition reveal a fluid and indivisible form where visual indicators such as topography, inhabitants or fixed phenomena are lacking. More recently, further divisions of the troposphere based on temperature and oxygen levels in the airspace have been suggested by Davy, Ford and Fraser[13] in proposing a schematic for aerial-habitat conservation purposes (further discussed in Parts IV and VII). These divisions described from ground up are basoaerial (0–1 kilometres), mesoaerial (1–8 kilometres), epiaerial (8–13 kilometres) and lower stratosphere (13–17 kilometres). The proposed schematic vertically divides and classifies those areas where human activities are likely to coincide with wildlife habitat.

III. Airspace as Wildlife Habitat

An eclectic and extensive range of organisms rely upon aerial habitat for a variety of life-cycle purposes.[14] Of the vertebrates, some 28% of those assessed by the International Union for the Conservations of

[8] John Thornes et al, "Communicating the Value of Atmospheric Services" (2010) 17 *Meteorological Applications* 243, 245.

[9] Catherine J Iorns Magallanes, "Maori Cultural Rights in Aotearoa New Zealand: Protecting the Cosmology That Protects the Environment" (2015) 21 *Widener Law Review* 273, 277.

[10] *Te Urewera Act 2014* (NZ) s 11; *Te Awa Tupua (Whanganui River Claims Settlement) Act 2017* (NZ) s 14.

[11] Margaret Boorstein et al, *Earth Science: Earth's Weather, Water, and Atmosphere* (Salem Press, 2012) 75.

[12] Boorstein et al, n 11, 75.

[13] Davy, Ford and Fraser, n 3, 776.

[14] Robert H Diehl et al, "Extending the Habitat Concept to the Airspace" in Phillip Chilson et al (eds), *Aeroecology* (Springer, 2017) 47, 50–53; Davy, Ford and Fraser, n 3, 773

Nature either fly or glide, and the proportion for insects and spiders is thought to be much higher.[15] Not only does the capacity for flight propel birds, bats and insects into a wider variety of habitats than non-aerial vertebrates and invertebrates,[16] but also it enables access to aerial habitat independent of land or water.

Flight likely evolved separately for birds, bats and insects, each developing different adaptations for flight.[17] Flight duration, height, temporality and speed vary widely among flying animals and relate to purpose, for example, foraging, display, escape or migration.[18] Flying enables animals to travel at speed, in a straight line, and historically without encountering obstacles.[19] Aerial migration – a cyclical phenomenon common to many birds, expressed on all continents, and well established in bats[20] and insects[21] – is built upon the benefits of flight and the support of wind. It is designed to maximise environmental potential in terms of favourable climate, food supply and habitat availability.[22] Although migrating swans have been recorded at a height of 8,230 metres,[23] and aircraft/avian collisions reported at 9,754 metres in the United States[24] and 11,278 metres in Africa[25] most flight typically occurs within the "first several hundred meters above ground level".[26] Bat flight is characterised by greater manoeuvrability than bird flight, whereas birds have the edge in terms of stamina and distance.[27] The Arctic Tern flies a known migration route of 17,700 kilometres from the breeding grounds in Alaska to the pack ice of the Antarctic,[28] and kuaka (bar-tailed godwits) fly non-stop for 200 hours covering up to 12,000 kilometre across the Pacific Ocean between Alaska and New Zealand.[29] Although bats are known to forage widely for food, the limits of range appear to be approximately 800 kilometres.[30] Flying insects are diverse, their flight mechanisms differ and they select aerial habitat for a range of life-cycle purposes, including foraging, reproduction and migration.[31]

[15] Davy, Ford and Fraser, n 3, 773.

[16] Kevin McGowan, "Introduction: The World of Birds" in Sandy Podulka, Ronald W Rohrbaugh Jr and Rick Bonney (eds), *Handbook of Bird Biology* (Cornell University, 2nd ed, 2004) 1.1, 1.67; Christian C Voigt and Tigga Kingston, "Bats in the Anthropocene" in Christian C Voigt and Tigga Kingston (eds), *Bats in the Anthropocene: Conservation of Bats in a Changing World* (Springer, 2016) 1, 2–5.

[17] Philip Hunter, "The Nature of Flight" (2007) 8 *EMBO Reports* 811, 811–813.

[18] Felix Liechti and Liam P McGuire, "Facing the Wind: The Aeroecology of Vertebrate Migrants" in Phillip Chilson et al (eds), *Aeroecology* (Springer, 2017) 179, 180.

[19] Liechti and McGuire, n 18, 180.

[20] John D Altringham, *Bats: From Evolution to Conservation* (OUP, 2011).

[21] VA Drake and AG Gatehouse (eds), *Insect Migration: Tracking Resources through Space and Time* (CUP, 1995).

[22] Kenneth P Able, "Birds on the Move: Flight and Migration" in Sandy Podulka, Ronald W Rohrbaugh Jr and Rick Bonney (eds), *Handbook of Bird Biology* (Cornell University, 2nd ed, 2004) 5.1, 5.57; Frank B Gill, *Ornithology* (WH Freeman, 3rd ed, 2007) 273.

[23] Jonathan Elphick and TE Lovejoy, *The Atlas of Bird Migration: Tracing the Great Journeys of the World's Birds* (Firefly Books, 2007).

[24] Edward C Cleary, Richard A Dolbeer and Sandra E Wright, *Wildlife Strikes to Civil Aircraft in the United States 1990-2005* (Federal Aviation Administration, 2006) 21; see also Richard A Dolbeer, "Height Distribution of Birds Recorded by Collisions with Civil Aircraft" (2006) 70 *The Journal of Wildlife Management* 1345, 1345.

[25] Roxie C Laybourne, "Collision between a Vulture and an Aircraft at an Altitude of 37,000 Feet" (1974) 86 *The Wilson Bulletin* 461, 461; Dolbeer, n 24, 1345.

[26] Diehl et al, n 14, 50; see also Ruud H Jongbloed, Institute for Marine Resources & Ecosystem Studies, *Flight Height of Seabirds, A Literature Study*, Report C024/16 (25 March 2016) 4; Sergio A Lambertucci, Emily LC Shepard and Rory P Wilson, "Human-Wildlife Conflicts in a Crowded Airspace" (2015) 348 *Science* 502, 502.

[27] Hunter, n 17, 812.

[28] Hunter, n 17, 812; Able, n 22, 5.53.

[29] Thomas Alerstam and Johan Bäckman, "Ecology of Animal Migration" (2018) 28 *Current Biology* R968, R968.

[30] Hunter, n 17, 812.

[31] Don R Reynolds, Jason W Chapman and V Alistair Drake, "Riders on the Wind: The Aeroecology of Insect Migrants" in Phillip Chilson et al (eds), *Aeroecology* (Springer, 2017) 145, 146; Diehl et al, n 14, 53; Thomas Alerstam and Johan Bäckman, "Ecology of Animal Migration" (2018) 28 *Current Biology* R968, R968.

In the 21st century technological advances such as radar and animal-borne telemetry have advanced understanding of aerial-wildlife habitat and patterns of use, illuminating life-history characteristics of threatened and cryptic species.[32]

IV. Airspace and Human Use

While technology borne by animals has brought significant understanding of wildlife behaviour, even greater change has occurred through humans borne by technology. The study of aeromobilities reveals intensifying patterns of human mobility by aircraft and related airspace consumption over the 20th and 21st centuries.[33] Added to this is the recent intensification[34] in airspace use through the arrival of remotely piloted aircraft (RPA) including drones. RPA airspace use can be distinguished from traditional aircraft due to its predominant occupation of airspace near ground level. Although traditional aircraft must operate near ground level for take-off and descent, most of the flight takes place in excess of 10,000 feet, with commercial aircraft cruising at about 30–40,000 feet. RPA by contrast require close spatial connection to land and operator, and are commonly regulated by line-of-sight requirements and height limitations of about 400 feet.[35] In addition, RPA occupy space in a manner different to traditional aircraft through the ability of common RPA (such as quadcopters) to orientate vertically and horizontally and to hover, pitch, roll and yaw in close proximity to a subject.[36]

Garrett and Anderson,[37] in examining vertical geographies and drone methodologies, underscore the verticality and volumetric nature of human activity in airspace, and argue[38] for revisioning of existing cartographic techniques, transforming a two-dimensional surface into a three-dimensional volume to account for it. In doing so they draw attention to how "social, environmental and technological concerns are entangled with the politics of access to proximal airspace" and further to the volumetric aspects of connections between the terrestrial and activities in airspace.[39] Consequently, the authors propose a new categorisation of proximal airspace to accommodate the drone, the Nephosphere:

> From the Greek, nepho (cloud), and sphere (round geometrical three-dimensional [3D] object), the term engenders a volumetric perspective that is, generally, above rooftops and below piloted airplanes, an area of the sky previously looked at but rarely from, the "habitat for new animate forms including the drones that buzz above our heads".[40]

This "near earth" classification of the Nephosphere is founded upon accommodation of the drone and highlights a spatial extent commensurate with drone activity. Spatial extent is also loosely described by reference to "uncontrolled" aviation airspace classification and through connection with aircraft regulatory grey zones.[41] The classification corresponds to some degree with the "basoaerial" (and

---

[32] Judy Shamoun-Baranes, Felix Liechti and Wouter MG Vansteelant, "Atmospheric Conditions Create Freeways, Detours and Tailbacks for Migrating Birds" (2017) 203 *Journal of Comparative Physiology A* 509, 509–510; V Alistair Drake and Bruno Bruderer, "Aeroecological Observation Methods" in Phillip Chilson et al (eds), *Aeroecology* (Springer, 2017) 201–207; Jennifer McGowan et al, "Integrating Research Using Animal-borne Telemetry with the Needs of Conservation Management" (2017) 54 *Journal of Applied Ecology* 423, 423; Ian Davidson-Watts, Sean Walls and Gareth Jones, "Differential Habitat Selection by *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* Identifies Distinct Conservation Needs for Cryptic Species of Echolocating Bats" (2006) 133 *Biological Conservation* 118, 124.

[33] Peter Adey, Lucy Budd and Phil Hubbard, "Flying Lessons: Exploring the Social and Cultural Geographies of Global Air Travel" (2007) 31 *Progress in Human Geography* 773, 773.

[34] Ian GR Shaw, "The Great War of Enclosure: Securing the Skies" (2017) 49 *Antipode* 883, 886.

[35] See, eg, *Civil Aviation Regulations 1988* (Cth) regs 101.025, 101.070, 101.073, 101.245, 101.280.

[36] Pip Wallace, Ross Martin and Iain White, "Keeping Pace with Technology: Drones, Disturbance and Policy Deficiency" (2018) 61 *Journal of Environmental Planning and Management* 1271, 1281.

[37] Bradley Garrett and Karen Anderson, "Drone Methodologies: Taking Flight in Human and Physical Geography" (2018) 43 *Transactions of the Institute of British Geographers* 341, 343.

[38] Eyal Weizman, *Hollow Land: Israel's Architecture of Occupation* (Verso Books, 2012) 2.

[39] Garrett and Anderson, n 37, 341.

[40] Garrett and Anderson, n 37, 343.

[41] Garrett and Anderson, n 37, 349.

potentially the "mesoaerial") advanced by Davy, Ford and Fraser – with classifications, despite different disciplinary perspectives, driven by recognition of proliferation of human activity in airspace and the vertical and volumetric nature of the space and attendant use.

Humans have invented a range of other craft and objects that are driven or projected into airspace including rockets, fireworks and weaponry such as bullets, missiles and lasers. Shaw describes how "the birth of airpower enabled new vertical regimes of state power, capital accumulation, and violence" and, in discussing enclosure of the skies, describes new atmospheric spatialities.[42] Related to this, in prior literature, Elden discusses the meaning of territory and explains "how the vertical dimension of territory shows that territory is a volume rather than an area", and he notes that "lines on maps have only a limited height when translated into lines on the ground".[43] The discussion reveals the vulnerabilities of territories drawn on maps and limited to the two-dimensional and the lack of definition of what "is", a vulnerability that will be returned to in discussing law and protection of aerial habitat. It also points to a further set of airspace classifications, those drawn in law and defining territory, government and rights of access and use.

In addition to the airborne, the skyscape is altered by intensifying vertical and volumetric intrusion into airspace by terrestrial and marine structures and craft. Increasing population and a global urbanisation trend is expressed through significant growth in cities such that, by 2050, 80% of the world's population (7.7/9.7 billion) will dwell in cities, with significant amounts of this shift to be accommodated in tall buildings.[44] Tall buildings now extend through four categories from the tall at 50 metres+ to the mega-tall at 600 metres+.[45] In addition to built form, the airspace has also been physically altered by outputs[46] from built form and other human activity and development, which will be described further in connection with threats posed to wildlife in the following part.

Technology has enabled humans to occur "unnaturally" in airspace, habitat previously reserved for animals. The significant and recent shifts in proliferation of aircraft and human activity in airspace have redrawn the skyscape, materially altered its composition and intensified the coincidence of human activity and wildlife.

V. Threats to Wildlife in Airspace

A systematic review of the literature reveals a growing awareness of the threats to wildlife in airspace, the species-specific nature of the problems[47] and discernible spatial and temporal features,[48] the limits of the science and methodology,[49] and the fragmented nature of the legal responses.[50] The scale of the loss to wildlife is significant and much remains unmeasured. The key threats originate from three distinct sources identified to highlight discrete spatial characteristics and ultimately their treatment at law.

[42] Ian GR Shaw, "The Great War of Enclosure: Securing the Skies" (2017) 49 *Antipode* 883, 884.

[43] Stuart Elden, "Secure the Volume: Vertical Geopolitics and the Depth of Power" (2013) 34 *Political Geography* 35, 36; Stuart Elden, *Terror and Territory: The Spatial Extent of Sovereignty* (University of Minnesota Press, 2009) xxii.

[44] Kheir Al-Kodmany, "The Sustainability of Tall Building Developments: A Conceptual Framework" (2018) 8 *Buildings* 1, 2.

[45] Al-Kodmany, n 44, 1.

[46] See below nn 71–77 and related discussions.

[47] Scott R Loss et al, "Bird–building Collisions in the United States: Estimates of Annual Mortality and Species Vulnerability" (2014) 116 *The Condor* 8, 17.

[48] Chris Johnson and Martin Hugues St Laurent, "Unifying Frameworks for Understanding the Impacts of Human Development on Wildlife" in David Naugle (ed), *Energy Development and Wildlife Conservation in Western North America* (Island Press, 2011) 27.

[49] Christian C Voigt et al, "Conservation Strategies for Bats Flying at High Altitudes" (2018) 68 *BioScience* 427, 430; Maureen Thompson et al, "Factors Associated with Bat Mortality at Wind Energy Facilities in the United States" (2017) 215 *Biological Conservation* 241, 244; R Seaton and LP Barea, "The New Zealand Falcon and Wind Farms: A Risk Assessment Framework" (2013) 40 *New Zealand Journal of Zoology* 16, 26.

[50] For example, Voigt et al, n 49, 433.

A. Building and Infrastructure – Collisions, Obstruction, Displacement and Aerial Fragmentation

Loss et al suggest that collisions with buildings is the second greatest cause of "direct human-caused mortality" for birds after loss to feral cats.[51] Heavy collision losses for bats, birds and invertebrates are reported globally, although the full extent can only be estimated and cumulative effects on specific populations are not well understood.[52] In the eastern United States some species – particularly migrating or nocturnal species – have been termed "super-colliders" for their disproportionate abundance among the collision dead.[53] The New Zealand and Australian positions are not well understood,[54] and literature on the subject is scarce. Artificial light and glare/sunlight emission are known to compound the problem.[55] Collision rates are also affected by the extent of glass coverage on a building and the presence and height of vegetation, with a range of structures – including the average dwelling (due to its ubiquity),[56] the mid-rise, tall buildings[57] and renewable-energy and power-supply infrastructure[58] – being implicated in collision mortality. Buildings and infrastructure, including roads, cause further disruption through energy costs of collision avoidance, displacement and related habitat loss, and aerial fragmentation.[59]

[51] Loss et al, n 47, 8.

[52] Voigt et al, n 49, 430; Travis Gallo et al, "Need for Multiscale Planning for Conservation of Urban Bats" (2018) 32 *Conservation Biology* 638, 639; Albert M Manville, "Impacts to Birds and Bats Due to Collisions and Electrocutions from Some Tall Structures in the United States: Wires, Towers, Turbines, and Solar Arrays—State of the Art in Addressing the Problems" in Francesco M. Angelici (ed), *Problematic Wildlife* (Springer, 2016) 415, 418–421; J Bernardino et al, "Estimating Bird and Bat Fatality at Wind Farms: A Practical Overview of Estimators, Their Assumptions and Limitations" (2013) 40 *New Zealand Journal of Zoology* 63, 63; Daniel Klem Jr, "Landscape, Legal, and Biodiversity Threats That Windows Pose to Birds: A Review of an Important Conservation Issue" (2014) 3 *Land* 351, 352; Francesca Coccon et al, "A Land-Use Perspective for Birdstrike Risk Assessment: The Attraction Risk Index" (2015) 10 *PLoS On*e e0128363; James Gleeson and Deborah Gleeson, *Reducing the Impacts of Development on Wildlife* (CSIRO Publishing, 2012) 11; Scott R Loss, Tom Will and Peter P Marra, "Direct Mortality of Birds from Anthropogenic Causes" (2015) 46 *Annual Review of Ecology, Evolution, and Systematics* 99, 101.

[53] Todd W Arnold and Robert M Zink, "Collision Mortality Has No Discernible Effect on Population Trends of North American Birds" (2011) 6 *PLoS One* e24708.

[54] Stuart Parsons and Phil Battley, "Impacts of Wind Energy Developments on Wildlife: A Southern Hemisphere Perspective" (2013) 40 *New Zealand Journal of Zoolog*y 1, 2; Seaton and Barea, n 49, 26; Ralph G Powlesland, "Impacts of Wind Farms on Birds: A Review" (2009) *Science for Conservation* 289, 6; Rachel Fetherston, "Striking Out: Window Collisions A Growing Threat to Our Birds", *Australian Geographic*, 30 January 2019 <https://www.australiangeographic.com.au/topics/science-environment/2019/01/striking-out-windows-collisions-a-growing-threat-to-our-birds/>; Debbie Saunders and Chris Tzaros, *National Recovery Plan for the Swift Parrot Lathamus discolor* (Birds Australia, 2011) 12.

[55] James D McLaren et al, "Artificial Light at Night Confounds Broad-scale Habitat Use by Migrating Birds" (2018) 21 *Ecology Letters* 356, 356; EG Rowse et al, "Dark Matters: The Effects of Artificial Lighting on Bats" in Christian C Voigt and Tigga Kingston (eds), *Bats in the Anthropocene: Conservation of Bats in a Changing World* (Springer, 2016) 187, 187; Loss et al, n 47, 8.

[56] Loss et al, n 47, 8.

[57] Al-Kodmany, n 44, 1.

[58] Hannu Tikkanen et al, "Modelling Golden Eagle Habitat Selection and Flight Activity in Their Home Ranges for Safer Wind Farm Planning" (2018) 71 *Environmental Impact Assessment Review* 120, 120; J Bernardino et al, "Bird Collisions with Power Lines: State of the Art and Priority Areas for Research" (2018) 222 *Biological Conservation* 1, 1; Maximiliano Adrián Galmes et al, "Electrocution Risk for the Endangered Crowned Solitary Eagle and Other Birds in Semiarid Landscapes of Central Argentina" (2018) 28 *Bird Conservation International* 403, 403; Juan Manuel Pérez-García et al, "Using Risk Prediction Models and Species Sensitivity Maps for Large-scale Identification of Infrastructure-related Wildlife Protection Areas: The Case of Bird Electrocution" (2017) 210 *Biological Conservation* 334, 334; Maureen Thompson, "Factors Associated with Bat Mortality at Wind Energy Facilities in the United States" (2017) 215 *Biological Conservation* 241, 241; Edward B Arnett et al, "Impacts of Wind Energy Development on Bats: A Global Perspective" in Christian C Voigt and Tigga Kingston (eds), *Bats in the Anthropocene*: *Conservation of Bats in a Changing World* (Springer, 2016) 295, 295.

[59] Voigt et al, n 49, 430; Amy Grace Fensome and Fiona Mathews, "Roads and Bats: A Meta-analysis and Review of the Evidence on Vehicle Collisions and Barrier Effects" (2016) 46 *Mammal Review* 311, 311; Diehl, n 3, 377.

B. Vehicles – Terrestrial, Aqueous and Airborne-Collisions, Obstruction, Displacement and Aerial Fragmentation

The perceptual difficulties[60] airborne animals encounter in negotiating the fixed, built environment are compounded by mobile vehicles. Whether terrestrial, marine or airborne, mobile vehicles intruding into airspace cause loss to airborne animals on a significant scale, the depth of which is only beginning to be understood. Aviation collisions with flying vertebrates are well established in the literature.[61] Data collation and research is directed largely at human safety and economic concerns, and estimates annual cost to commercial air carriers exceeding US$1.2 billion annually.[62] Aircraft collide with a wide range of species, with most strikes occurring ≤500 feet as aircraft climb and descend from airports.[63] In addition to spatial grouping, temporal aspects are also influential with strike rates altering according to season and time of day.[64] In the literature, reference to "crowded airspace" is common and this has only intensified with the entry of the drone, which exacerbates collision risk, displacement and disturbance.[65]

Collisions with terrestrial vehicles in airspace cause further heavy loss to birds,[66] bats[67] and insects.[68] Avian collision with boats, and aerial fouling by fishing gear in marine and freshwater environments, are known threats.[69] Whether mobile, stationary, airborne or not, the presence of vehicles in airspace has the potential to create havoc for airborne animals by direct mortality, and habitat modification through displacement, barrier effects and aerial fragmentation in heavily trafficked areas.[70]

C. Contaminant Discharges and Other Alteration of Aerial Environmental Conditions

Modification of aerial environmental conditions is a by-product of human built form and activity.[71] This category of threat introduces new concepts such as whether sunlight can be a contaminant,[72] an urban heat island a hazard,[73] or wind shear effects from buildings a barrier to essential pollination provisioning services.

[60] Diehl et al, n 14, 58.

[61] Voigt et al, n 49, 430; David R Bradbeer et al, "Crowded Skies: Conflicts between Expanding Goose Populations and Aviation Safety" (2017) 46 *Ambio* 290; Lambertucci, Shepard and Wilson, n 26, 502; Coccon et al, n 52; Richard A Dolbeer, "Increasing Trend of Damaging Bird Strikes with Aircraft outside the Airport Boundary: Implications for Mitigation Measures" (2011) 5 *Human–Wildlife Interactions* 235; Blackwell et al, n 4.

[62] John R Allan, "The Costs of Bird Strikes and Bird Strike Prevention" (2000) 18 *Human Conflicts with Wildlife: Economic Considerations* 147, 148–149.

[63] Dolbeer, n 24, 1347.

[64] Dolbeer, n 24, 1347; Jennifer G Parsons et al, "Bat Strikes in the Australian Aviation Industry" (2009) 73 *Journal of Wildlife Management* 526, 526.

[65] Wallace, Martin and White, n 36, 1272.

[66] Magne Husby, "Traffic Influence on Roadside Bird Abundance and Behaviour" (2017) 52 *Acta Ornithol* 93, 93; Magne Husby, "Factors Affecting Road Mortality in Birds" (2016) 93 *Ornis Fennica* 212, 213; Éric Guinard, Romain Julliard and Christophe Barbraud, "Motorways and Bird Traffic Casualties: Carcasses Surveys and Scavenging Bias" (2012) 147 *Biological Conservation* 40, 40.

[67] Fensome and Mathews, n 59, 313–314.

[68] James H Baxter-Gilbert et al, "Road Mortality Potentially Responsible for Billions of Pollinating Insect Deaths Annually" (2015) 19 *Journal of Insect Conservation* 1029, 1030.

[69] Davy, Ford and Fraser, n 3, 775; Graham Robertson et al, "Setting Baited Hooks by Stealth (Underwater) Can Prevent the Incidental Mortality of Albatrosses and Petrels in Pelagic Longline Fisheries" (2018) 225 *Biological Conservation* 134, 134; Edward R Abraham, Katrin N Berkenbusch and Yvan Richard, Ministry of Fisheries, *The Capture of Seabirds and Marine Mammals in New Zealand Non-commercial Fisheries* (Report No 64, New Zealand Aquatic Environment and Biodiversity, 2010) 22.

[70] Voigt et al, n 49, 430.

[71] Diehl, n 3, 58.

[72] *Podolsky v Cadillac Fairview Corp* [2013] ONCJ 65 (CanLII).

[73] Aurélien Kaiser, Thomas Merckx and Han Van Dyck, "The Urban Heat Island and Its Spatial Scale Dependent Impact on Survival and Development in Butterflies of Different Thermal Sensitivity" (2016) 6 *Ecology and Evolution* 4121, 4121.

It requires "rethinking" the role of air in supporting life and "new science" to understand the impacts. Air pollution effects to humans may be reasonably well understood, but tolerances for airborne animals are not well established,[74] and other impacts such as barotrauma to bats from wind-turbine-generated air-pressure changes,[75] or effects from special audible characteristics, noise[76] and artificial light[77] are nascent.

From the review of threats, wildlife would benefit from spatial protection, which reflects the vertical and volumetric nature of airspace use, limits the risk of collision with objects, reduces displacement from and obstruction of habitat, and maintains ecological quality commensurate with conservation status. The balance of this article examines the manner in which the law approaches airspace and provides for conservation of wildlife, including at the international level, and through a case study of the New Zealand and Australian approaches.

VI. The Treatment of Airspace at Law

Rights to airspace are evolving in response to intensifying human activity, and this article argues that changes are needed to accommodate successful co-existence of humans and animals.

Air law is built around private-property rights and sovereign rights.[78] Traditionally the common law linked rights to airspace with ownership of land relying on the expression *cujus est solum, ejus est usque ad coelum et ad inferos,* and thus extending ownership of the surface of the land to everything under the land and everything above it. These rights, described by Lord Wilberforce[79] as "imprecise", have been reduced by statute and by common law to accommodate aircraft overflight,[80] limit discharge of contaminants,[81] enable three-dimensional subdivision of airspace[82] and impose restrictions upon built form to avoid nuisance effects, and provide for the public interest.[83] As populations grow, cities are experiencing escalating interest in the sale and purchase of "air rights" to enable higher rates of urban intensification.[84] The point at which airspace above land ceases to be considered private property is not fully resolved in the New Zealand and Australian examples.[85] Currently it appears to extend to that

[74] Olivia V Sanderfoot, and Tracey Holloway, "Air Pollution Impacts on Avian Species Via Inhalation Exposure and Associated Outcomes" (2017) 12(8) *Environmental Research Letters* 083002; Sara Bayat et al, "Organic Contaminants in Bats: Trends and New Issues" (2014) 63 *Environment International* 40, 41.

[75] Erin F Baerwald et al, "Barotrauma Is a Significant Cause of Bat Fatalities at Wind Turbines" (2008) 18 *Current Biology* R695.

[76] Graeme Shannon et al, "A Synthesis of Two Decades of Research Documenting the Effects of Noise on Wildlife" (2016) 91 *Biological Reviews* 982; Darren S Le Roux and Joseph R Waas, "Do Long-tailed Bats Alter Their Evening Activity in Response to Aircraft Noise?" (2012) 14 *Acta Chiropterologica* 111.

[77] James D McLaren et al, "Artificial Light at Night Confounds Broad-scale Habitat Use by Migrating Birds" (2018) 21 *Ecology letters* 356; EG Rowse et al, "Dark Matters: The Effects of Artificial Lighting on Bats" in Christian C Voigt and Tigga Kingston (eds), *Bats in the Anthropocene: Conservation of Bats in a Changing World* (Springer, 2016) 187; Gareth R Hopkins et al, "Artificial Light at Night as a Driver of Evolution across Urban–Rural Landscapes" (2018) 16 *Frontiers in Ecology and the Environment* 472.

[78] Ruwantissa Abeyratne, *Air Navigation Law* (Springer-Verlag, 2012) 1.

[79] *Commissioner for Railways v Valuer-General* [1973] 3 All ER 268, 278 (Privy Council).

[80] See, eg, *Civil Aviation Act 1990* (NZ) s 92(2).

[81] See, eg, *Resource Management Act 1991* (NZ) s 15.

[82] *Ruapekapeka Sawmill Co Ltd v Yeatts* [1958] NZLR 265 (Haslam J); *Finlay Stonemasonry Pty Ltd v Jd & Sons Nominees Pty Ltd* (2011) 164 NTR 12, 23; [2011] NTSC 37; *Janney v Steller Works Pty Ltd* (2017) 53 VR 677; [2017] VSC 363; see also *Unit Titles Act 2010* (NZ) ss 3(a) (stratum estates) and 5 (definition of "unit").

[83] See, eg, *Resource Management Act 1991* (NZ) ss 2 and 9, which respectively define land to include the airspace above land and place restrictions upon the use of such land.

[84] Colleen Hawkes, "No More Land in London, So They're Selling Off the Air Space", *Stuff*, 13 February 2018 <https://www.stuff.co.nz>.

[85] See Struan Scott et al, *Adams' Land Transfer* (LexisNexis, online ed) 2.5; Australian Law Reform Commission, *Traditional Rights and Freedoms – Encroachments by Commonwealth Laws,* Report No 129 (2015) 468 [18.36]–[18.37] (13 September 2019) <https://advance.lexis.com/document/?pdmfid=1230042&crid=c94cc3f9-ab36-4535-9d21-d247b77d70ef&pddocfullpath=%2Fshared%2Fdocument%2Fanalytical-materials-nz%2Furn%3AcontentItem%3A5VP3-9HF1-DYFH-X2PV-00000-00&pdtocnodeidentifier=AAGAABAADAAD&ecomp=5dstk&prid=582968ed-dd92-4fa3-b625-cf5d3153d438>.

which can be "captured" by built form and consideration of the connection of the airspace activity to the landowner.[86]

In relation to sovereign rights, the concept of State control over airspace coalesced with the arrival of aviation.[87] International law has since developed to regulate aviation-traffic rights and security.[88] Military imperatives, commercial opportunities and human-safety concerns have dominated the schemes that control airspace in an exclusionary manner conditioned upon opportunity to access airspace and related rights. Flipped to the terrestrial domain, this approach would correspond with allowing commercial transport interests to dominate land-use systems, without recognising wider interests, such as private transport, housing, food systems, recreation, and conservation. Civil aviation control has partitioned or zoned three-dimensional areas in airspace applying a series of classifications to regulate air traffic.[89] The utility and application of the classifications for conservation purposes will be returned to in Part VIII A.

While air-traffic control systems apply strategic spatial-planning techniques in airspace that recognise its three-dimensional nature, corresponding conservation systems have been slow to follow suit. Provided the threats to wildlife in airspace are within contemplation, in many instances fixed terrestrial-habitat protection and development control can effectively limit aerial threats to wildlife, however, the mobility of airborne animals, their presence in airspace outside of protected reserves and the intensifying incidence of aircraft in lower airspace suggest the need for more comprehensive protection. Aerial routes, connections and spaces of congregation that sit outside underlying protected areas or stretched across them may require definition and protection as discrete areas, without reference to underlying terrestrial or aquatic areas.

The mobility of wildlife in airspace also exposes the limitations of habitat protection and suggests, despite some practical limitations, that species protection/mobile-habitat protection is an important adjunct to fixed-habitat protection. The threats issue from a range of sources, are species specific, and may have particular spatial and temporal characteristics. The review of threats also established that, for many airborne species, data is deficient, movement patterns and congregations are temporally or spatially fluid,[90] and that in many instances, such as impacts from vehicles/aircraft and buildings, everyday human activity is incompatible with airborne species' survival. Apprehension of these issues has led to calls to better recognise airspace as habitat in law and policy and the development of dynamic aerial reserves and protected areas are growing.[91]

VII. Provision in International Law

International law reflects an understanding that conservation measures require expression beyond two-dimensional spaces shown on maps and extend to airspace. Measures to protect ecosystems, areas and systems of protected areas suggest extension to the environment as a whole,[92] although the lack of explicit reference to airspace means this is not entirely clear. For instance, in the *Convention on Biological Diversity*'s Aichi Target 11 the focus upon the terrestrial and coastal marine areas and the use of the phrase "and integrated into the wider landscapes and seascapes" could imply exclusion of airscapes in this "well connected system":

> ***Target 11*:** By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected

---

[86] *Dome Valley District Residents Society Inc v Rodney District Council* [2008] 3 NZLR 821, [43].

[87] Abeyratne, n 78, 3.

[88] David Hodgkinson and Rebecca Johnston, *Aviation Law and Drones: Unmanned Aircraft and the Future of Aviation* (Routledge, 2018) 83.

[89] In the New Zealand context, this approach is explained in the description to the *Civil Aviation Rules 2008* (NZ) Pt 71, CAA Consolidation, "Designation and Classification of Airspace".

[90] Davy, Ford and Fraser, n 3, 779.

[91] Diehl et al, n 14, 378; Davy, Ford and Fraser, n 3, 779; Lambertucci, Shepard and Wilson, n 26, 503; Wallace, n 3, 240.

[92] See, eg, *Convention on Biological Diversity*, opened for signature 5 June 1992, 1760 UNTS 79 (entered into force 29 December 1993) Art 8 (CBD); Barbara Lausche et al, *The Legal Aspects of Connectivity Conservation: A Concept Paper* (IUCN, 2013) 58.

systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.[93]

Some agreements define habitat to include all areas that contain suitable conditions for species to live, thrive or survive and thus arguably or implicitly include aerial habitat. The *Convention on the Conservation of Migratory Species of Wild Animals* defines habitat as "any area in the range of a migratory species which contains suitable living conditions for that species" and encourages activities that protect habitat and that eliminates "activities and obstacles which hinder or impede migration".[94] Species-specific agreements also enable spatial and/or temporal zoning restrictions, which may have the effect of limiting harm in airspace to aerial species from specific threats such as incidental fisheries bycatch.[95]

Other agreements expressly refer to airspace in the context of habitat. *The Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia* is such an example and pledges the parties to endeavour to "identify important habitats, significant routes and congregatory sites for birds of prey" within their territories and to protect and conserve them.[96] The largely implicit attention to wildlife conservation in airspace at international law perhaps reflects the fugitive characteristics of air, the dynamism of wildlife and a preference to bind spatial protection to a more tangible two-dimensional terrestrial reference point. It may also be conditioned upon an apprehension that land and coastal marine areas include the airspace above them. The following part explores implementation measures which advance protection into airspace, including three-dimensional measures.

A. Implementation

The literature review demonstrates the wide variety of legal instruments and approaches that support connectivity conservation, but a paucity of specific reference to and protection of airspace. Wildlife conservation responses to the three categories of threat described in Parts V A– V C have tended to rely on the control of activities on underlying land and water as a proxy for control of airspace or assumed extensions of that protection to the air. For instance, regulatory effort aimed at connectivity conservation commonly relies upon mechanisms to protect terrestrial corridors and areas.[97] Alternatively, specific activities in airspace such as aircraft are controlled through dedicated civil aviation regulation.

---

[93] *Strategic Plan for Biodiversity 2011-2020, including Aichi Biodiversity Targets*, CBD Dec UNEP/CBD/COP/DEC/X/2, 10th mtg, Agenda Item 4.4 (29 October 2010) l para (IV) (13) Strategic Goal C, Target 11.

[94] *Convention on the Conservation of Migratory Species of Wild Animals*, opened for signature 23 June 1979, 1651 UNTS 333 (entered into force 1 November 1983) Arts 1(g), 5(h) (CMS); see CBD, Art 2 (defining "habitat" as "the place or type of site where an organism or population naturally occurs"); *Memorandum of Understanding on the Conservation of High Andean Flamingos, CMS MOU* (Bolivia, Chile and Peru) (November 2008) s 1 (agreeing to protect high Andean flamingos and "the habitats upon which they depend to complete their entire lifecycle"); *Agreement on the Conservation of African-Eurasian Migratory Waterbirds*, opened for signature 15 August 1996, 2365 UNTS 203 (entered into force 1 November 1999), Art III(2)(c) (AEWA) (agreeing "to identify sites and habitats for migratory waterbirds occurring within their territory and encourage the protection, management, rehabilitation and restoration of these sites"); *African Convention on the Conservation of Nature and Natural Resources,* opened for signature 15 September 1968, 1001 UNTS 4 (entered into force 16 June 1969) Art IX(2)(iii" (identifying species that are migratory or congregatory and therefore confined to specific areas at particular seasons, and providing them with appropriate protection); *Convention on the Conservation of European Wildlife and Natural Habitats,* opened for signature 19 September 1979, 1284 UNTS 210 (entered into force 1 June 1982), Arts 4(1), (3) (committing to preserving habitat, including "areas that are of important to migratory species…and which are appropriately situated in relation to migration routes, as wintering, staging, feeding, breeding or moulting areas").

[95] See, eg, *The Agreement on the Conservation of Albatross and Petrel,* opened for signature 19 June 2001, [2004] ATS 5 (entered into force on 1 February 2004) Annex 2, para 2.3.1

[96] *Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia CMS MOU* (November 2008) para 8(a). *Council Directive 92/43/ on the Conservation of Natural Habitats and of Wild Fauna and Flora* [1992] OJ L 206/7, 12 (*EU Habitats Directive*) Art 10 commits member states to manage "features of the landscape … of major importance for wild fauna" including features "by virtue of their linear and continuous structure (such as rivers with their banks or the traditional systems for marking field boundaries) or their function as stepping stones (such as ponds or small woods), are essential for the migration, dispersal and genetic exchange of wild species".

[97] Lausche et al, n 92, 105.

Significant work has been undertaken identifying national and international avian flyways, establishing flyways partnerships and defining connection routes and important sites; methods are evolving to use this knowledge to manage the effects of human development.[98] Land-use controls to protect underlying terrestrial or wetland areas, sites and features important to migration are becoming more widespread,[99] but despite this, a significant extent remains unprotected.[100] In the New Zealand context much of the work has been driven by active non-governmental groups and scientists, working from the ground up over many years to locate flyways, identify critical staging posts and influence governments to protect habitat, such as that of the bar-tailed godwit in the Yellow Sea. The connectivity/flyways literature demonstrates a focus on birds, as opposed to bats or invertebrates. Although flyways and migratory routes are growing in recognition, absent are integrated and strategic approaches to protecting the actual airspace. The Australian experience is similar. While there have been some efforts to identify key habitat[101] and to plan for habitat connectivity and protect flyways,[102] much of that work is admittedly based on two-dimensional models.[103] There is official recognition of "airspace" as a third-dimension in habitat for some species, but little recognition of the need to conserve that "airspace" habitat.[104] Instead, land-use controls for biodiversity and connectivity focus on terrestrial or wetland areas.

Much of the material located was in the form of guidance material and designed to support sensitive location of development, particularly for energy development, to limit impacts to species, including airborne animals.[105] The review identified innovative land-use controls to identify sensitive/hazard areas, to limit activities that are incompatible with airborne animals, and to apply graduated controls across a landscape – from providing information to landowners, requiring consultation, restricting land use or to imposing mitigation requirements dependent upon proximity to the sensitive area.[106] Due to the focus on the underlying sites, maps used to define the areas tended to be two-dimensional representations without specific relationship to activity or location in airspace. Although standard buffer zones provide a degree of protection (species and activity dependent) it is becoming apparent that for some species, simple two-dimensional, distance-base safety zones are insufficient and a more nuanced approach is required.[107] Models are being developed based on remote sensing techniques, which combine information on flying

---

[98] GC Boere and T Piersma, "Flyway Protection and the Predicament of Our Migrant Birds: A Critical Look at International Conservation Policies and The Dutch Wadden Sea" (2012) 68 *Ocean & Coastal Management* 157; Gerard C Boere and David A Stroud, "The Flyway Concept: What It Is and What It Isn't" in GC Boere, CA Galbraith and DA Stroud (eds), *Waterbirds Around the World: A Global Overview of the Conservation, Management and Research of the World's Waterbird Flyways* (The Stationery Office, 2006) 40, 40–46; Jeff S Kirby et al, "Key Conservation Issues for Migratory Land-and Waterbird Species on the World's Major Flyways" (2008) 18 *Bird Conservation International* 49; Department of Sustainability, Environment, Water, Population and Communities (Cth), *National Wildlife Corridors Plan: A Framework for Landscape-scale Conservation* (2012).

[99] See, eg, *Conservation of Habitats and Species Regulations 2010* (UK) s 39(3); see also Lausche et al, n 92, 53–168.

[100] Claire A Runge et al, "Protected Areas and Global Conservation of Migratory Birds" (2015) 350 *Science* 1255.

[101] Canran Liu et al, Note the scarcity of actual data for most species on key habitat and the need to rely extensively on modelling in "Identifying Wildlife Corridors for the Restoration of Regional Habitat Connectivity: A Multispecies Approach and Comparison of Resistance Surfaces" (2018) 13(11) *PloS one* e0206071.

[102] Liu et al, n 101, 2/14.

[103] Liu et al, n 101; Department of Sustainability, Environment, Water, Population and Communities, n 98; Stuart Whitten et al, *A Compendium of Existing and Planned Australian Wildlife Corridor Projects and Initiatives, and Case Study Analysis of Operational Experience: A Report for the Australian Government Department of Sustainability, Environment, Water, Population and Communities* (CSIRO, June 2011).

[104] Australian Capital Territory, *Action Plan for Listed Migratory Species* (March 2018) 17, 18, 40.

[105] See, eg, Jenny Bright et al, "Map of Bird Sensitivities to Wind Farms in Scotland: A Tool to Aid Planning and Conservation" (2008) 141 *Biological Conservation* 2342; JA Bright, RHW Langston and S Anthony, "Mapped and Written Guidance in Relation to Birds and Onshore Wind Energy Development in England" (Report No 35, Royal Society for the Protection of Birds, 2009); Ontario Ministry of Natural Resources, *Birds and Bird Habitats: Guidelines for Wind Power Projects* (2011).

[106] See, eg, Larry Burrows, No*rth Somerset and Mendip Bats Special Area of Conservation: Guidance on Development* (Somerset County Council, 2017).

[107] Tikkanen et al, n 58, 127.

times and heights with aerial-habitat use information, in order to estimate airspace use and risks for airborne species in different parts of different territories.[108]

The entrance of the drone into airspace is driving interest in airspace conservation, although research reveals that law and policy are struggling to keep pace with technology.[109] Reservation of airspace from incursion by RPA is becoming commonplace in areas such as national parks; however, other less-protected spaces are unlikely to receive this treatment despite the potential presence of threatened species in airspace. De facto aerial reserves for mobile species may be achieved with vertical aerial setbacks where congregations of aerial species are present in airspace in given seasons.[110] Technological controls represent a further avenue with geo-fencing and drone technology such as "detect and avoid" respectively enabling strategic protection of sensitive airspace and mitigation/avoidance of impact.[111]

Design guidelines and regulatory building standards[112] that recognise threats to airborne animals are now emerging, with cities located on major bird-migration pathways leading the way, as awareness of the heavy losses to species grows.[113] Measures to address light pollution and limit bird collision with buildings are applied and performance measures are supported by guidance and advances in building technology.[114] In recognition of the potential harm, the Ontario Court of Justice (in a rare private prosecution on an environmental matter under the provincial *Environmental Protection Act* and the federal *Species at Risk Act*) recognised sunlight as a potential contaminant. The decision established that the discharge of a contaminant, particularised as radiation (light) from reflective glass, caused or was likely to cause an adverse effect namely the birds' death or injury.[115] Despite this finding, a defence of due diligence on behalf of the defendants was successful.

Science and conservation efforts around bird migration are well established, but attention is now being drawn to other highways in the sky, particularly in relation to bats, bees and butterflies, with voluntary initiatives raising awareness and support for enhanced connectivity.[116] It is well understood that the definition of habitat corridors, networks and connections and their protection enhances biodiversity conservation, and further that their expression is useful in co-ordinating conservation efforts across areas and jurisdictional boundaries.[117]

VIII. Provision in New Zealand and Australia

In the New Zealand example, protection of wildlife in airspace is not particularly explicit and where it does occur it will generally be due to protection mandated during permitting under the *Resource Management Act 1991* (NZ) (RMA)[118] or the *Wildlife Act 1953* (NZ), protection from hunting or killing

---

[108] Tikkanen et al, n 58, 127.

[109] Wallace, Martin and White, n 36.

[110] See, eg, Canadian Wildlife Service, *Environment and Climate Change Canada's Input to the Nunavut Planning Commission Regarding Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area* (May 2016) 132.

[111] Bart Elias, *Unmanned Aircraft Operations in Domestic Airspace: US Policy Perspectives and the Regulatory Landscape* (Report No 7-5700, Congressional Research Service, 2016) 19.

[112] See, eg, City of Toronto, *Toronto Green Standard Version 3* (2017) <https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/design-guidelines/bird-friendly-guidelines/>.

[113] Daniel Klem, "Bird–Window Collisions: A Critical Animal Welfare and Conservation Issue" (2015) 18 *Journal of Applied Animal Welfare Science* s11, s13.

[114] See, eg, City of Toronto, n 112, cls EC4.1 (Bird collision) to EC5 (Light pollution).

[115] *Podolsky v Cadillac Fairview Corp* [2013] ONCJ 65 (CanLII).

[116] Peter Kotecki, "A 'Bee Highway' Is Being Created in Detroit, and It Could Help Offset the Dangerous Decline of Honeybees", *Business Insider Australia*, 10 October 2018 <https://law.unimelb.edu.au/__data/assets/pdf_file/0005/2877782/AGLC3.pdf>.

[117] Claire A Runge et al, "Coordinating Domestic Legislation and International Agreements to Conserve Migratory Species: A Case Study from Australia" (2017) 10 *Conservation Letters* 765.

[118] See eg, Board of Inquiry, *Final Report and Decision of the Board of Inquiry into the Hauāuru mā Raki Wind Farm and Infrastructure Connection to Grid* (May 2011) 150.

under the latter Act[119] or that gained by association with the protected-area network administered by the Department of Conservation under Sch 1 of the *Conservation Act 1987* (NZ).

The Australian example is similar albeit inherently more complex. Unlike New Zealand's unitary government and relatively unified legislative framework, Australia, operates under a federal system with multiple, overlapping legislative schemes. The role of the federal government is limited[120] and most planning authority rests with the State and Territorial governments.[121] Where it does act, the Commonwealth Government generally uses co-operative mechanisms such as "delegations and referrals of legislative power, intergovernmental agreements backing interlocking legislation, co-operation at executive levels and in the application of judicial power".[122]

A. Aircraft and Wildlife Conservation

The *Civil Aviation Act 1990* (NZ) (CAA) regulates aviation in New Zealand with primary objectives of aviation safety and compliance with international agreements. The *Civil Aviation Act 1988* (Cth) and the *Airspace Act 2007* (Cth) serve similar functions in Australia. These statutes enable rules to be made for a range of purposes including for ensuring environmental sustainability[123] and for classifying and regulating airspace for purposes of civil aviation safety, national security and "for any other reason in the public interest".[124]

By this legislation, rules have been used to restrict aircraft in specified areas in Australia and New Zealand. In general terms aircraft in New Zealand and Australia must fly at least 500 feet above ground and 1,000 feet above urban/congested areas.[125] However, all craft must take off and descend to ground level and a significant issue for wildlife is the presence of airports and aerodromes in areas where avian species congregate. Impacts extend beyond aerodromes. The use of lakes and water bodies as service airports for floatplanes, for instance New Zealand's Lake Taupo, is a further potential area for harm.

1. Public Conservation Land and Aircraft

Although the *Conservation Act 1987* does not specifically define land to include airspace, in its absence the common-law doctrine applies to reserve ownership rights to the airspace to the Crown. Development is restricted on public conservation lands and regulated through the concession process, which extends to capture aircraft landings and take-off including drones.[126] In addition RPA pilots require consent to fly above any person and consent from the property owner or occupier to fly above property,[127] whereas overflight by aircraft is not regulated in the same manner due to the altitude of flight path. Noise-abatement certification may also apply in specified locations.[128]

The restricted area classification may be applied for conservation purposes "in the public interest", and limit aircraft intrusion,[129] including height of overflight of an area defined as a three-dimensional

[119] *Wildlife Act 1953* (NZ) s 63(1)(a).

[120] Nicole Gurran, *Australian Urban Land Use Planning: Principles, Systems and Practice* (Sydney University Press, 2nd ed, 2011) 56.

[121] Gurran, n 120, 84.

[122] RS French "Cooperative Federalism in Australia – An Intellectual Resource for Europe? I" (2006) 65 *Amicus Curiae* 9, 9–10.

[123] *Civil Aviation Act 1990* (NZ) s 28(1)(cd); *Civil Aviation Act 1988* (Cth) s 9A; see also *Airspace Act 2007* (Cth) s 3.

[124] *Civil Aviation Act 1990* (NZ)s 29A(c); *Airspace Act 2007* (Cth) s 8; *Australian Airspace Policy Statement* (Cth) s 16.

[125] *Civil Aviation Rules 2018* (NZ) r 91.311; *Civil Aviation Regulations 1988* (Cth) reg 157. Additionally, sightseeing flights generally must observe minimum distances, including altitude, from marine mammals. See *National Parks and Wildlife (Protected Animals—Marine Mammals) Regulations 2010* (SA) reg 12; *Marine Mammals Protection Regulations 1992* (NZ) s 18(g), (h).

[126] *Conservation Act 1987* (NZ) s 17O; *Reserves Act 1977* (NZ) s 59A; *National Parks Act 1980* (NZ) s 49; *Wildlife Act 1953* (NZ) s 14AA.

[127] *Civil Aviation Rules 2017* (NZ) r 101.207(a)(1)(i-ii)).

[128] Department of Conservation, *Aircraft Activities* <https://www.doc.govt.nz/get-involved/apply-for-permits/business-or-activity/aircraft-activities/>.

[129] Office of the Parliamentary Commissioner for the Environment, *Management of Noise from Aircraft Overflying Sensitive Environments* (PCE, 2000) 4–5; Alon Tal, "Naturally Quiet: Towards a New Legislative Strategy for Regulating Air Space above National Parks in New Zealand" (2001) 10 *Otago Law Review* 537, 546.

space.[130] Maps and schedules[131] demonstrate application of this classification (17 in total) largely associated with fauna protection in conservation areas (13 in total), such as Farewell Spit, administered by the Department of Conservation. Those for non-conservation purposes are a rocket facility on Mahia Peninsula, the Marsden Point Oil refinery, avalanche protection at the Homer tunnel and RPA spatial-engineering research. Given the significant number of Important Bird Areas in New Zealand[132] 13 restricted areas nationwide are not an extensive use of the restriction. The facts that "low flying zones"[133] are not generally associated with conservation areas and would require consent of the registered owner or administrator of the land or water below the low flying zone[134] and in accordance with zone protocol[135] are seen as ameliorating the position.[136] However, an examination of the mapped low flying zones and associated schedules demonstrates coincidence with, or close proximity to, several sites where threatened New Zealand avian species are known to congregate in airspace in high numbers including the Firth of Thames Ramsar site and Whangapoua Harbour.[137] Conservation management strategies apprehend these issues for sensitive flyways and migratory routes;[138] however, in the instance of the Firth of Thames Ramsar site, the policy is limited to advocacy for prevention of low-flying aircraft including paragliding and aerobatics during important migratory periods, including from early September to the end of March each year for wading birds.[139] The CAA and associated Rules are largely silent on impacts to wildlife, and greater regulatory recognition and integration of the issues would ensure a stronger focus and more rigorous protection for wildlife, especially in area identification for flight purposes, execution of agreements with landowners and administering agencies and related flight protocols.

Comparatively little of Australia's public lands – also called Crown lands – are controlled by the Commonwealth government. Most Crown lands are subject to State or Territory control.[140] Although State and Territory regulations differ, most preclude both aircraft and RPA in national parks without a permit. South Australia seems to have the most restrictive rules for flying RPA in national parks; Queensland, the most permissive. In South Australia, it is an offense to fly RPA in national parks, reserves, or marine park restricted access zones without a permit, and permits are given sparingly.[141] Likewise, piloted aircraft may not land or take off from park and reserve lands;[142] overflights are not precluded, but are encouraged to observe Fly Neighbourly Advice parameters restricting flights to specific routes. In

[130] *Civil Aviation Rules 2008* (NZ) r 71.15 (b)(1), requires establishment of New Zealand Air Navigation Register, including a current description of each portion of airspace that is designated under Pt 71.

[131] Civil Aviation Authority (NZ), *Aeronautical Services: NZANR – Part 71 – Restricted Areas (R)* (18 November 2018) AIP New Zealand <http://www.aip.net.nz/pdf/NZANR_Part_71_Restricted_Areas_(R).pdf>.

[132] For instance, for seabirds alone, there are 141 sites of global significance on land, and 69 in the marine environment. Forest and Bird, *Important Bird Areas for New Zealand Seabirds* (1 May 2018) <https://www.forestandbird.org.nz/resources/important-bird-areas-new-zealand-seabirds>.

[133] *Civil Aviation Rules 2008* (NZ) r 71.163 (these zones designate a portion of airspace as a low flying zone where pilot training in low-level manoeuvres may be conducted the vertical limits of a which must extend from the surface of the earth to a height of 500 feet).

[134] *Civil Aviation Rules 2008* (NZ) r 71.163(e).

[135] *Civil Aviation Rules 2008* (NZ) r 91.131 (low-flying zones).

[136] Civil Aviation Authority, *Civil Aviation Rules, Part 71 – Re-issue, Designation and Classification of Airspace (Docket 98/CAR/1304)* (5 July 2004) 35.

[137] Civil Aviation Authority, *Aeronautical Services: NZANR – Part 71 – Low Flying Zones (LFZ)* (8 November 2018) <http://www.aip.net.nz/pdf/NZANR_Part_71_Low_Flying_Zones_(LFZ).pdf>.

[138] See, eg, Department of Conservation, A*uckland Conservation Management Strategy 2014–2024*, Objective 6.1.1 and Policy 15.2.2.12.

[139] Department of Conservation, *Auckland Conservation Management Strategy 2014–2024*, s 23 (Firth of Thames/Tīkapa Moana Wetland Place) cl 23.2.2.2.

[140] See *Crown Land Management Act 2016* (NSW); *Crown Lands Act 1976* (Tas); *Crown Land Management Act 2009* (SA); *Crown Land (Reserves) Act 1978* (Vic); the *Land Act 1958* (Vic); *Land Act 1994* (Qld).

[141] *National Parks and Wildlife (National Parks) Regulations 2016* (SA) regs 12, 42.

[142] *National Parks and Wildlife (National Parks) Regulations 2016* (SA) regs 12, 42.

contrast, Queensland does not restrict use of RPA by small parties in parks.[143] Piloted aircraft are subject to greater restrictions; the *Nature Conservation (Protected Areas Management) Regulation 2006* (Qld) directs aircraft to maintain a minimum height of 1,500 feet above sea level.[144]

2. General Land and Aircraft

The management and regulation of bird collision at or near New Zealand airports is primarily recognised as a human safety concern, despite occasional and significant bird loss, including threatened species such as the New Zealand wrybill.[145] Australian Civil Aviation Safety Authority general civil aviation rules and regulations similarly focus on mitigating wildlife hazards at aerodromes.[146] Both nations are signatories to the *Chicago Convention on International Civil Aviation* with concomitant association to the International Civil Aviation Organisation and requirements to mitigate bird hazards to aircraft operations. Aerodrome operators are required to establish an environmental management program for minimising or eliminating any wildlife hazard to aircraft operations at the aerodrome.[147] Accordingly, the New Zealand and Australian authorities advise a range of passive and active techniques to mitigate or eliminate the bird-strike hazard.[148] Passive management techniques include habitat modification to reduce attractants, exclusion techniques and the management of ground cover. In New Zealand, more active techniques such as dispersal through auditory deterrents, pyrotechnics or dogs, or removal by elimination or translocation will usually require authorisation under the *Wildlife Act 1953*. A Department of Conservation guidance document advises killing of birds "as a last resort" due to risks to the population of a protected species and significant negative publicity for the airport operator.[149] From a strategic view point the Authority urges early engagement by aerodrome operators in land-use planning processes to influence both the location and in-situ practices of other land uses that may exacerbate bird-collision hazard such as landfills, wastewater treatment plants, and a range of agricultural and recreational activities.[150]

Drones and other RPA can be distinguished from piloted aircraft due to the height at which they fly, their flight characteristics and the close connection between the operator and the aircraft. Protection of wildlife from the impacts of collision mortality and disturbance occasioned by RPA would be improved by (among other things) better identification of sensitive sites for wildlife on private land, increased public information, implementation of wildlife setbacks and non-exemption from resource management schemes.[151]

---

[143] Queenstown Government, Business Queensland, *Commercial Filming and Photography in National Parks, Conservation Parks, Recreation Areas and State Forests* (1 Jul 2018) <https://www.business.qld.gov.au/industries/hospitality-tourism-sport/tourism/starting-up/regulations/parks-recreation-forests/filming-photography>.

[144] *Nature Conservation (Protected Areas Management) Regulation 2006* (Qld) s 110, Sch 7; *Nature Conservation Act 1992* (Qld) s 752(2) (power to enact regulations on flight of aircraft).

[145] CAA, Bird Incident Rate Report 2018 (2018), *Evidence of John Dowding in the Matter of a Board of Inquiry Appointed under Section 146 of the Resource Management Act 1991 to Consider Resource Consent Applications by Contact Wind Limited in Respect of the Hauāuru mā raki Wind Farm Proposal*, [90]; JE Dowding, "Wrybill" in CM Miskelly (ed), *New Zealand Birds Online* (2017) <www.nzbirdsonline.org.nz>.

[146] See, eg, *Civil Aviation Regulations 1988* (Cth) reg 175.130; Civil Aviation Safety Authority, *Wildlife Hazard Management at Aerodromes* (Advisory Circular AC139-26) (July 2011) <https://www.casa.gov.au/files/139c26pdf>; Department of Infrastructure and Regional Development (Cth), *National Airports Safeguarding Framework: Guidelines C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports* (Department of Infrastructure and Regional Development, undated).

[147] *Civil Aviation Rules 2008* (NZ) r 139.71 (Wildlife Hazard Management).

[148] Civil Aviation Authority, *Wildlife Hazard Management at Aerodromes* (Advisory Circular AC139-16) (7 October 2011) <www.caa.govt.nz>; Civil Aviation Safety Authority, *Wildlife Hazard Management at Aerodromes* (Advisory Circular AC139-26) (July 2011) <https://www.casa.gov.au/files/139c26pdf>; Department of Infrastructure and Regional Development, n 146.

[149] Department of Conservation (NZ), *Guidelines Relating to Authorisations Giving Authority to Disturb or Kill Protected Birds at Airports* (2018) 2.

[150] Civil Aviation Authority, n 148, 12–15

[151] Wallace, Martin and White, n 36; Pip Wallace, "Aerial conflicts: Drone regulation and gaps in spatial protection" [2016] *Resource Management Journal* 17.

B. Other Human Activities in Airspace and Wildlife Conservation

1. RMA in New Zealand

The RMA influences outcomes for wildlife in airspace due to its focus upon the sustainable management of natural and physical resources. Governing activities within terrestrial and coastal marine areas,[152] the RMA provides mechanisms to protect biodiversity including purpose and principle clauses,[153] resource use restrictions,[154] the preparation of extensive resource management standards, policies and plans,[155] and development of permitting procedures with mandatory environmental impact assessment requirements.[156]

The approach to the protection of airspace, particularly airspace as wildlife habitat, is not fully resolved. Protection of air quality from point source pollution is explicit under s 15 of the Act, largely through application of a restrictive presumption and Regional Plan regulation. Strategic planning and management of the airspace itself is, however, complicated through the nature of its definition. Regulation of land use includes the airspace above land (s 2); likewise, regulation of the coastal marine area includes the airspace above that area (s 2). Although supporting recognition of the interconnections between the spaces, the definition may limit specific recognition of the airspace as a place in its own right. It also tends to focus planning efforts on the underlying spaces, perhaps limiting definition of areas that require protection independent of, or only partially dependent upon, the underlying spaces, as in the example of aerial corridors. Where habitat protection is tied to discrete patches of terrestrial habitat of an underlying aerial corridor or route, without definition of the full route, it may also enable strategic planning for future urban development including infrastructure such as power lines, without fully accounting for the existence and/or value of the aerial corridor.

A review of the legislation, case law and a selection of RMA plans demonstrates both implicit and explicit recognition that activities in airspace can be regulated under the RMA and further that airspace can be the subject of ecological protections for this purpose. The RMA provides for the protection of the significant habitat of indigenous fauna as a matter of national importance to be recognised and provided for under s 6(c), and protection of significant habitat is common in resource management plans. Due to the definitions in s 2 it is likely that when an area of land or water is protected as significant habitat then it includes the airspace above it; however, ideally, the plans or the mapping/scheduling identification should make this explicit, including the vertical and horizontal dimensions of protection. Airspace is habitat,[157] capable of being independently recognised and protected as significant habitat,[158] but spatially explicit protection is very limited.

It is common for plans to identify areas more broadly in relation to ecological protection, combining mandates in ss 5 and 6 and applying terms such as "significant natural area" or "significant ecological area". Administering authorities may elect to specifically exclude airspace from definition within these areas; however, arguably sound justification would be required for failure to recognise and protect aerial habitat that is significant under s 6(c).[159] This is particularly so for coastal areas subject to directive protection, and recognition and identification policies under the New Zealand Coastal Policy Statement

[152] As defined by *Resource Management Act 1991* (NZ) s 2.

[153] *Resource Management Act 1991* (NZ) ss 5–8, 17.

[154] *Resource Management Act 1991* (NZ) ss 9–17.

[155] *Resource Management Act 1991* (NZ) Pt 5.

[156] *Resource Management Act 1991* (NZ) Pt 6.

[157] Wallace, n 3.

[158] Board of Inquiry, *Final Report and Decision of the Board of Inquiry into the Hauāuru mā Raki Wind Farm and Infrastructure Connection to Grid* (May 2011) [1108b].

[159] See, eg, *Royal Forest and Bird Protection Society of New Zealand Inc v Auckland Council* [2018] NZHC 1069, [15]–[19] and its approaches to area identification and recognition.

2010 and any other national policy.[160] Some plans do recognise airspace as a habitat type (as opposed to a defined place) and enable protection accordingly.[161]

The use of ecological overlays in spatial plans, which inform regulatory plans, is an advance in extending protection for wildlife in airspace, although reconciling the intention of the overlay with underlying activities is fraught due to competing interests.[162] Clear language is required in spatial and resource management plans to explain the legal relationships between competing and often complex plan notations and provisions,[163] at the same time ensuring consistency with statutory mandates. In addition, the volumetric proportions of these overlays are unclear. Protective lateral buffer zones are not consistently applied in the New Zealand example to protect wildlife, even for areas of international importance such as Ramsar sites.[164] Nor have we seen advances in "green building standards" which deal with issues of impacts to wildlife from light, heat and building-collision risks as in the North American examples.

In an operational sense, it is not uncommon to recognise and manage threats to wildlife in airspace as adverse effects identified through the consenting process.[165] However, these processes generally fail to inform wider strategic processes, with the information being siloed to the concerns of any permit or consent.

A further complication is introduced by airborne threats that are not fixed to or bounded by terrestrial areas or water bodies. Overflying aircraft are the most significant class of untethered activities, and they are largely exempted from consideration under the RMA as a territorial authority's power to regulate or restrict overflying aircraft is limited to noise-emission controls for airport use,[166] and s 12(5) essentially reproduces the position in the coastal marine area. (Likewise, in Australia, while State and Territories enjoy broad powers, the regulation of aircraft is an area controlled by national and international law.) This position limits the ability to protect wildlife habitat/sensitive airspace from the impacts of aircraft, particularly in the case of RPA and local effects.[167] The position could be ameliorated by better definition of critical or significant airspace for birds, bats and invertebrates, and either the inclusion of RPA within the ambit of the RMA (and similar regimes) or alternatively integration with civil aviation regulation and advice systems. Either way, currently a gap exists in the identification and protection of significant

[160] For example: Policy 11, particularly 11(b)(v) habitats including areas and routes important to migratory species and (vi) ecological corridors and areas important for linking or maintaining biological values identified under this policy, Policy 7(b) Strategic Planning and Policy 15(c)(i) and (vi). For judicial discussion, see *Opoutere Ratepayers and Residents' Association v Waikato Regional Council* [2015] NZEnvC 105, [55]–[72] (Harland J).

[161] Policy 11A "Criteria for determining significance of indigenous biodiversity" Waikato Regional Council, Waikato *Regional Policy Statement* (operative 2016) refers to: "Criteria may be specific to a habitat type including water, land or airspace or be more inclusive to address connectivity, or movement of species across habitat types."

[162] *Royal Forest and Bird Protection Society of New Zealand Inc v Auckland Council* [2018] NZHC 1069, [15] onwards, describes the competing interests and the acceptance of the parties that the identified Significant Ecological Areas could not be modified or deleted on account of "other planning imperatives".

[163] *Auckland Council v Budden* [2017] NZEnvC 209, [38].

[164] Wallace, n 3, 497.

[165] See, eg, *Mainpower NZ Ltd v Hurunui District Council* [2011] NZEnvC 384, [160]–[161], imposing preconstruction monitoring to determine if birds use the site and if conditions for mitigation of "avifauna" are adequate; *Rangitikei Guardians Society Inc v Manawatu-Wanganui Regional Council* [2010] NZEnvC 14, [221], discussing conditions to manage potential risks to bats and avifauna of a wind farm operation; *Genesis Power Ltd v Franklin District Council* (2005) 12 ELRNZ 71, [231]; [2005] NZRMA 541, discussing conditions to monitor bird fatalities; see also Decision of Hearing Commissioners, *On a Review of Resource Consent Conditions Relating to the Te Rere Hau Wind Farm Operated by New Zealand Windfarms Limited* (PGR-120496-5-208-V1, 27 November 2017) [26], discussing conditions to monitor bird kill; Report and Decision of Hearings Commissioners, *On the Application to the South Taranaki District Council for Land Use Consents – RML16030.1 to Construct, Operate and Maintain the Waverley Wind Farm and RML16030.2 2 for the Construction, Operation and Maintenance of a Single Circuit 110 KV Transmission Line between the Waverley Wind Farm and an Electric Substation on Mangatangi Road Waverle*y (PGR-124781-1-106-V17, 7 July 2017) [106], [145], mandating pond removal to "displace birds" who might collide with turbines.

[166] *Resource Management Act 1991* (NZ)s 9(5); *Dome Valley District Residents Society Inc v Rodney District Council* [2008] 3 NZLR 821, [40] (High Court).

[167] Wallace, n 151, 22.

airspace habitat. As pressure on airspace intensifies with the increasing presence of drones, commercial rocket applications, airborne recreation and industry devices to better secure boundaries in airspace are required.

2. Aeroconservation in Planning in Australia

In Australia, fragmentation in governance renders an inconsistent approach to airspace conservation and protection.[168] There is some overlay of national environmental law for matters of national significance, but Australia lacks a national framework for spatial planning, and thus the States and Territories "have evolved their own idiosyncratic planning systems, policies, legislation and approaches".[169] While government structures and policies observe these arbitrary boundaries, the habitat needs of aerial and other mobile species do not. Nevertheless, there are multiple opportunities to influence outcomes for wildlife in airspace at both the Federal and at the State and Territorial level.

The Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (*EPBC Act*) provides limited authority for national direction on wildlife protection. The *EPBC Act* is broadly aimed at promoting ecologically sustainable development, which includes "conservation of biodiversity"[170] and protecting the environment.[171] The *EPBC Act*'s ambit is restricted due to the limited "role for the Commonwealth in relation to the environment", which is primarily "on matters of national environmental significance".[172] Activities with significant impacts on matters of national significance require review and approval by the Commonwealth,[173] a process that could be used to reduce habitat impacts.[174] The *EPBC Act* contains further potentially powerful but sparingly employed provisions that could underpin a national framework for habitat protection, such as the processes for identifying critical habitat for species[175] (including recognized aerial habitat) and for bioregional planning to identify key "components of biodiversity".[176] Both processes would promote more "support strategic, consistent, and informed decision-making" under the Act.[177]

Due to the actual and applied limits on national authority, spatial planning remains largely a matter for the State and Territorial authorities. A comprehensive discussion of all statutory schemes is beyond the scope of this article, however, the focus of the discussion here is on Queensland, which was selected for examination as it hosts two World Heritage Areas. Furthermore, the statutory nature of its regional plans could potentially support extensive habitat corridors, aerial and terrestrial.

---

[168] See, eg, Rachel Miller et al, "Protecting Migratory Species in the Australian Marine Environment: A Cross-Jurisdictional Analysis of Policy and Management Plans" (2018) 5 *Frontiers in Marine Science* 229, 2; Runge et al, n 117.

[169] Gurran, n 120, 105.

[170] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 171(3), (4) explains that the "components of biodiversity includes species, habitats, ecological communities, genes, ecosystems and ecological processes" and that the components are to be identified "having regard to the matters set out in Annex I to the 'Biodiversity Convention', which for Australia focuses on protected areas".

[171] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 3(1)(a), (1)(c).

[172] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 3. Matters of national significance include among other things: world heritage properties (s 12), national heritage places (s 15B), wetlands of international importance (s 16), threatened species and ecological communities (s 18), listed migratory species (s 20), Commonwealth marine areas (s 23), Great Barrier Reef Marine Park (s 24C).

[173] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) Ch 2, Pt 3, Div 1.

[174] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) Ch 2, Pt 3, Div 1, s 34; Samantha Hepburn "Why aren't Australia's Environment Laws Preventing Widespread Land Clearing?" *The Conversation*, 8 March 2018 <https://theconversation.com/why-arent-australias-environment-laws-preventing-widespread-land-clearing-92924>.

[175] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 207A–207C; Australian Government, Species Profile and Threats Database: Register of Critical Habitat, Department of the Environment and Energy <http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl> (noting five areas identified as critical habitat in 2002, 2004, and 2005).

[176] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 176.

[177] Australian Government, *Marine Bioregional Plansi,* Department of the Environment and Energy <http://www.environment.gov.au/marine/marine-bioregional-plans>.

A review of Queensland's legal authorities and select plans demonstrate existing opportunities to recognise and protect airspace as habitat. For instance, the *Environmental Protection Act 1994* (Qld) authorises the Minister to adopt environmental policies to protect or enhance Queensland's environment, although the Act, in practice, seems to be more narrowly aimed at environmental pollution, including air pollution.[178]

Spatial planning occurs under the *Planning Act 2016* (Qld).[179] The act's purpose is to establish a system for land-use planning and development that achieves "ecological sustainability",[180] including "protecting biological diversity".[181] It contains several mechanisms to further these purposes: State planning policies,[182] regional plans,[183] planning schemes, instruments, and policies,[184] and development assessments.[185] The approach to airspace as habitat – while achieving limited recognition in some Australian jurisdictions[186] – is unclear in Queensland. Under the Act, land-use regulation explicitly includes the airspace above land,[187] which could include aerial habitat. That said, the concept of habitat in the *Planning Act 2016* is largely undefined, indeed scarcely mentioned. Where it is mentioned, it tethers habitat to vegetation in the context of a cross-reference to the *Vegetation Management Act 1999* (Qld),[188] tying habitat to vegetation by implication.[189] Given the ambiguity, express authority to regulate airspace as habitat would provide greater clarity and greater protection for wildlife dependent on airspace.

State Planning Policy acknowledges that Queensland's "biodiversity is unique and irreplaceable", but contains few strict mandates.[190] State Planning Policy does favour avoidance of significant impacts on matters of national or State environmental significance as well as maintaining and enhancing ecological connectivity.[191] Although these policies might implicitly authorise habitat preservation and connectivity, including in airspace, the notion of connectivity is not expressly tied to habitat. Rather, connectivity is to be achieved by avoiding "fragmentation of matters of environmental significance".[192] Where protection is tied to landscapes and vegetation, without full definition of habitat values and uses, it may encourage strategic planning and impact assessment that does not fully account for the existence and value of the habitat or indeed the compatibility of the proposed land use with wildlife and their habitat needs.[193]

Just beneath State Planning Policy in the planning hierarchy, regional planning documents must be considered in local planning.[194] The *Far North Queensland Regional Plan 2009–2031* is such a plan and

[178] *Environmental Protection Act 1994* (Qld) ss 18, 19, 26, 27; *Environmental Protection (Air) Policy 2008* (Qld); *Environmental Protection (Water) Policy 2009* (Qld).

[179] *Planning Act 2016* (Qld).

[180] *Planning Act 2016* (Qld) s 3(1).

[181] *Planning Act 2016* (Qld) s 3(3)(a)

[182] *Planning Act 2016* (Qld) ss 4(a), 8(2), 10, 12.

[183] *Planning Act 2016* (Qld) ss 4(b), 8(2), 10.

[184] *Planning Act 2016* (Qld) ss 4(c), 4(d), 4(e), 8(3), 10, 12.

[185] *Planning Act 2016* (Qld) s 4(f), Ch 3.

[186] Australian Capital Territory, *Action Plan for Listed Migratory Species* (March 2018) 17, 18, 40, recognizes airspace as primary habitat for certain species.

[187] *Planning Act 2016* (Qld) Sch 2 (definition of "land").

[188] *Planning Act 2016* (Qld) ss 329, 330; *Vegetation Management and Other Legislation Amendment Act 2018* (Qld) s 141.

[189] *Vegetation Management and Other Legislation Amendment Act 2018* (Qld) s 141.

[190] Department of Infrastructure, Local Government and Planning (Qld), *State Planning Policy* (July 2017) 38.

[191] Department of Infrastructure, Local Government and Planning, n 190, 39.

[192] Department of Infrastructure, Local Government and Planning, n 190, 39.

[193] See, eg, Tim Flannery, *After the Future: Australia's New Extinction Crisis* (Quarterly Essay, No 48, Collingwood: Black Inc, November 2012); Stephen Garnett, "Saving Australian Endangered Species – A Policy Gap and Political Opportunity", *The Conversation*, 22 November 2012 <https://theconversation.com/saving-australian-endangered-species-a-policy-gap-and-political-opportunity-10914>; see also Steve Gray, "Put Ecosystem First, Says Garrett", *The Age*, 17 August 2009 <https://www.theage.com.au/national/put-ecosystem-first-says-garrett-20090817-emy1.html>.

[194] *Planning Act 2016* (Qld). Note that the Act defines regional plans as state instruments (s 8(2)(b)) and reinstated the statutory power of regional plans (which has fluctuated under different governments) with full effect upon plan review.

contains an overarching planning regime for some of the "most important natural habitat for conservation of biological diversity world-wide", including extensive areas of the Wet Tropics and the Great Barrier Reef World Heritage areas.[195] The plan's policies are generally worded but are intended to "avoid locating urban developments within areas of high ecological significance" and to avoid or minimise adversely impacting ecological values where urban development is already sited in such areas.[196]

Thus, as in the New Zealand example, Queensland's scheme provides tools that could be used to protect airspace-dependent wildlife, but those tools are rarely deployed. The situation is, as noted above, complicated by the greater fragmented structures of government, resulting in greater siloing of information and governance.

The exemplary case is the Spectacled Flying-Fox, a large fruit-feeding bat species inhabiting north-eastern Queensland and the Wet Tropics. The flying-fox population has been falling for decades,[197] despite listing under the *EPBC Act* in 2003 and under the *Nature Conservation Act 1992* (Qld) in 2015, as threats to and needs of the species are not well understood.[198] What is known is that the population is nomadic, following flowering and fruiting events round its range.[199] The recovery plan notes that critical habitat for the species includes not only foraging and roosting habitat, but also "may" include migration corridors,[200] although its critical habitat remains unmapped.[201] It is likely that the failure to invoke federal powers in this area has led to less strategic, consistent, or informed decision-making. As Roberts et al observed, "Effective conservation and management of flying-foxes are constrained by lack of knowledge of their ecology, especially of movement patterns over large spatial scales."[202]

The Cairns Regional Council's *CairnsPlan 2016* reflects State planning policy and the regional plan, recognising the value of maintaining and protecting the "region's biodiversity values and associated habitats" and the "[E]ndangered, vulnerable, and threatened flora and fauna species and their habitats".[203] Apparently to effectuate these policies, the plan designates much of the Wet Tropics, and thus a great deal of the flying-foxes' range, within a Conservation Zone and a Natural Area Overlay.[204]

This is perhaps the classic case in which discrete two-dimensional spatial protections strain fitness for purpose. The failure to explicitly account for the aerial mobility of the flying fox has been detrimental to the species. The species is known to forage widely outside of the Wet Tropics, and key threats to the species are found in those areas,[205] including habitat degradation and destruction, displacement, persecution. For instance, the species' national recovery plan has identified human-made obstacles in the species' airspace, such as netting, fencing, and powerlines that are a "significant threat" to the species.[206] In one particularly infamous case, an electrified aerial "fence" electrocuted about 18,000 Spectacled

[195] Department of Infrastructure and Planning (Qld), *Far North Queensland Regional Plan 2009–2031* (2009) 37.

[196] Department of Infrastructure and Planning, n 195, 40.

[197] Threatened Species Scientific Committee, Australian Government, *Conservation Advice: Pteropus conspicillatus* (22 February 2019) 7 <http://www.environment.gov.au/biodiversity/threatened/species/pubs/185-conservation-advice-22022019.pdf>.

[198] Threatened Species Scientific Committee, n 197, 8.

[199] Department of Environment and Resource Management (Qld) (DERM), *National Recovery Plan for the Spectacled flying-fox Pteropus conspicillatus* (2010) 17.

[200] DERM, n 199, 17.

[201] DERM, n 199, 17.

[202] See, eg, Billie J Roberts et al, "Long-Distance and Frequent Movements of the Flying Fox *Pteropus poliocephalus*: Implications for Management" (2012) 7 *PLoS One* e42532; see also Australian Government, *Draft Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus* (Department of the Environment and Energy) (January 2017) 5 (recovery success requires "improved understanding of habitat critical to the survival of the species").

[203] Cairns Regional Council, *CairnsPlan 2016* (March 2016) s 3.4.2.1.

[204] Cairns Regional Council, n 203, s 3.4.2.1.

[205] Threatened Species Scientific Committee, n 197, 3.

[206] DERM, n 199, 5.

Flying Foxes at one farm in a single season.[207] Other conflicts arise when urban uses, such as residential developments or airports, are sited near longstanding camps or in migratory pathways.[208] Nuisance and perceived risk of disease have resulted in significant persecution of the species, and the recovery plan urges that urban habitat be identified and protected by appropriate spatial setbacks to reduce the conflict.[209]

3. Discussion – Spatial Capture

Where ecological overlays and protective zones are applied to include airspace, greater certainty will be achieved by advancing spatial capture from two-dimensional (points, lines and polygons) to three-dimensional (volume, corridors and surfaces). Although the dynamic mobility of many species will confound static capture, established and significant routes, corridors, and spaces can be fixed, and areas subjected to adaptive review cycles with shorter time frames than general plan provisions. In addition, the temporal characteristics of the species' movements (or fourth dimension) can also be captured to enable explicit recognition of species presence in time,[210] and provide additional spatial flexibility beyond that time.

Jay argues that developing more responsive practices to manage environmental uncertainty and dynamism are required in the context of marine spatial planning,[211] and this thinking can equally apply to wildlife in airspace. Commentators are suggesting not only development of more flexible approaches to spatial planning but also to the territories and governance of spatial planning. The concept of "soft space" is seen as transcending conventional planning areas, "reflecting the real geographies of problems and opportunities" and bring new configurations and collaborations.[212] The geographies of problems that wildlife encounter in airspace, are not well defined, spatially described, matched to territories or comprehensively responded to by contemporary law and planning mechanisms. The lack of integration of airspace concerns, the silos of government and the privileging of human activities mean that many threats to wildlife in airspace are unmanaged. New strategic governance mechanisms and attention to the spaces of threats are needed.

Furthermore, as a mechanism to respond to mobility of both wildlife and humans, lateral spatial setbacks/approach distances from species are applied in New Zealand and Australia for marine mammals, and are now advised by the Department of Conservation in relation to drone users and wildlife in New Zealand.[213] In searching for methods to limit harm to mobile wildlife in airspace, further consideration should be given to three-dimensional species setbacks where aircraft can achieve the required degree of control in lower airspace. This technique blends species and habitat protection, to act as a virtual shield to an animal and protect spatial volume as the animal travel through media, such as air or water.

IX. Conclusion

Aerial wildlife face increasing human-induced threats in airspace and co-ordinated efforts are needed to provide more comprehensive responses. This article demonstrates the geographies of the threats to wildlife, and how the legal and planning responses fail to adequately respond both to the threats and their spatial characteristics.

Strategic planning efforts in airspace are largely driven by air-traffic concerns. These systems apply a three-dimensional approach to ensure that air traffic and navigation rights are managed and protected in

[207] *Booth v Bosworth* (2001) 114 FCR 39: [2001] FCA 1453 (17 October 2001).

[208] See, eg, DERM, n 199, 8.

[209] DERM, n 199, 29.

[210] See, eg, Nunavut Planning Commission, *Draft Nunavut Land Use Plan* (Nunavut, 2016) 78.

[211] Stephen Jay, "The Shifting Sea: From Soft Space to Lively Space" (2018) 20 *Journal of Environmental Policy & Planning* 451.

[212] Phil Allmendinger and Graham Haughton, "Soft Spaces, Fuzzy Boundaries, and Metagovernance: The New Spatial Planning in the Thames Gateway" (2009) 41 *Environment and Planning A* 619.

[213] Department of Conservation (NZ), *Flying Drones near Birds* <https://www.doc.govt.nz/get-involved/apply-for-permits/drone-use-on-conservation-land/flying-drones-near-birds/>.

a manner consistent with the vertical and volumetric features of airspace. The same cannot be said for management of the threats to wildlife. Although bats, birds and invertebrates occupy extensive tracts of airspace for a variety of life cycle purposes, specific recognition of airspace as habitat and related conservation protection is rare. Such efforts tend to be focused upon the terrestrial or marine spaces, with only implicit reach to the airspace above. Although this enables capture of many of the sources of threat to wildlife in airspace, some significant issues go unmanaged, or without sufficient focus upon the threats, such as strategic spatial planning for infrastructure or aircraft control in lower airspace. In particular, two-dimensional terrestrial area protection may not correspond to important aerial routes, connections and congregatory spaces, which may require specific designation in their own right. The lack of definition and visibility of these important wildlife spaces in planning, compounds with siloed approaches to management of airspace to ensure that the spaces receive insufficient treatment.

In response to the problem the following policy recommendations are made. First, wildlife would benefit from spatial protection, which reflects the vertical and volumetric nature of airspace use. Accordingly, we recommend stronger efforts to identify and record significant/critical aerial habitat accompanied by cartographic techniques to define three-dimensional volumes, and regulatory, policy and educational measures to support this. Further scientific effort is required to explain all wildlife occupation of airspace, and the manner in which human development threatens this, but there is a particularly significant gap in respect of bats and invertebrates.

Second, we recommend development of universal databases which record this spatial information at the national and international level and integrate with existing databases defining important aerial habitat. We suggest collation of the temporal characteristics of the occupation of airspace to enable greater flexibility in spatial planning. In addition, we recommend that where significant aerial habitat is identified in a development permit context that the consent authority be required to link the information to the database.

Third, we recommend the development of integrated conservation planning schemes at the local, national and international scale which apply categorisation and zonation of airspace in a manner which reflects wildlife occupation and human use of the space. In particular we suggest that aircraft use in lower airspace be subject to these schemes.

Fourth, we recommend the development of “green building standards” designed to mitigate the impact of collision risk through sensitive building siting, design and materials in locations where the risk is identified as incompatible with favourable conservation status of threatened species

Finally, as the mobility of wildlife in airspace exposes the limitations of habitat protection, we recommend species-protection/mobile-habitat protection as an important adjunct to fixed-habitat protection. We encourage the use of three-dimensional spatial setbacks from wildlife by aircraft where aircraft can achieve the required degree of control in lower airspace.