Rivers without fences: Testing the promise and limits of virtual fencing

Greg Peters[1]

1 Riverness, Torquay, Victoria, 3228. Email: greg@riverness.com.au

Key points

- Virtual fencing (VF) has the potential to improve stock management and environmental outcomes in riparian settings, but its reliability as a substitute for physical fencing remains unproven.
- Current evidence contains important technical, behavioural, operational and regulatory uncertainties that require further testing.
- Adoption within the NRM sector should proceed through staged partnerships and targeted pilots rather than immediate broad-scale use.
- Future support for VF should be based on demonstrated landscape suitability, landholder readiness, compliance feasibility and value for money.

Abstract

As Victoria's river systems become more dynamic and flood-prone, the long-held assumption that riparian protection requires physical fencing is being challenged. The commercial arrival of virtual fencing (VF) for cattle in 2026 introduces both opportunity and uncertainty for Catchment Management Authorities (CMAs): can a digital boundary deliver reliable riparian outcomes, and under what conditions is it defensible, appropriate, and cost-effective?

This project provides the first structured assessment of VF's potential role in Victorian riparian programs. At present, CMAs and the Department of Energy, Environment and Climate Action (DEECA) lack a shared, evidence-based position on VF's suitability, risks, and policy implications. The project synthesises literature, commercial trials, CMA insights, and targeted engagement to evaluate how VF performs in riparian contexts and what it means for program design, compliance, monitoring, and long-term protection.

The analysis identifies the key constraints, enablers, and uncertainties shaping VF adoption, and presents conceptual models and decision frameworks that support consistent, transparent decision-making. The resulting guidance establishes a defensible basis for determining where VF is appropriate, feasible, and aligned with public expectations, and where conventional riparian fencing remains essential.

By clarifying regulatory dependencies, cost-sharing considerations, data-governance requirements, and operational risks, the project offers CMAs a coherent pathway for assessing VF across diverse landscapes. More broadly, it demonstrates how digital tools are beginning to reshape riparian management in an era of increasing climatic variability and infrastructure vulnerability.

Keywords

Virtual fencing, riparian management, decision frameworks, floodplain fencing

Introduction

Riparian protection in Victoria has historically relied on physical fencing, evolving from shepherding in the 1780s to wire, barbed wire, and electric fencing through the 19th and 20th centuries (Pickard, 2010). However, flood prone river corridors continue to impose high repair and replacement costs, with Catchment Management Authorities (CMAs) often reporting repeated damage and/or complete fence loss during major flood events. Drop-down and other flood-resilient designs address part of this problem, but some sites remain difficult to fence because of steep banks, rocky ground, access constraints or erosion risks.

In late 2025, virtual fencing (VF) was approved for use on cattle in Victoria. A VF system controls livestock movement by creating digital (rather than physical) boundaries. This is achieved by fitting animals with collars that use GPS positioning, communication, audio warnings and, if required, electrical stimuli (see Figure 1). At the time of writing, Victoria has approved three commercial systems for cattle.

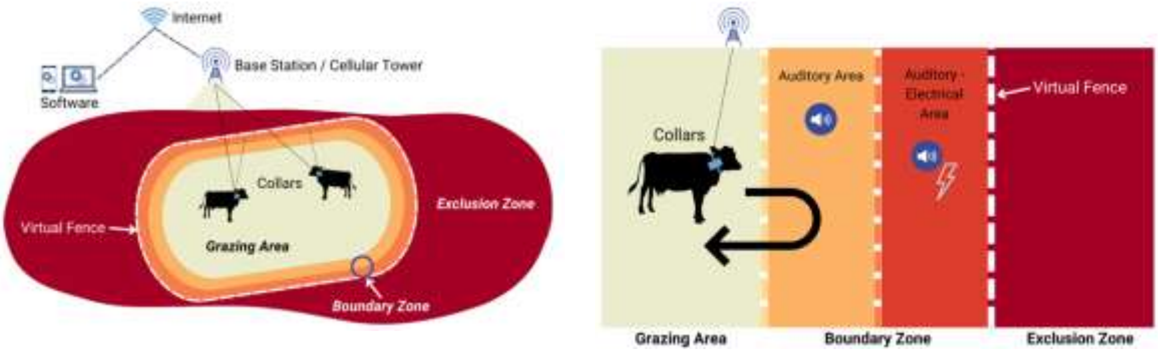

Figure 1 Conceptual models of a) hardware and software used to draw VF lines and define the grazing area, boundary zone, and exclusion zone; and b) animal conditioning in a VF system (from (Mayer, et al., 2024)

Despite growing interest, CMAs and the Department of Energy, Environment and Climate Action (DEECA) lack a shared, evidence-based position on VF's defensibility, compliance requirements, monitoring expectations, and alignment with riparian investment principles. For example, in a recent survey, CMAs noted uncertainty about VFs "legal enforceability, minimum standards and compliance triggers in the absence of physical infrastructure" (Riverness, 2026) and highlighted risks associated with public perception, animal welfare, and data governance.

This paper presents the findings of a report (Riverness 2026) that synthesised 20 peer-reviewed VF studies, two technical reports, a CMA survey and targeted engagement. It identifies where the evidence for VF is strongest (animal learning and short-term exclusion) and where it is weaker (long-term ecological outcomes, property transfer risks, compliance under government-funded agreements), and clarifies the regulatory, operational and governance conditions under which VF could be defensibly applied in riparian programs.

The VF evidence base

At the beginning of the project, CMAs were surveyed (Riverness 2026) to identify their key concerns in applying VF in riparian contexts. Survey respondents reported moderate to high familiarity with VF and strong interest in its potential application in riparian areas, particularly where conventional fencing is repeatedly damaged or impractical. However, CMAs also identified several potential risks:

- technology reliability (battery life, GPS drift, connectivity gaps, hardware lifespan)
- animal containment risks (calves or uncollared stock accessing riparian areas)
- data limitations in steep or vegetated terrain
- public perception and welfare concerns
- compliance challenges due to lack of physical boundaries
- regulatory uncertainty (Crown land frontages, property transfers)
- defensible funding models and equity considerations.

The literature confirmed these concerns. For example:

- Most cattle adapt to VF within ~2 weeks, but individual animal variation can be significant (Campbell et al., 2020; Campbell et al., 2018).
- Some animals require extended training or may not be suitable for VF (Gadzama et al., 2025).
- GPS drift increases under canopy and steep terrain; a condition common along waterways (Lomax et al., 2019; Eastwood et al., 2026).
- VF can be cost competitive in steep or flood prone terrain, but less viable where physical fencing is cheap or already present (Eastwood et al., 2026).
- Adoption depends on landholders' digital literacy, trust in technology, and willingness to share data (Eastwood et al., 2026).

These findings suggest that VF is not a universal alternative to physical fencing in riparian areas. More specifically, it is likely to be a context-specific riparian tool whose useability and defensibility will depend on landscape suitability, landholder capability, data governance, regulatory alignment, and cost sharing logic.

A promising but context-specific riparian tool

Published trials (e.g. Campbell et al., 2020; Campbell et al., 2018) demonstrate that VF can exclude cattle from riparian and other sensitive areas. However, reported exclusion performance ranges widely (from 28% to 96%) depending on terrain, riparian width and cue placement (Campbell et al. 2018; Murray et al. 2025). This variation is important as VF useability in riparian contexts is not about whether VF will work; but whether VF can reliably and consistently work at a particular site under the conditions relevant to achieving riparian outcomes.

The literature is consistent in that VF is particularly promising in flood-prone corridors, steep or rocky areas and sites requiring temporary or seasonal exclusion. It can also be useful in supporting targeted controlled grazing and adaptive responses to floods or fires. However, riparian-specific attributes can also amplify known weaknesses within the technology. For example:

- Water, shade and lush riparian vegetation can create strong incentives for animals to ignore both audio cues and electric stimuli and cross a VF boundary (Bennett et al. 2026).
- Tree canopy and steep banks can reduce GPS positioning accuracy and communication reliability (Gadzama et al. 2025, May et al. 2025). Narrow riparian strips leave little room for error in this regard.
- Calves (who cannot be legally collared within Victoria) may cross boundaries, causing parent cattle to follow (Hoag et al. 2024, Mayer et al. 2024, O'Donoghue 2022).
- VF cannot exclude neighbouring or uncollared livestock and cannot perform the functions of a legal boundary fence (May et al. 2025).

Issues requiring clarification before investment

Before CMAs can confidently move from VF evidence to VF investment, four key issues (identified through the literature review, CMA survey and CMA workshop) must be addressed (see Table 1).

Table 1 Key issues requiring clarification before CMA investment in virtual fencing

Issue	Key investment question
Compliance and monitoring	How can stock exclusion be verified without relying solely on field inspection?
Data governance	What data can a CMA access, for what purposes and for how long?
Cost sharing	Which part of VF represents a public riparian benefit rather than a private productivity gain?
Policy and regulation	Can VF satisfy riparian licence obligations or public expectations where no physical fence exists?

Compliance, monitoring and data governance

VF changes compliance monitoring from inspecting a physical asset (the fence) to verifying digital animal behaviour. GPS locations, boundary positioning and movement, collar status and breach events could provide stronger temporal evidence than periodic field inspections, but only if CMAs can access the data and interpret it consistently.

CMA survey respondents (Riverness, 2026) noted VF "makes non-compliance harder to detect because there is no physical boundary". As such, if CMAs were to co-invest in the technology, they would require:

- direct access to VF data
- defined data sharing agreements
- limits on secondary use
- secure storage and governance arrangements.

However, the literature cited landholder concerns with mandatory data sharing as it could expose sensitive information about grazing patterns or management decisions (Bennett et al. 2026). A defensible VF program must therefore balance CMA compliance needs with landholder privacy.

Two approaches could enable this (depending on whether the riparian area was on freehold or Crown land):

1. CMA funding contributions (e.g. collar hire, subscription fees) in exchange for direct data access.
2. Embedding data sharing requirements into public land agreements (e.g. where a landholder has a licence to graze a Crown water frontage).

Without access to VF data, compliance would be no different to current field-based observations.

Economics and public investment

VF implementation costs

VF and physical fencing are difficult to compare directly as they measure cost differently. Physical fencing is primarily a capital cost expressed by length, while VF involves collars, communication infrastructure, subscriptions, training and ongoing management (some portion of which would be borne by the riparian area whilst some (the majority) would be borne by regular farm management).

An example costing arrangement provided in Duval et al. (2025), had first-year VF costs approximating $175-$400 per cow, with annual costs of about $80-$130 per cow. However, these costs could not be transferred directly to another farm or project as prices, enterprise structures, implementation objectives and service conditions will differ substantially. For example, the same VF system may be economical for a large dairy enterprise but unsuitable for a small beef herd.

Cost sharing arrangements

VF has the potential to generate both private benefits (e.g. labour savings, grazing flexibility) and public benefits (e.g. riparian protection). CMAs emphasised that if they were to co-invest in VF, they "did not wish to subsidise general farm productivity gains unrelated to riparian protection" (Riverness, 2026).

Cost sharing must therefore be:

- defensible
- transparent
- aligned with environmental outcomes
- equitable across landholders.

VF may be cost competitive in steep or flood prone terrain, but less viable where fencing is cheap or already present (Eastwood et al., 2026). Funding models must reflect this variability with CMAs only funding the environmental advantage that conventional fencing cannot deliver, rather than general productivity benefits.

Policy and regulatory dependencies

VF interacts with several regulatory settings that determine whether it can be used in riparian programs.

Crown land water frontages

Uncertainty exists regarding VF's ability to meet licence obligations and public access requirements. Physical fencing has historically been the compliance mechanism so VF would require a new regulatory interpretation.

Property transfer

VF is vulnerable to ownership changes. As one CMA noted, "VF technology may not be adopted by the new owner… and we are back to square one" (Riverness, 2026). Without a physical fence, riparian protection may lapse immediately upon sale.

Property boundaries

VF is not a boundary fence. It does not prevent neighbouring cattle entering and does not establish a legal land boundary. CMA-supported funding arrangements should state this explicitly.

Animal welfare

Animal welfare evidence is generally reassuring, with VF outcomes often comparable with electric fencing once cattle have learned the system. Nevertheless, welfare safeguards and public perceptions cannot be assumed. Communication should explain both the evidence and the limitations without dismissing community concerns.

Recommended pathway: From evidence-building to potential adoption

The limitations and uncertainties outlined in previous sections do not necessarily prevent CMAs from adopting VF technology as a riparian management tool. However, they do indicate that CMAs should not assume VF is a proven, landscape-wide substitute for physical fencing. Instead, its role should be established progressively through practical experience, comparative evaluation and the development of appropriate operating and governance arrangements.

The following proposed pathway has three stages, recognising that early activity may be driven by landholder interest, existing relationships and available funding opportunities rather than a fully defined investment program.

Stage 1: Early-adopter partnerships

CMAs should work with landholders who are independently adopting VF. In doing so, they should observe rather than direct farm decisions, while building internal VF capability, seeking voluntary access to relevant information and documenting technical, behavioural and operational lessons. This provides a low-cost opportunity to test assumptions without transferring technology ownership or performance risk to CMAs.

Stage 2: CMA-funded pilots

Where suitable riparian opportunities arise, CMAs may fund targeted pilots. Sites should be selected to generate useful evidence across a range of relevant conditions and should, where practicable, compare VF with realistic physical fencing alternatives.

Pilots should be structured around clearly defined performance, welfare, data-governance and reporting requirements. They should also establish how technical failures, animal-welfare issues and compliance concerns will be identified and managed.

Stage 3: Evaluation and refinement

Evidence from partnerships and pilots should then be assessed against practical questions, including:

- Can VF reliably exclude livestock in riparian settings?
- Does performance remain adequate with variable GPS coverage, connectivity or power supply?
- Are animal-welfare risks identifiable and can they be appropriately managed?
- Does VF deliver comparable or better environmental outcomes than feasible alternatives?
- What are the initial and ongoing costs, including monitoring and staff effort?
- Are ownership, access, privacy and retention arrangements for location and compliance data acceptable?
- Does the CMA have the capability to assess, administer and monitor VF-supported arrangements?

The findings should be used to refine eligibility requirements, operating conditions and future funding support.

Decision framework for future support

Once sufficient evidence has been gathered, CMAs should apply a decision framework to determine whether VF is appropriate for a particular site, purpose and level of support. Proposed applications should be assessed against five core criteria:

1. Landscape suitability: whether terrain, waterways, vegetation, remoteness, connectivity and environmental values are compatible with reliable operation.
2. Farming-system compatibility: whether VF can be integrated with grazing management, stock movements and normal farm operations.
3. Landholder readiness: whether the landholder can operate and maintain the system, respond to alerts, participate in monitoring and comply with agreed conditions.
4. Compliance feasibility: whether livestock exclusion performance can be demonstrated, failures can be detected and corrective action can be taken within an appropriate timeframe.
5. Cost-benefit alignment: whether the environmental and operational benefits justify the cost, uncertainty and residual risk compared with physical or hybrid fencing.

If any condition fails, CMAs should default to physical fencing or other livestock control methods.

Conclusions

VF has genuine potential to improve riparian management in Victorian landscapes where flood, terrain or ecological constraints make physical fencing difficult. Its ability to provide riparian outcomes is promising but not yet proven at the scale required for active public investment. As such, the technology should be considered a targeted and potentially complementary riparian management tool, not a universal replacement for physical fencing.

Before CMAs actively invest in VF, there is a need to establish consistent expectations for compliance, monitoring, data governance, cost allocation and regulation. The recommended path is sequential: learn with early adopters, test with well-designed CMA-funded pilots and only then consider broader investment. This approach recognises the promise of VF while ensuring that public funding remains transparent, environmentally effective and defensible.

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