Edge-of-range camera-trap records of Superb Lyrebird (*Menura novaehollandiae*) in western and central-north Tasmania (2018–2025)

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Abstract

Tasmania's Superb Lyrebird (*Menura novaehollandiae*) was deliberately introduced to south-east Tasmania in 1934 and has since dispersed across much of the island's central bioregions. Despite this expansion, the Lyrebird's future range dynamics remains uncertain, with recent modelling projecting that it will take over 50 years for the species to establish in the north-west of the island. Here we document recent, verified camera-trap detections at or well beyond the extreme edge of the expected spread in 2025, at three locations: repeated sequences near Bird River at Macquarie Harbour (2018 to 2022), a single event near Rosebery in the southern Tarkine (2021-11-16), and a three-second video near Mt Roland in the central north (2025-08-08). These camera observations extend well beyond the Atlas of Living Australia records current to 2025. Local sampling intensity in each region was high: 24,516 camera-days across 36 sites near Bird River–Queenstown (median = 762 camera days per site), 36,669 camera-days across 77 sites near Rosebery (median = 400), and 17,822 camera-days across 32 sites around Mt Roland (median = 651). The observed north-west dispersal appears to be consistent with an early advance along rainforest–scrub corridors. The 2025 Mt Roland record might represent the leading edge of an undetected expansion front, or a vagrant individual. Targeted surveillance in north-west Tasmania will be required to test these alternatives and refine forecasts of the species' future spread across the island.

Introduction

The Superb Lyrebird (*Menura novaehollandiae*) is an avian ecosystem engineer from south-east Australia whose foraging and display behaviours can restructure forest ground layers by turning over large volumes of leaf litter and soil, with consequences for invertebrate prey, seedling dynamics and surface fuels (Maisey *et al.* 2021, 2025; Hughes *et al.* 2023). Although it is not native to Tasmania, the island state was considered as a possible refuge for the Superb Lyrebird due to persecution by foxes on the mainland, and after a number of failed release attempts in the late 1920s (Dove 1928), the species was successfully at two locations in south-east Tasmania, at Mt Field in 1934 and Hastings in 1945 (Wall & Wheeler 1966). It is now well established within the southern–central–western forest core of the state and continues to spread across an extended dispersal front directed towards the north and west (Fig. 1).

At the edge of the range, however, population status can be difficult to judge, because rare detections might reflect transient individuals rather than establishment. Yet these distributional margins are precisely where predictive models (Amin *et al.* 2025) are most uncertain, and where management attention is often focused (Phillips *et al.* 2010). Two lines of contemporary evidence help reduce ambiguity at species' range margins. First, extensive camera-trap networks now provide structured long-term sampling against which rarity can be interpreted relative to survey effort (camera-days) and site longevity (Vaughan *et al.* 2022). Where detection is imperfect, occupancy models offer a principled approach for interpreting non-detections and estimating the survey effort required to achieve near-certain detection when a species is truly present (MacKenzie *et al.* 2002). Second, public biodiversity repositories such as the Atlas of Living Australia (ALA), which integrates data from Birdata, eBird, iNaturalist and the Natural Values Atlas of Tasmania (NVA), offer spatial context when filtered to recent periods and accompanied by appropriate quality filtering (complete checklists, deduplication and conservative thinning), while acknowledging biases that are well documented for community-science data (Johnston *et al.* 2021; Backstrom *et al.* 2025).

From a process perspective, early outliers of species at an advancing range edge can arise via several mechanisms. In classic diffusion theory, range expansion proceeds predictably as a travelling wave from an occupied core (Skellam 1951), with its speed and shape mediated by demographic rates and environmental constraints, and subject to modification by rare long-distance dispersal and landscape heterogeneity (Klein *et al.* 2006). For Superb Lyrebirds in Tasmania, a recently published pattern-oriented model, which combined habitat suitability with a diffusion-spread-with-leaps process, predicted a gradual infill across the west and arrival of the expansion front in the central north by about the years 2080–2100 (Amin *et al.* 2025). Verified detections well ahead of this forecast are therefore informative: they may indicate rare long-distance movement, underestimated corridor permeability, or a mismatch between model assumptions and the spatial or temporal structure of monitoring effort, and they identify where targeted surveillance should be concentrated.

Here we report three independently verified camera-trap detections that lie at or well beyond the currently mapped Tasmanian core (Fig. 2): multiple still images at Bird River near Macquarie Harbour, south-west of Queenstown (2019–2021), a single short still-image sequence near Rosebery, in the southern Tarkine (2021), and a three-second infrared video at Mt Roland in the central north (August 2025). Each detection occurred within wet-forest mosaics consistent with the Superb Lyrebird's Tasmanian habitat preferences (rainforest and wet sclerophyll with deep litter and rotting logs), and in two cases occurred against a backdrop of intensive local camera effort in which the species had not previously been detected. At Bird River–Queenstown, repeated events across several cameras over multiple years suggest recurrent local use, whereas the Rosebery and Mt Roland records were singletons. Given the long term, high-effort sampling in these regions, particularly around Mt Roland, these occurrences are best interpreted as new, frontier arrivals rather than difficult-to-detect residents.

This study does not seek to refit the existing dispersal-spread model (Amin *et al.* 2025), but rather to document verified edge records, quantify their rarity relative to local sampling effort, and derive falsifiable predictions that can be tested with targeted surveillance. Specifically, we (i) collate and archive the media and metadata supporting each detection; (ii) summarise effort and coverage within a 50 × 50 km area centred on each detection and report simple effort metrics (camera-days) to anchor statements about rarity; (iii) interpret these records in the context of contemporary atlas portrayals (see Methods) and local habitat structure; and (iv) outline monitoring criteria capable of distinguishing early range advance (persistence or growth in the number of independent events) from vagrancy (continued absence despite comparable effort). In parallel, we treat the records as independent tests of the Tasmanian spread forecast (Amin *et al.* 2025), asking whether small, ecologically plausible changes to corridor permeability or dispersal tails could reconcile observed timing without inflating spread elsewhere.

Two features of the Tasmanian landscape make corridor-based hypotheses plausible. First, the west coast region of the island contains extensive tracts of wet forest and scrub that thread around open buttongrass (*Gymnoschoenus sphaerocephalus*) plains and along river valleys; the Bird River system, in particular, provides continuous cover through steep, moist gullies. Second, in the central north, the Kentish foothills and the Mersey–Forth valley systems (east of Cradle Mountain) form a chain of suitable habitat linking the central core to Mt Roland in the north. If a rapid westward and northward advance is underway, repeat detections should begin to accumulate along these pathways of least resistance; if not, isolated events should remain unreplicated despite continued monitoring effort. Either outcome is informative for management and surveillance priorities. Because lyrebirds strongly influence litter structure, seedling recruitment and surface fuels (Maisey *et al.* 2021, 2025; Nugent *et al.* 2014), earlier-than-expected establishment in the north-west would have tangible implications for understorey composition and fire behaviour within these corridors.

Study Area and Methods

Study regions

Three Tasmanian regions located at or beyond the outer margin of the commonly portrayed lyrebird core are the focus of this study (inset maps shown in Fig. 2): (i) Bird River–Queenstown (south-west), a wet-forest landscape adjoining buttongrass and scrub; (ii) Rosebery–Tullah (west coast), a mosaic of wet sclerophyll, regenerating forest and riparian strips; and (iii) Mt Roland and adjacent foothills in the central north, with pockets of wet sclerophyll embedded within mixed forest and agricultural edges.

Camera deployments, effort and observations

Passive, unbaited cameras were deployed and regularly serviced by co-authors Brook and Buettel (Vaughan *et al.* 2022), and separately by a citizen-science collaborator around the vicinity of Mt Roland (Kristen Lang). Cameras were positioned ~30–40 cm above ground, facing trails or small clearings to capture ground traffic while minimising glare. Cameras recorded time-stamped stills and/or infrared video depending on flash type and configuration. Candidate lyrebird media were independently reviewed by at least two observers; disagreements (none for the focal events) would have triggered a third review. Representative stills and the clearest frame from the Mt Roland three-second video are shown in Fig. 2.

To contextualise detections, we quantified effort as operating camera-days per site, per region, and as regional maxima to demonstrate sustained sampling intensity. For each focal region, cameras were pooled within a predefined local window centred on the detection(s) (Fig. 2) from which totals, medians and temporal coverage were calculated. The resulting data were compiled into two flat files to facilitate audit and reuse: i) lyr_op.csv: deployment-level metadata (site identifier, latitude and longitude decimaldegree coordinates, operating days, number of lyrebird detections, region), and ii) lyr_obs.csv: event-level site name and datetime.

Data record files and original media have been deposited in Zenodo (LINK).

Atlas baselines and range-edge mapping

We used an aggregated biodiversity repository to compile historical lyrebird records in Tasmania (ALA: ala.org.au, which also integrates verified records from iNaturalist, eBird, Birdata and NVA records) to provide state-wide context. These points were mapped against a satellite-image backdrop, with label years on selected northern/western records to highlight chronology near the edge (Fig. 1).

Landscape continuity was then examined using satellite imagery (Fig. 1) and Tasmanian vegetation mapping (TASVEG 4 groups; Fig. 2). From these maps, we identified wet-sclerophyll and rainforest belts that could link the occupied southern-western core to the focal regions (e.g., Bird River system on the west coast; Kentish foothills and Mersey–Forth/Dasher valleys in the north). These descriptions are used to propose targeted camera arrays across potential choke points and to frame falsifiable surveillance predictions; they do not imply proof of functional connectivity. All data analysis and mapping code are available open-source via GitHub (github.com/BWBrook/localmap).

Detectability framing and assumptions

Because detection is inevitably imperfect, we use the occupancy framework as qualitative scaffold for interpretation (MacKenzie *et al.* 2002). In areas of known presence, detection probability for ≥50 camera-days is typically near-certain due to the ground-foraging habits of Superb Lyrebirds and their behaviour propensity to investigate camera equipment. We report effort denominators and verification procedures, carrying associated uncertainty forward to the Interpretation section.

Observations

Across the three focal regions (Fig. 2) we observed: (i) repeated Superb Lyrebird detections at multiple Bird River cameras spanning several years; (ii) a single short still-image sequence near Rosebery in 2021; and (iii) a brief infrared video near Mt Roland in August 2025. Each occurred within a heavily sampled network characterised by numerous non-target detections despite prolonged, standardised camera-trap surveillance, making these events informative about rarity rather than just presence.

Bird River–Queenstown (west coast)

Citizen science records of Superb Lyrebirds are few within the western Tasmania region (Fig. 1), with a few notable outliers such as an apparently robust sighting of an adult male on the Lyell Highway between Queenstown and Strahan in 2013. However, intensive camera trapping by the authors along this stretch of road between 2018–2021, including near the 2013 sighting, failed to detect any further Lyrebirds.

From the camera-trapping work further south, multiple independent Lyrebird events, including both sexes and a range of ages, were recorded across several sites within the Bird River regional network between late 2018 and 2021 in wet-forest habitats near freshwater. A representative still shows the diagnostic body form and tail carriage of lyrebirds (Fig 2d). This regional camera network was long-running, with sustained deployment across 36 sites (24,516 operating camera-days; median = 762 per site; max = 1,193 per site). Repeated detections across multiple units and months suggest recurrent local use rather than a single transient pass. Per-camera counts and date ranges for all contributing devices, including those for the regions below, are reported in the lyr_obs.csv data table.

Rosebery–Tullah (central west and southern Tarkine)

A single, time-stamped still-image sequence of an adult female was recorded on 16th November 2021 at 18:00 in a wet-forest/regrowth mosaic. No further lyrebird events were recorded at that site or nearby cameras despite sustained sampling from 2018 to 2022. Across the surrounding Rosebery–Tullah region 77 cameras accumulated 36,669 camera-days (median = 400; max = 1,122). The single episode is therefore best interpreted against this substantial local denominator as a rare, isolated event. Images were unequivocally diagnostic (Fig. 2e) and independently verified without disagreement (P.M. Allen, pers. comm.). No citizen-science records have come from this region to date (Fig. 1).

Mt Roland (central northern slopes)

A single three-second infrared video of a lyrebird was captured on 9th September 2025 at 08:17 by citizen scientist Kristen Lang, a volunteer with Parks and Mt Roland Land

Care. The site, a rocky, moss-covered ridge near a stream at 920 m a.s.l., supports mid-height tea tree (*Leptospermum* sp.) and banksia (*Banksia* sp.), with myrtle (*Nothofagus* sp.) and white-top stringybark (*Eucalyptus delegatensis*) in the valley below (K. Lang, pers. comm.). In the video, the lyrebird's profile, gait and tail carriage are diagnostic of *Menura novaehollandiae*, most likely an adult female, but possibly a juvenile male (P.M. Allen, pers. comm.). The surrounding camera network, operating from 2019 to 2025 [ongoing], totals 17,822 camera-days across 32 sites (median = 651), with no prior or subsequent Superb Lyrebird detections to date. The most diagnostic still frame is shown in Fig. 2f, with the complete video sequence archived on Zenodo. No other citizen-science records have come from this region to date, but there were two notable records (an observation and a call) from the southern end of the Mersey–Forth/Dasher valleys in 2021-2022, along the Overland Track, just north of Lake St. Clair (Fig. 1).

Interpretation and Wider Implications

Two working hypotheses fit the three verified detections of Superb Lyrebird located north and west of the currently mapped edge of the species' range. The *early-advance* hypothesis holds that lyrebirds occur at low density beyond the known edge and will be re-detected with continued sampling, particularly in moist gullies and wet-sclerophyll corridors that provide deep litter and cover. The *vagrancy* hypothesis instead, interprets the Rosebery and Mt Roland singletons as transient through-movements with negligible local persistence. To distinguish these alternatives, we propose three falsifiable tests: (i) *Persistence*. Classify a site as "likely persistent" if two or more independent events (≥30-min separation) occur at two or more cameras within 12–24 months under standard camera placements and ≥30 camera-days per site. (ii) *Corridor testing*. Deploy cameras in an array across choke points predicted by habitat geometry (e.g., west-coast saddles; Kentish foothills and the Mersey–Forth/Dasher valleys) and have them operating for at least 180 days. (iii) *Archive mining*. Systematically rescreen nearby camera archives using AI-classifier-assisted triage (Brook *et al.* 2025) followed by human verification, recording false-positive rates to maintain transparency. These rules are designed to be low-cost, rapidly falsifiable, and robust to single anomalous events.

Landscape context of the invasion front

Landscape geometry strongly influences the movement of range edges. Classic diffusion theory predicts smooth travelling waves from an occupied core (Skellam 1951), but wave speed and front shape are sensitive to dispersal tails and habitat heterogeneity (Kot *et al.* 1996; Hastings *et al.* 2005). Along Tasmania's west-coast, long, contiguous bands of wet forest and scrub track valley floors and river systems around buttongrass plains. Such structure plausibly supports stepwise advance by a ground-foraging, cover-seeking species like the Superb Lyrebird. In the central north, a chain of wet-sclerophyll patches across the Kentish foothills and the Mersey–Forth catchment could act as stepping stones toward Mt Roland. Although our observations do not demonstrate functional connectivity, they pinpoint where that question can be tested most efficiently with targeted monitoring.

A recent Tasmanian forecast of future Superb Lyrebird distribution, combining habitat suitability with a diffusion-spread model, predicted gradual west-coast infill and a late-century arrival in the central north (Amin *et al.* 2025). The Mt Roland detection, occurring ~ 50 years earlier than the modelled window (2070-2080), does not necessarily falsify the model, but it does provide a valuable check – suggesting either rare long-distance movement, underestimated corridor permeability, or a mismatch between the model assumptions and a heterogeneous camera network. We recommend targeted re-sampling to test persistence and corridor use directly. Should repeat detections accumulate along predicted pathways of least resistance, recalibration with heavier dispersal tails or anisotropic permeability (Klein *et al.* 2006) aligned to wet-forest belts might reconcile timing without over-prediction elsewhere. Continued null results, by contrast, would support the vagrancy interpretation.

Lyrebirds are not passive colonisers; their foraging and display behaviours restructure the litter and soil layer, with flow-on effects for invertebrate communities, seedling dynamics and fuel beds (Ashton & Bassett 2006; Doty *et al.* 2015; Hughes *et al.* 2023; Maisey *et al.* 2025). If early advance along the west-coast corridors is confirmed, managers should anticipate accelerated litter turnover and patchy understorey disturbance in moist gullies. These changes could interact with herbivory and disturbance regimes and might, in some contexts, reduce surface fuels (Nugent *et al.* 2014). In the central-north foothills, even sparse occupancy could alter micro-habitats around recurrent display or foraging sites. While we do not quantify those consequences here, we highlight these as decision-relevant pathways so monitoring can capture ecological interactions early. Where sensitive ground-nesting birds or rare fern/forb assemblages occur, co-locating sentinel monitoring with cameras would allow for rapid detection of undesirable impacts.

Inference with imperfect detection: effort denominators matter

Interpreting detections near range edges requires explicit attention to effort and detectability. Occupancy theory provides a principled approach for this: repeated surveys increase the probability of detecting a species if it is truly present, and non-detections cannot be read as absence without reference to effort and detection probability (MacKenzie *et al.* 2002). Future replicated sampling at fixed sites could apply dynamic occupancy models to test colonisation versus transient use directly. However, for now, explicit effort denominators and transparent persistence criteria, such as what we used here, remain the soundest way to keep inference proportional to evidence.

Ultimately, range maps like Fig. 1 are decision tools; their edges determine where management effort should be directed. We therefore recommend conservative updates to public portrayals of true establishment until persistence or breeding is shown locally. Once criteria are met, updates should be prompt and clearly referenced to archived media and effort summaries. For community-science repositories (e.g., eBird, iNaturalist), analytical best practice emphasises the value of complete checklists and effort covariates (Johnston *et al.* 2021), while persistent sampling biases must be acknowledged before definitively inferring range change from point clusters (Backstrom *et al.* 2025).

Lessons for invasion ecology and surveillance design

Several general lessons emerge from this study. First, effort denominators are crucial near moving edges; expressing inference in camera-days (or other measures of survey intensity) and site longevity moves interpretation beyond anecdote. Second, pattern-oriented model checking adds value even with small sample sizes: comparing where and when models predict range edges to where detectors actually record organisms can guide surveillance before parameters are changed (Amin *et al.* 2025). Third, variation in observation processes often matters more than fine adjustments to dispersal parameters; study designs that stabilise detection (standard placements, independence rules, consistent duty) will enable stronger inference and, if needed, formal modelling later. Finally, theory remains a reliable compass: diffusion and invasion frameworks (Skellam 1951; Hastings *et al.* 2005) remind us that heavy-tailed dispersal and structured landscapes produce jagged, stochastic fronts, where outliers may be vagrants or harbingers, and only sustained sampling will decide which.

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Figure Legends

Figure 1. Notable edge-of-range records of Superb Lyrebird (*Menura novaehollandiae*) in Tasmania in the 21st century. Blue points are Atlas of Living Australia (ALA) occurrences (sourced September 2025). Red points are the camera-trap detections reported herein: Bird River (stills on multiple camera traps, 2018–2021) near Macquarie Harbour, Rosebery (stills, 2021) in the north-west Tarkine, and Mt Roland (3-second IR video, 2025) near the northern slopes, along with scattered 2018 and 2020 records close to the Lyell Highway. Year labels are shown on all red points and on selected northern/western ALA outliers, to indicate chronology near the mapped range edge. White arrows depict hypothesised, unobserved movement pathways (dashed arrows mark speculative future dispersal directions, as discussed in the text). Coastline and graticule are WGS84 geographic; satellite imagery provides geographic context only.

Figure 2. Regional context and diagnostic imagery for three edge-of-range lyrebird records. (a–c, left column) Maps of 50 km × 50 km windows centred on each focal record with TASVEG 4 group classes as the backdrop (water in grey). Camera stations with lyrebird detections are red; stations without detections are black; symbol size scales to effort (camera-days). The focal-site camera effort for each region and the largest effort from all cameras in that panel region were: Bird River (top row) = 990 (maximum 1,193), Rosebery (middle row) = 318 (max.1,165), and Mt Roland (bottom row) = 203 (max. 986). Bird River had multiple detections along wet-forest corridors; Rosebery and Mt Roland each had a single outlying detection amid heavy local effort and numerous non-detections. (d–f, right column) Diagnostic camera-trap images from each region: (d) Bird River, first record (female); (e) Rosebery, one of three images from the single 2021 event (female); (f) Mt Roland, still from the only 5-s IR video recorded in August 2025 (female or juvenile). Timestamps are those written to the images by the cameras (Bird River and Rosebery in mm/dd/yy; Mt Roland in dd/mm/yy). Media for all three sites are archived and unambiguously identify *Menura novaehollandiae*.

Figure 1


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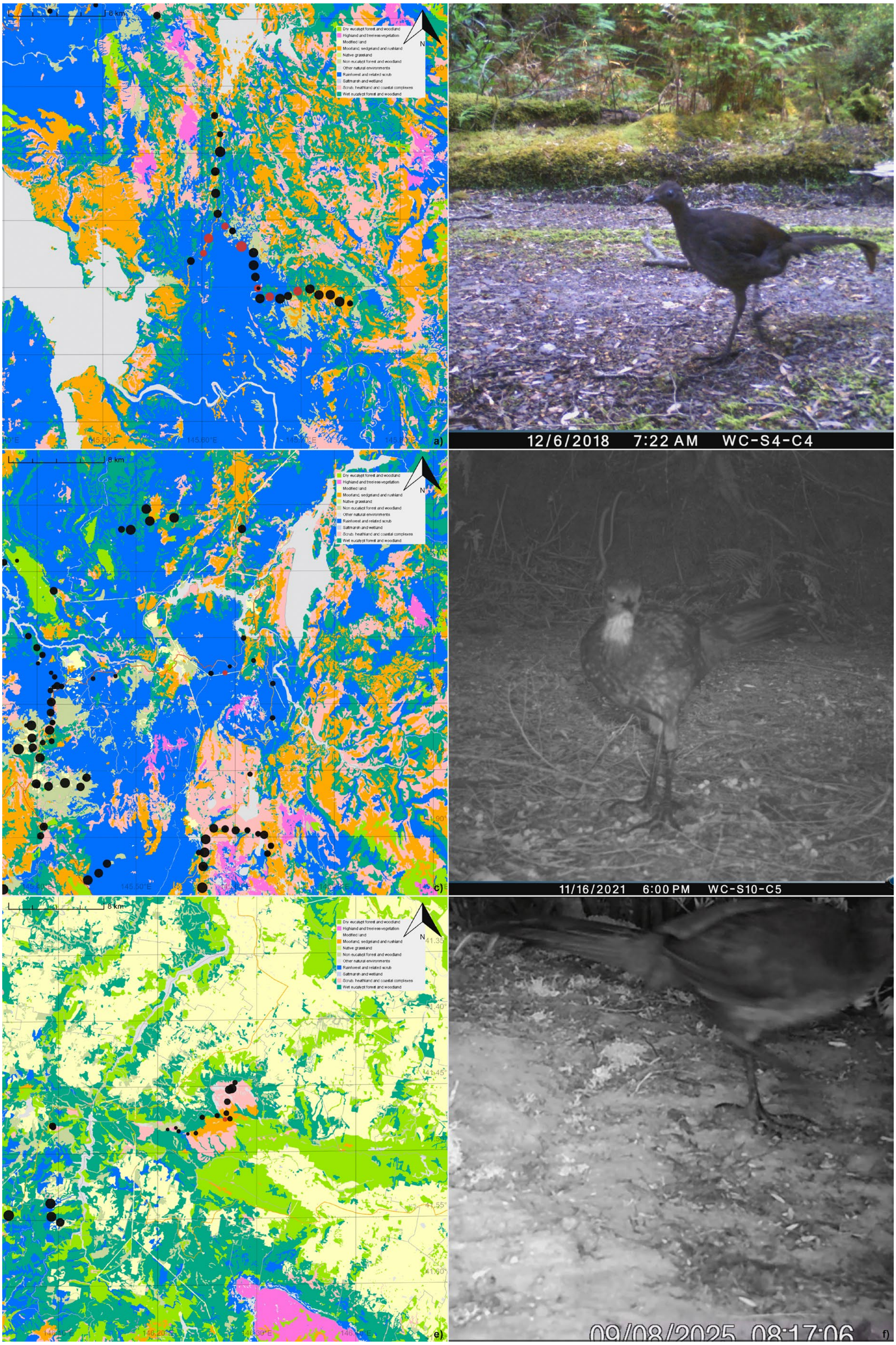
Figure 2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Highland and treeless vegetation
Modified land
Moorland, sedgeland and rushland
Native grassland
Non eucalypt forest and woodland
Other natural environments
Rainforest and related scrub
Saltmarsh and wetland
Scrub, heathland and coastal complexes
Wet eucalypt forest and woodland
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