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AGRISEARCH CONSULTATION RESPONSE

Potential Wildlife Intervention Options for Bovine Tuberculosis in Northern Ireland

Response to the DAERA consultation on the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication

Scientific, Economic and Evidence Assessment

September 2026



About AgriSearch

AgriSearch (the Northern Ireland Agricultural Research and Development Council) is an independent, farmer-led research and innovation charity, established in 1997, working across Northern Ireland's dairy, beef and sheep sectors. Funded principally through farmer levies on milk, beef and lamb, AgriSearch commissions, supports and communicates research and evidence, working with farmers, researchers, industry and government to help ensure that evidence is relevant, robust and capable of practical application.

AgriSearch's *Strategic Statement 2025–2030: Equipping Farmers to Face Future Challenges* sets out its vision of driving farm profitability and sustainability through science, research and innovation, and its purpose of equipping farmers through the application of science, research and innovation to make a difference for the rural economy, environment and society.

AgriSearch seeks to deliver this through three connected strategic pillars:

- **Pillar 1 – Evidence and Insight** – placing farmers' needs at the heart of research and innovation in Northern Ireland;
- **Pillar 2 – Research and Innovation** – growing long-term research and innovation platforms; and
- **Pillar 3 – Research into Practice – The Last Mile** – helping ensure that research, evidence and proven practice result in meaningful change on farms.

This consultation response sits primarily within Pillar 1 – Evidence and Insight.

Disclaimer

This consultation response has been prepared by AgriSearch as a focused critical assessment of the scientific, economic and other evidence relevant to DAERA's consultation. AgriSearch has taken reasonable care to check the accuracy of the information presented and the representation of the sources cited. However, the assessment is not a systematic review, independent peer review or legal assessment, and AgriSearch does not guarantee that the document is free from error or omission or that every potentially relevant source has been identified.

The views, interpretations and conclusions expressed are those of AgriSearch, based on the evidence available at the date of publication. Readers should refer to the original scientific publications, official reports and consultation documents where decisions depend on particular technical, legal or policy matters.

Chair's Foreword



Norman McMordie
Chair of AgriSearch Board of Trustees

Bovine tuberculosis remains one of the most serious and persistent challenges facing Northern Ireland's cattle sector. Its consequences extend far beyond the animals removed through the eradication programme. It affects animal health and welfare, undermines the financial resilience of farm businesses, takes a significant toll on the mental health and wellbeing of farmers and their families, and has wider consequences for rural communities, while imposing substantial and growing costs on both farmers and the public purse. There can be little disagreement that Northern Ireland needs to make sustained progress in reducing the burden of this disease and ultimately achieving eradication.

AgriSearch is a farmer-led research and innovation organisation, funded principally through farmer levies on milk, beef and lamb. Under our *Strategic Statement 2025–2030*, one of our three principal areas of activity is **Evidence and Insight**: bringing evidence to bear on significant emerging challenges and policy issues affecting Northern Ireland's ruminant livestock sector, identifying important gaps in knowledge and helping ensure that decisions are informed by robust and relevant evidence. Our role is not to advocate for a predetermined policy outcome, but to help ensure that major decisions affecting farmers are informed by the best available science and by evidence that is balanced, proportionate and relevant to Northern Ireland conditions.

DAERA's consultation on potential wildlife intervention options is an important stage in the development of future bTB policy. The decisions which follow it may shape wildlife intervention in Northern Ireland for many years and could involve significant financial, operational and animal-welfare consequences. DAERA has stated that any decision will be science-led and evidence-based. AgriSearch strongly supports that principle.

It was in that context that AgriSearch's Trustees decided that AgriSearch should undertake complementary scrutiny of the scientific evidence and economic appraisal underpinning the consultation. We did not do so because AgriSearch had reached a predetermined view on whether non-selective culling, Test and Vaccinate or Remove

(TVR), vaccination-only, or any other approach should ultimately be adopted. Rather, our initial examination of the consultation material raised important questions which we believed warranted further scrutiny.

The consultation is supported by a substantial body of material and contains much that is useful. However, the existence of a large evidence base does not in itself remove the need to examine how that evidence has been interpreted, weighted and applied. Different intervention options should, as far as possible, be assessed against consistent evidential standards, with the strengths and limitations of the available evidence made clear. Where conclusions depend upon modelling, assumptions or evidence transferred from other jurisdictions, that distinction is important.

Similar considerations apply to the economic analysis. Estimates of intervention costs and benefits necessarily depend upon assumptions about matters such as badger population density, capture rates, intervention scale, staffing and delivery requirements, disease prevalence and the speed and extent of any resulting reduction in cattle bTB. Where those inputs are uncertain, the resulting economic conclusions are also uncertain. That does not make such analysis invalid, but it does make transparency, sensitivity testing and appropriate qualification particularly important. These were central questions within the scopes established for the two strands of work.

Northern Ireland-specific evidence is also important. The epidemiology of bTB is not uniform, nor are badger populations or patterns of infection. Decisions about the choice, scale and location of intervention therefore need to reflect local circumstances rather than assuming that a single approach will necessarily be optimal everywhere. The emergence of new information, including contemporary work on badger population density and distribution, reinforces the importance of ensuring that policy assumptions are capable of being revisited as the evidence develops.

For that reason, we believe the eventual decision should not simply be about selecting an intervention and implementing it. Whatever approach is chosen should form part of a wider, integrated bTB eradication programme, with clear objectives, appropriate monitoring and a willingness to adapt in response to what is found in practice. Uncertainty should not become a reason for indefinite inaction, but neither should it be hidden behind apparently precise estimates or treated as though all important questions have already been resolved.

AgriSearch is publishing this work in that constructive spirit. Our purpose is not to prescribe the Minister’s decision, nor to diminish the considerable work already undertaken by DAERA and others. It is to contribute additional evidence-led scrutiny at an important point in the policy process and to help farmers, industry, government and other stakeholders understand more clearly what the available evidence can tell us,

where its limitations lie, and which assumptions may be especially important to the success of any future programme.

Bovine tuberculosis has blighted Northern Ireland's cattle sector for far too long. Progress will require difficult decisions, sustained commitment and action across cattle, wildlife and people. Those decisions will command greater confidence, and stand a better chance of succeeding, if they are founded on evidence that has been tested rigorously, uncertainties that have been acknowledged openly and a programme capable of learning and adapting as it proceeds.

Norman McMordie
Chair, AgriSearch

Guide to this response

This document has been prepared as AgriSearch's response to DAERA's consultation on potential wildlife intervention options for bovine tuberculosis in Northern Ireland. It combines AgriSearch's assessment of the scientific evidence, consideration of the independent economic review undertaken by The Andersons Centre, and AgriSearch's resulting conclusions and recommendations. The full independent economic review by The Andersons Centre is available on the AgriSearch website.

The response has been structured to allow readers to engage with the analysis at different levels of detail:

- **Executive Summary (Section 1)** provides the principal overview of AgriSearch's assessment, including the overall conclusions, the main scientific and economic qualifications, and a summary of the recommendations.
- **Main response (Sections 2–11)** provides the detailed scientific, economic and implementation analysis underpinning those conclusions.
- **Recommendations and Conclusion (Sections 12–13)** bring together AgriSearch's formal recommendations to DAERA and the overall position arising from the assessment. A summary of the recommendations is also provided in the Executive Summary.
- **References (Section 14)** provides the full reference list for the evidence cited throughout the response.
- **Appendices** provide supporting detail on the scientific review methodology and evidence assessment, interim Northern Ireland badger-population findings, the independent economic review and the assessment of the Easy Read Summary.

A one-page **Contents at a Glance** is provided on the following page, showing the principal sections of the response. A more detailed contents list is provided at the end for readers wishing to navigate individual sections and subsections.

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Glossary and abbreviations

Terminology in this review generally follows that used in DAERA's consultation documents. Where a term has a particular technical or policy meaning, this is set out below. In particular, the terms selective and non-selective refer primarily to whether individual badgers are selected for removal on the basis of infection status and should not be confused with the geographical targeting of an intervention.

Term	Meaning
Adaptive approach	A wildlife-intervention strategy in which the intervention is reviewed and adjusted in response to surveillance, epidemiological findings and measured outcomes. The intervention used, its intensity, geographical extent or timing may therefore change as local disease conditions change. An adaptive approach may include sequencing, but does not require a predetermined sequence.
AFBI	**Agri-Food and Biosciences Institute.** Northern Ireland's principal public-sector organisation undertaking scientific research and diagnostic work relevant to agriculture, animal health and the environment.
APHA	**Animal and Plant Health Agency.** UK Government agency providing animal-health science, epidemiology and modelling. APHA produced the 2019 Northern Ireland-parameterised model used in DAERA's assessment of the relative effects of the wildlife intervention options.
Badger density	The number of badgers within a defined land area, normally expressed as badgers per km². Density may vary substantially between locations and should not be assumed to be spatially uniform.
BCG	**Bacillus Calmette–Guérin.** The vaccine used to reduce the susceptibility of badgers to infection with *M. bovis*.
Breakeven	The point at which the estimated benefits of an intervention equal its estimated costs. In DAERA's analysis this is commonly expressed as the number of cattle herd breakdowns that would need to be avoided for an intervention to cover its estimated costs.
bTB	**Bovine tuberculosis.** An infectious disease caused principally by *Mycobacterium bovis*, affecting cattle and a range of other mammals, including badgers.
CI / CrI	**Confidence interval / credible interval.** Statistical ranges expressing uncertainty around an estimate. A confidence interval is used in frequentist statistical analysis; a credible interval is the corresponding type of probability interval used in Bayesian analysis.

Term	Meaning
CITT	**Comparative Intradermal Tuberculin Test.** The comparative statutory skin-test approach used for surveillance and detection of bTB in cattle. See also **SICCT (skin test).**
Comparator / comparator area	A population or geographical area against which outcomes in an intervention area can be compared, helping assess whether observed changes are reasonably attributable to the intervention rather than to wider disease trends or other concurrent measures.
Coverage	The extent to which the intended intervention is actually delivered. This may refer to **spatial or operational coverage** of the intervention area, or to **population coverage**, meaning the proportion of the local badger population captured, vaccinated or removed. These measures are related but should not be treated as equivalent.
CVO	**Chief Veterinary Officer.** DAERA's senior veterinary adviser. References to the "CVO Review" in this document relate to the 2024 Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland.
DAERA	**Department of Agriculture, Environment and Rural Affairs.** The Northern Ireland government department responsible for the bTB eradication programme and the wildlife intervention consultation.
DAFM	**Department of Agriculture, Food and the Marine.** Government department responsible for agriculture and animal-health policy in the Republic of Ireland.
DARD	**Department of Agriculture and Rural Development.** Predecessor Northern Ireland department to DAERA. The term occurs principally in relation to historic Northern Ireland bTB and TVR work.
Defra	**Department for Environment, Food and Rural Affairs.** The UK Government department responsible for animal health policy, including bovine tuberculosis policy and badger intervention in England.
Diagnostic sensitivity	The probability that a truly infected animal will test positive. A test with imperfect sensitivity will produce some false-negative results.
Diagnostic specificity	The probability that a truly uninfected animal will test negative. A test with imperfect specificity will produce some false-positive results.
Difference-in-differences	A statistical approach that compares the change in an outcome over time in an intervention area with the change over the same period in a comparator area, helping distinguish an intervention effect from wider underlying trends.

Term	Meaning
Discount rate / discounting	The rate used to convert costs and benefits occurring in future years into present values, reflecting the principle that costs and benefits occurring at different times are not valued identically.
DPP	**Dual Path Platform.** A rapid diagnostic test used during the Northern Ireland TVR study to inform trap-side decisions on whether a captured badger was removed or vaccinated.
Hard boundary	A geographical feature expected to restrict or reduce badger movement across the edge of an intervention area, for example a coastline, major river or other substantial landscape feature. Hard boundaries may be relevant to reducing immigration, recolonisation or potential perturbation effects.
Herd breakdown	An episode in which a cattle herd loses or has its Officially Tuberculosis Free status suspended or withdrawn because of bTB. Different studies may use different breakdown definitions; where this materially affects interpretation, the definition used is specified in the review.
Hotspot	An area exhibiting relatively high levels of bTB, badger activity, badger density, infection or another relevant epidemiological indicator. The precise meaning depends on the context and should not be assumed to denote a single nationally standardised threshold.
HRA	**Habitats Regulations Assessment.** A statutory assessment process used to determine whether a plan or project could adversely affect protected sites within the UK National Site Network, including Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). The process considers potential effects both alone and in combination with other plans or projects and against the conservation objectives of the sites concerned. It begins with screening for likely significant effects; where such effects cannot be excluded, a more detailed Appropriate Assessment is required. In Northern Ireland the process operates under the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995, as amended.
IFNγ / IFNG	**Interferon-gamma blood test.** A supplementary blood test used in cattle to detect an immune response associated with M. bovis infection. It can identify some infected animals earlier than the SICCT skin test and, when used alongside the skin test, can increase the overall sensitivity of bTB detection. In Northern Ireland it is used particularly in higher-risk or infected herds rather than as the primary routine surveillance test.
Incidence / Herd Incidence	**Incidence** measures new disease events occurring within a defined population over a specified period. **Herd incidence** refers to new bTB herd breakdowns rather than the proportion of individual animals infected. It is distinct from prevalence.

Term	Meaning
M. bovis	***Mycobacterium bovis*****.** The principal causative organism of bovine tuberculosis.
MAP	**Mycobacterium avium subsp. paratuberculosis.** The causative organism of Johne's disease, considered in the document in relation to mycobacterial co-infection and diagnostic research.
MNA	**Minimum Number Alive.** A capture-based measure representing the minimum number of individually identified animals known to have been alive during a specified period. It should not automatically be treated as an estimate of the total population because capture behaviour, age structure and trapping history can introduce bias.
Non-selective culling	DAERA terminology for removal of badgers irrespective of their individual infection status. The term is sometimes described as **"unselective culling"** in other literature. It does not necessarily mean that the intervention is geographically indiscriminate. Proactive non-selective culling may be directed at specifically identified bTB intervention areas. A more descriptive formulation is therefore **"geographically targeted, non-selective culling"**: targeted in the selection of the area, but non-selective at the level of the individual badger. This review retains DAERA's terminology for consistency.
NPV / NPC	**Net Present Value / Net Present Cost.** Measures comparing discounted future costs and benefits in present-value terms. In DAERA's appraisal, a positive NPV indicates an estimated net economic benefit under the assumptions used, while an NPC indicates an estimated net economic cost.
OTF / OTF-W	**Officially Tuberculosis Free / Officially Tuberculosis Free status Withdrawn.** OTF-W generally denotes a confirmed bTB herd breakdown. Where published studies distinguish confirmed breakdowns from a wider category of herd restrictions, this distinction is important to interpretation of their results.
PATUBES	**Plan de Actuación sobre Tuberculosis en Especies Silvestres.** Spanish national framework for the surveillance and control of tuberculosis in wildlife species, used in this review as an example of a risk-based multi-host approach.
PCR / qPCR / PhMS-qPCR	**Polymerase chain reaction / quantitative polymerase chain reaction.** Molecular techniques used to detect genetic material. **PhMS-qPCR** refers to phagomagnetic separation followed by qPCR, an emerging method considered in cited Northern Ireland diagnostic research.
Perturbation	A change in badger social organisation, territorial behaviour, ranging or movement following disturbance or population reduction. Behavioural perturbation does not in itself demonstrate an increase in disease transmission.

Term	Meaning
Perturbation effect	The proposed or observed **epidemiological consequence** of perturbation, particularly an increase in transmission of *M. bovis* associated with altered badger movement or social organisation. This is distinct from demonstrating behavioural perturbation alone.
Phage / bacteriophage	**A virus that infects bacteria.** In the phage-based diagnostic methods discussed in this review, bacteriophages are used as part of an assay designed to detect **viable (living) mycobacteria**, rather than simply detecting bacterial DNA that may remain after the organism is no longer viable. See also **PhMS-qPCR.**
PhMS-qPCR	**Phagomagnetic Separation followed by quantitative Polymerase Chain Reaction.** An emerging phage-based molecular approach used in research considered in this review to detect viable mycobacteria, including M. bovis. See also **Phage / bacteriophage.**
Prevalence	The proportion of a defined population infected with, or testing positive for, a disease at a particular point or over a defined period. It is distinct from incidence, which measures new disease events.
Proactive intervention	Intervention undertaken across the entirety of a defined area rather than being initiated only around individual cattle herd breakdowns.
QUB	**Queen's University Belfast.** University undertaking research relevant to this review, including the current Northern Ireland badger population reassessment and associated work on wildlife surveillance and diagnostics.
RBCT	**Randomised Badger Culling Trial.** A large-scale replicated field trial undertaken in England between 1998 and 2005 comparing proactive culling, reactive culling and no culling and measuring effects on cattle bTB.
Reactive culling	Localised badger removal undertaken in response to individual cattle bTB breakdowns or epidemiological evidence implicating badgers in a particular locality, rather than intervention across an entire predefined area.
Reactor / reactor animal	An animal that gives a positive response to the statutory bTB test and is classified for removal under the disease-control programme.
Reservoir host / wildlife reservoir	A host population capable of maintaining an infectious agent and contributing to its transmission to other hosts. In this review, badgers are considered an important wildlife reservoir of M. bovis within the Northern Ireland cattle–badger system.
RTA survey	**Road Traffic Accident survey.** Surveillance based on the collection and examination of badgers killed on roads to provide information on infection prevalence and spatial distribution.

Term	Meaning
SEA	**Strategic Environmental Assessment.** Assessment of the likely significant environmental effects of a proposed plan or programme and reasonable alternatives.
Selective culling / removal	Removal of individual badgers according to their assessed infection status rather than removal irrespective of infection status. TVR is the principal selective-removal approach considered in the DAERA consultation.
Sensitivity analysis	Analysis examining how results change when important assumptions or input values are varied. It is used to test how dependent a conclusion is on uncertain assumptions.
Sequenced approach	A wildlife-intervention strategy in which different interventions are applied in a planned order, for example an initial intervention intended to reduce infection pressure followed by vaccination or lower-intensity surveillance. Progression between stages may be predetermined or triggered by defined epidemiological and monitoring criteria.
SICCT (skin test)	**Single Intradermal Comparative Cervical Tuberculin test.** The comparative tuberculin skin test used for bTB testing in cattle. Some sources use the broader abbreviation CITT for the comparative intradermal tuberculin test.
STAR-IDAZ	**STAR-IDAZ International Research Consortium.** International animal-health research collaboration whose bTB research roadmap is considered in this review.
TBPSG	**TB Partnership Steering Group.** Partnership established to oversee and support delivery of Northern Ireland's current bTB eradication programme and responsible for the 2025 Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication. Distinct from the earlier **TBSPG – TB Strategic Partnership Group.**
TBSPG	**TB Strategic Partnership Group.** Northern Ireland stakeholder partnership which developed the 2016 Bovine Tuberculosis Eradication Strategy for Northern Ireland and associated recommendations on cattle, wildlife, finance and governance. It should not be confused with the later **TBPSG – TB Partnership Steering Group.**
TVR	**Test and Vaccinate or Remove.** Captured badgers are tested for evidence of bTB infection; animals testing positive are removed and those testing negative are vaccinated and released.
Unselective culling	Term used in some scientific and policy literature for the removal of badgers without selecting individual animals according to their infection status. In this review it is treated as equivalent in meaning to DAERA's term **"non-selective culling"**. It should not be interpreted as meaning geographically indiscriminate culling: intervention may still be

Term	Meaning
	targeted to defined areas on epidemiological or other relevant grounds. See **Non-selective culling**.
Vaccination-only	An intervention in which captured badgers are vaccinated with BCG and released, without intentional removal on the basis of infection status.
Wildlife intervention area	A defined geographical area selected for implementation of a wildlife intervention. Its appropriate scale and boundaries may depend on cattle epidemiology, badger density and distribution, landscape features, land access and other local factors.
WGS	**Whole-genome sequencing.** Genetic analysis of *M. bovis* isolates that can help investigate relationships between infections in cattle, badgers and other hosts and provide information on likely transmission patterns.
WOAH	**World Organisation for Animal Health (formerly OIE).** International organisation responsible for animal-health standards and guidance, including guidance relevant to bovine tuberculosis control.

1. Executive Summary

Purpose and overall position

AgriSearch's overall conclusion is that wildlife infection must be addressed alongside effective cattle controls, and that wildlife intervention should aim to achieve a substantial and sustained reduction in bTB as rapidly as can reasonably be achieved, taking account of the available evidence, local epidemiology and wider policy considerations. The three principal approaches are supported by different types and strengths of evidence, so decisions should be based on consistent evidential standards, current Northern Ireland data, transparent economic assumptions and local epidemiology, with outcomes monitored and the approach adapted as evidence develops.

Bovine tuberculosis remains one of the most serious and persistent animal-health, welfare and economic challenges facing Northern Ireland agriculture. Disease incidence remains historically high, recurrent and prolonged herd breakdowns continue to impose substantial costs on farmers and Government, and the existing programme has not placed Northern Ireland on a sufficiently clear trajectory towards eradication.

AgriSearch accepts the substantial scientific evidence that badgers form an important wildlife reservoir of *Mycobacterium bovis* in Northern Ireland and that effective eradication will require infection to be addressed in both cattle and wildlife. At the same time, cattle-to-cattle transmission, residual infection within herds, cattle movements and other epidemiological pathways remain important. The predominance of cattle-to-cattle transmission within an infected herd does not, in itself, identify the source responsible for introducing or reintroducing infection. Effective control must address within-herd amplification and persistence, cattle-mediated spread between herds, and wildlife-associated introduction or reintroduction. Wildlife intervention cannot substitute for effective cattle controls; both must operate as complementary elements of an integrated eradication programme. [1]

AgriSearch has approached the consultation without a predetermined preference for non-selective culling, Test and Vaccinate or Remove (TVR), or vaccination-only. The purpose of this response is to examine the nature, strength and limitations of the evidence supporting each option; whether that evidence has been interpreted and weighted consistently; the applicability of the assumptions to Northern Ireland; and

[1] DAERA (2025), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Scientific Opinion Conclusions 2–3; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly pp. 28–32. See Sections 3.2 and 7.7 of this response.

whether the economic appraisal provides a sufficiently transparent and robust basis for decision-making.

The scientific assessment represents AgriSearch's own critical review of the evidence. The economic appraisal was independently reviewed for AgriSearch by The Andersons Centre.

DAERA has assembled a substantial scientific evidence base. Its Scientific Opinion recognises the direct cattle-outcome evidence for proactive culling, the design limitations of the Northern Ireland TVR project, the context in which vaccination evidence has been generated and the limitations of mathematical modelling. AgriSearch's principal concern arises when that evidence is carried forward into modelling, option comparison, economic analysis, risk scoring, public-facing summaries and final rankings. At those stages, some qualifications are not carried through consistently, the distinction between demonstrated, observed, modelled and inferred outcomes is not always maintained clearly, and evidential uncertainties are not always treated symmetrically between the three principal intervention approaches.

Public consultation material should enable respondents to understand the evidential basis, strengths and principal uncertainties associated with each option. AgriSearch is concerned that the distinctions between demonstrated, observed, modelled and inferred evidence are not always articulated consistently enough to achieve this, particularly when the evidence is translated into later analysis and public-facing consultation material.

What the scientific evidence demonstrates

The three principal interventions all have a scientific basis, but the evidence supporting them differs substantially in directness, strength and relevance to cattle outcomes.

Non-selective culling, meaning removal irrespective of individual infection status within a geographically targeted intervention area, has the strongest direct field evidence of the three approaches for reducing cattle bTB herd incidence. This evidence relates principally to sustained, large-scale proactive removal and includes replicated trials in England and the Republic of Ireland, supported by subsequent English operational evidence. Recent reassessments reinforce uncertainty about the magnitude of the Randomised Badger Culling Trial (RBCT) effect, while later English programme results reflect a package of wildlife and cattle measures and should not be presented as an isolated estimate of the effect of culling alone. Important uncertainties also remain over transferability to Northern Ireland, perturbation, appropriate scale, boundaries, coverage, duration and the point at which removal should cease or transition to another intervention. Non-selective culling also removes infected and

uninfected badgers alike and raises significant welfare, ethical, ecological and public-acceptability considerations. Those considerations are legitimate factors in the eventual policy decision, but they do not reduce the strength of the direct cattle-outcome evidence. [2]

TVR has a particularly valuable Northern Ireland evidence base. The Banbridge project demonstrated that badgers can be captured, tested, vaccinated or selectively removed under local field conditions. Estimated badger infection prevalence declined substantially during the intervention, and no broad, sustained increase in badger ranging behaviour was detected under the selective-removal intensity studied. These are important findings. Although cattle herd bTB breakdowns were monitored, the project was undertaken in a single approximately 100 km^2 intervention area without replicated intervention and untreated control areas. Its design was therefore not sufficient to establish a causal effect of TVR on cattle herd incidence, and the subsequent analysis did not demonstrate such an effect. The appropriate conclusion is therefore that TVR is operationally feasible and was associated with encouraging badger-level outcomes, while a consequent cattle-level benefit remains to be demonstrated directly.

TVR performance also depends on incomplete capture, repeated intervention and an imperfect diagnostic test. Some infected badgers will not be captured in a particular year, and some infected captured animals will test negative and be vaccinated and released. More recent estimates of DPP diagnostic performance also indicate a potential trade-off between sensitivity and specificity. Expectations that TVR will produce cattle outcomes similar to non-selective culling therefore rely substantially on modelling and biological inference rather than equivalent field-observed cattle evidence. [3]

Vaccination-only has a strong biological evidence base. BCG vaccination reduces badger susceptibility to infection and can provide indirect protection within badger social groups. The Republic of Ireland also provides meaningful cattle-outcome evidence showing that vaccination was not inferior to continuing targeted culling in most of the areas studied. However, those areas had already experienced several years

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[2] DAERA (2025), *Scientific Opinion*, Annex VII, proactive culling section and Scientific Opinion Conclusion 5; Donnelly, C.A. et al. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', *Nature*, 439, 843–846; Griffin, J.M. et al. (2005), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', *Preventive Veterinary Medicine*, 67, 237–266; Birch, C.P.D. et al. (2024), 'Difference in differences analysis evaluates the effects of the badger control policy on bovine tuberculosis in England', *Scientific Reports*, 14, 4849. See Section 5.1.

[3] Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (*Meles meles*)', *PLoS ONE*, 16, e0246141; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151; DAERA (2025), *Scientific Opinion*, Annex VII, TVR section and Scientific Opinion Conclusion 6. See Section 5.2.

of badger removal. The direct cattle-outcome evidence therefore provides stronger support for vaccination as a transition from targeted culling under the circumstances studied. The Kilkenny work separately provides strong badger-level evidence of vaccine protection. What remains less directly demonstrated is the speed and magnitude of cattle benefit from vaccination-only as the initial intervention in a previously untreated Northern Ireland area with a substantial starting burden of badger infection.

BCG vaccination is principally preventive rather than therapeutic: it reduces susceptibility to infection but does not remove established M. bovis infection. Existing infection therefore remains within the population while vaccination progressively reduces susceptibility in uninfected animals and future cohorts. Sustained coverage over many years may be necessary, particularly where starting prevalence is high. The principal uncertainty is not whether vaccination has value, but how quickly and to what extent vaccination-only would reduce cattle disease under Northern Ireland starting conditions. [4]

Speed of effect is an important distinction between the interventions. Non-selective culling can reduce existing infection pressure directly by removing captured badgers irrespective of infection status, and field evidence demonstrates reductions in cattle bTB developing over several years. TVR also contains a removal component, but the rate at which it reduces infection pressure depends on the proportion of badgers captured, the sensitivity of the diagnostic test, starting infection prevalence and repeated intervention. Some infected animals will remain because they are not captured or because they test negative. TVR may therefore reduce infection pressure more gradually than well-delivered non-selective culling in some circumstances, but the size of that difference has not been demonstrated directly and modelling is equivocal as to whether TVR necessarily takes longer to achieve similar badger-level outcomes. More importantly for policy appraisal, the speed and magnitude of any resulting cattle-level benefit from TVR have not been demonstrated directly and remain principally model-dependent. Vaccination-only is expected to act more slowly again, particularly where starting infection prevalence is high, and may require sustained high coverage over many years before a substantial cattle-level benefit is realised. [5]

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[4] DAERA (2025), *Scientific Opinion*, Annex VII, badger vaccination section and Scientific Opinion Conclusion 4; Carter, S.P. et al. (2012); Gormley, E. et al. (2017); Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland?', *Preventive Veterinary Medicine*, 179, 105004. The relevant Republic of Ireland cattle-outcome evidence was generated in populations with a history of previous badger removal. See Section 5.3.

[5] DAERA (2025), *Scientific Opinion*, Annex VII, particularly Scientific Opinion Conclusions 4–6 and the Opinion Summary; DAERA (2026), *Badger Intervention Options Analysis Paper*, Annex VIII, section 8.3 and Tables 27–28; Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*. DAERA's Scientific Opinion concludes that interventions involving a lethal component tend to provide a faster bTB response than

There is also a credible scientific rationale for **sequenced and adaptive intervention**, including initially reducing infection pressure where necessary and subsequently transitioning towards vaccination and lower-intensity surveillance. The broader principle is supported by biological reasoning, modelling, international experience and the Republic of Ireland transition from removal towards vaccination. The specific flexible hybrid approach described in the CVO Review, however, has not itself been field-tested or subjected to detailed specific modelling. It should therefore be presented as a scientifically plausible approach requiring development and evaluation, not as an established evidence-based intervention. [6]

Consistency and potential asymmetries in DAERA's analysis and weighting

DAERA's Scientific Opinion recognises many of the distinctions set out above. It acknowledges the direct cattle evidence for culling, the design limitations of the Northern Ireland TVR project, the context in which the Irish vaccination evidence was generated and the limitations of mathematical modelling. The concern is that these qualifications do not always remain equally prominent in the later options analysis.

The most important asymmetry concerns the treatment of different evidence types. Direct cattle-outcome evidence for culling is extensively qualified by reference to perturbation, welfare, public acceptability, ecological effects and transferability. These are important qualifications, but they are different from the question of whether a cattle disease effect has been demonstrated. By comparison, TVR's operational feasibility, decline in estimated badger prevalence and absence of detected sustained perturbation are presented positively and are subsequently combined with favourable model outputs, despite the absence of equivalent controlled cattle-outcome evidence.

The practical effect is that TVR can appear to occupy a stronger evidential position than the direct cattle evidence supports, while culling can appear to occupy a weaker scientific position than its field evidence alone would indicate. This does not mean that TVR should not be selected or that culling must be preferred. It means that any preference for TVR should be presented transparently as reflecting a combination of modelled efficacy, welfare, ecological, operational and other policy considerations rather than stronger direct evidence of cattle benefit.

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vaccination-only, while recognising uncertainty over the relative speed of proactive culling and TVR. See Sections 5.1–5.3 and 6.6.

[6] DAERA (2025), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly pp. 62–65; Smith, G.C. et al. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192. See Sections 5.4 and 10.

There is a similar issue in the treatment of **perturbation**. DAERA appropriately tests a scenario in which culling produces an adverse peripheral effect. TVR is assumed not to produce perturbation because no sustained increase in ranging behaviour was detected during the Northern Ireland study. There is a reasonable scientific basis for considering perturbation less likely under TVR where only a relatively small proportion of the local badger population is removed. However, the evidence supports the narrower conclusion that no broad sustained perturbation was detected under the conditions and selective-removal intensity studied. It does not demonstrate that TVR could not produce behavioural or epidemiological effects under higher prevalence, higher removal rates or different spatial conditions. If future TVR deployment resulted in materially higher removal rates than those studied in the Northern Ireland project, DAERA should not assume that perturbation remains negligible. The possibility should be explicitly incorporated into the appraisal and implementation framework, with monitoring capable of detecting behavioural or epidemiological effects and predefined criteria for adapting the intervention if they emerge.[7]

During the consultation, DAERA published the previously unavailable 2019 APHA report underlying the Northern Ireland-parameterised model. This provides useful support for the plausibility of similar cattle outcomes from culling and TVR under specified assumptions, but does not establish equivalent field effectiveness. It also makes clearer the importance of starting prevalence, spatial configuration, perturbation and intervention sequencing. The relationship between the four-year initial intervention followed by vaccination in the model and the five-year intervention currently costed should be explained, with material differences carried through into sensitivity analysis.

Transferability should also be treated consistently. Evidence from England and the Republic of Ireland cannot simply be read across to Northern Ireland, but nor should evidence from different jurisdictions necessarily be treated as equally transferable. Where farming landscape, field pattern, herd structure, geography and intervention design more closely reflect Northern Ireland conditions, evidence from the Republic of Ireland may warrant greater weight. The same contextual test should apply to TVR and vaccination evidence generated under different badger densities, infection levels, intervention histories and cattle-control systems.

[7] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, prepared for AgriSearch, September 2026, particularly sections 5.4–5.7; DAERA (2026), *Badger Intervention Options Analysis Paper*, Annex VIII, particularly sections 6.1 and 9.3 and Table 29. Under DAERA's principal no-perturbation economic analysis, controlled shooting ranks first on illustrative NPV; when perturbation is applied to the non-selective culling options, restraint-based TVR ranks first. Restraint-based TVR ranks first in DAERA's composite assessment under both scenarios. See Sections 8.7–8.9.

Conclusions and statements requiring further qualification

Several propositions within the consultation should not be treated as established conclusions on the present evidence:

- A modelled projection that TVR could deliver a cattle disease-control impact similar to non-selective culling is not equivalent to a demonstrated cattle-outcome effect. Similar modelled long-term outcomes do not establish that the speed, reliability or magnitude of cattle benefit are equivalent.
- The substantial decline in estimated badger prevalence during the Northern Ireland TVR project is important, but the absence of replicated untreated controls means that the whole decline should not be attributed causally to TVR without qualification.
- The Northern Ireland TVR project did not demonstrate that TVR is ineffective in cattle. Its single-area design without replicated controls was not sufficient to establish a causal cattle-incidence effect. The correct conclusion is that cattle-level benefit was not demonstrated directly.
- The absence of detected sustained perturbation under the TVR trial conditions does not establish that perturbation is impossible under all future TVR deployment scenarios.
- Test-negative badgers should not be described as “healthy badgers”. The DPP test is imperfect, and some infected badgers will test negative.
- The Irish vaccination evidence does not directly demonstrate that vaccination-only will provide a sufficiently rapid cattle benefit when used as the initial intervention in an untreated, higher-prevalence Northern Ireland badger population.
- The proposed CVO hybrid approach is scientifically plausible but has no direct field or specific modelling validation in the form proposed.
- The description of England as having moved to a settled “vaccination-only policy” requires qualification. England is moving towards vaccination-led management, but the most recent recommended strategy includes targeted surveillance, adaptive review and the potential for exceptional lethal intervention; at the time of writing, those recommendations have not been adopted as a final replacement policy.
- Statements that intervention benefits are “expected” to outweigh costs should remain explicitly conditional where the number and timing of cattle breakdowns avoided are modelled or unknown.

AgriSearch recommends consistent terminology throughout the consultation: “demonstrated” or “observed” for field-measured outcomes; “associated with” for observational evidence where attribution is limited; “modelled” or “projected” for model outputs; and “plausible”, “inferred” or “hypothesised” where a conclusion rests on biological reasoning or extrapolation.

Economic appraisal

The Andersons Centre’s Stage 1 review assessed DAERA’s economic appraisal on the basis of the information made available through the published consultation. On 11 September 2026, following an information request submitted by Andersons on 18 August, DAERA released substantial additional underlying data. Preliminary examination indicates that this material provides considerably greater detail on the cage-trapping and controlled-shooting calculations and allows the headline cost figures for those options to be reconstructed. It does not, however, remove the need to test the robustness of important assumptions. DAERA has also not released the detailed DAFM cost information underpinning the stopped-restraint options, including Option 8, the highest-ranked option in its composite assessment. A fuller second-stage review remains possible if subsequently considered necessary, but has not been commissioned at this stage.

Within its Stage 1 review, Andersons did not conclude that DAERA’s economic framework is fundamentally unsound. Its general cost-building approach is logical, the use of a common 100 km^2 analytical unit is reasonable for comparison, and DAERA’s estimates of its own programme costs are broadly robust.

At the same time, the uncertainties and qualifications identified by Andersons do not in themselves remove the potential economic case for wildlife intervention. Andersons’ additional sensitivity analysis shows that restraint-based TVR retains a positive illustrative net present value when assumed effectiveness is reduced by 30%. This indicates that, within that particular sensitivity scenario, the economic case for Option 8 is not eliminated by a substantial reduction in assumed effectiveness. It does not, however, validate the underlying cattle-effectiveness assumption. The number and timing of herd breakdowns actually avoided remain critical to whether the projected benefits are realised.

The principal limitation identified in the Stage 1 review was insufficient transparency in the published consultation material to reproduce and independently test many of the headline intervention costs. Important underlying quantities, including labour hours, staff mix, wage assumptions, trapping and treatment inputs, equipment requirements and some external cost conversions, were not published in sufficient detail. The subsequent information released on 11 September materially improves transparency

around the cage-trapping and controlled-shooting calculations, but it was received after the Stage 1 analysis had been substantially completed and has not been subjected to a full independent reconstruction and assessment by Andersons. Detailed DAFM cost information underpinning the stopped-restraint options has not been released. Where commercial or procurement sensitivity prevents publication of detailed source information, greater transparency could still be provided through aggregated figures, ranges or sensitivity analysis. The presentation of single cost estimates, often to the nearest £1,000, conveys greater precision than the evidence appears to support. Additional sensitivity testing is required around badger population density, operational scale, labour, historical Banbridge costs, delivery systems, intervention duration, timing of benefits and the translation of Republic of Ireland and English programme data to Northern Ireland.

Badger population is a particularly important untested cost driver. The principal published Northern Ireland population estimate is based on fieldwork undertaken in 2007–08, while local densities may differ substantially from the averages and assumptions used in DAERA's calculations. Contemporary and geographically resolved badger population evidence should be incorporated before intervention coverage and cost estimates are finalised.

The Andersons review also concludes that DAERA is likely to understate the costs borne by farmers and therefore the economic value of preventing cattle herd breakdowns. This does not necessarily alter the relative ranking between interventions, but it makes effective wildlife intervention more economically valuable than DAERA's central estimates may suggest. AgriSearch considers the Andersons estimates should be used as the benchmark unless robust evidence supports an alternative, and DAERA's internal calculations should be reassessed accordingly. [8]

A further distinction must be maintained between DAERA's economic ranking and its final composite ranking. Under DAERA's principal no-perturbation economic scenario, controlled shooting is the highest-ranked option, whereas TVR using stopped restraints ranks highest in the composite assessment combining economic, non-monetary and operational-risk rankings. However, the separate economic ranking also changes under DAERA's sensitivity scenario applying perturbation to non-selective culling alone, in which restraint-based TVR ranks highest on illustrative net present value. Both the epidemiological scenario and the weighting of wider policy criteria therefore need to be explicit when presenting the preferred option. Given the material influence of this weighting choice on the overall ranking of the options, DAERA should explain the rationale for the approach and demonstrate how the ranking would change under

[8] The Andersons Centre (2026), *Review of the indirect costs borne by farmers, as a result of bovine TB (bTB) – Final Report*, prepared for LMC, UFU and DCNI, March 2026, particularly section 4.5, pp. 25–29, and section 5.6, pp. 50–54.

alternative plausible weightings, including scenarios in which greater weight is given to economic performance. Government is entitled to make such a multi-criteria policy judgement, but the weighting and resulting trade-offs should be explicit. The composite ranking should not be presented as though TVR has been shown to be the scientifically or economically superior option. If the sensitivity of the ranking to assumptions, scoring and weightings is not made sufficiently clear, the resulting ordering may be given greater weight than the underlying uncertainty justifies.

The consultation also asks whether intervention should be funded by the private sector without providing a developed assessment of how costs and benefits should be distributed. Who delivers an intervention is a separate question from who pays for it. AgriSearch does not consider that the current appraisal provides a sufficient basis for determining an industry contribution or funding split.

Issues identified with the Easy Read Summary

AgriSearch supports the provision of an accessible summary, but simplification must not alter the evidential balance.

The Easy Read treatment of non-selective culling does not explain the direct field evidence that sustained proactive culling can reduce cattle bTB herd incidence. Its principal option page appears to repeat generic material on intervention duration and monitoring rather than clearly describing the intervention, while the associated considerations give greater prominence to removal of untested badgers, welfare, cost, delivery and public confidence.

By contrast, TVR is described as removing infected badgers and vaccinating and releasing “healthy badgers”, while helping to reduce disease in the badger population. This wording gives greater certainty than the diagnostic evidence supports, because a test-negative result does not necessarily mean that a badger is uninfected. The Easy Read Summary also omits the critical qualifications that the Northern Ireland TVR project involved one intervention area, lacked replicated untreated controls and did not demonstrate a causal reduction in cattle herd incidence.

The vaccination-only section shows that significant scientific qualifications can be expressed in accessible language: it explains that vaccination does not treat existing infection and that disease reduction may take a long time. The same standard should be applied to all three interventions.

The indicative assessment at Appendix 6 also identifies issues concerning document length, explanation of technical concepts, the explanatory value of illustrations, accessible consultation questions and the updating of important consultation information. These are distinct from the accuracy of the scientific content. DAERA

should also make clear whether the material has been developed and tested with its intended audience; absence of that information should not be treated as proof that such involvement did not occur. Given that accessible material may be the principal, and for some consultees the only, consultation material they read, AgriSearch considers this a significant concern about the consistency and transparency with which the evidence is presented to consultees.

DAERA should revise the Easy Read Summary so that each option is described using a consistent structure: what the intervention involves; what has been demonstrated directly; what is modelled or inferred; the main uncertainties; likely speed of effect; and the principal welfare, operational and economic implications.

An evidence-led way forward

The evidence does not support a single abstract ranking that is necessarily appropriate across all of Northern Ireland. Starting badger infection prevalence, badger density, cattle breakdown history and recurrence, herd type and trading patterns, cattle movements, WGS and other transmission evidence, landscape, boundaries, land access, achievable coverage and the required speed of disease reduction can all affect which intervention is most appropriate.

The principal published Northern Ireland badger population estimate is based on fieldwork undertaken in 2007–08 and cannot, on its own, provide a sufficiently current or geographically resolved basis for intervention design. In particular, that study derived estimates of badger density indirectly from sett counts and assumed group sizes, with the potential for local under- or over-estimation and reduced resolution of population heterogeneity. Current Queen's University Belfast research remains ongoing and has not yet produced a revised Northern Ireland-wide population estimate. Earlier interim observations recorded local densities ranging from zero to 18 badgers/km^2, including 12–18 badgers/km^2 in four selected hotspot locations. A further field survey at a mid-Down site on 21 September 2026 recorded 36 badgers within a 1 km^2 survey area, with efforts made during the survey to avoid double-counting animals. These observations are site-specific direct minimum counts rather than complete population censuses and do not establish a Northern Ireland-wide population increase since 2007–08. They do, however, demonstrate substantial spatial variation and reinforce the extent to which local badger density can depart markedly from national-average assumptions. The best available contemporary evidence should therefore be incorporated into area selection, operational planning and coverage targets, and scientific and economic conclusions

should be sensitivity-tested against a range of locally relevant badger-density assumptions, including higher-density scenarios. [9]

Infection surveillance requires similar care. RTA and other test-positive proportions are influenced by sampling coverage and diagnostic methods and should not automatically be treated as true prevalence within a proposed intervention area. Local surveillance should therefore use clearly specified diagnostic protocols and appropriate complementary methods. Comparisons between cattle and badgers should distinguish herd-level from animal-level measures, and incidence from prevalence. [10]

DAERA already proposes area characterisation, continuing monitoring and adaptation. AgriSearch recommends bringing these components together into an explicit, published decision framework with predefined objectives, evaluation methods and criteria for changing intervention:

Diagnose → Select → Intervene → Monitor → Adapt → Transition/Exit

This should involve:

1. diagnosing the local cattle and wildlife epidemiology before selecting an intervention;
2. publishing transparent criteria for intervention-area selection and explaining how the evidence determines the intervention or sequence chosen;
3. specifying intended scale, boundaries, coverage, duration, delivery standards and concurrent cattle measures before implementation;
4. ensuring that the required speed of cattle disease reduction is considered explicitly, alongside eventual efficacy;
5. establishing a robust baseline and measuring actual rather than assumed intervention coverage;

[9] Reid, N., Etherington, T.R., Wilson, G.J., Montgomery, W.I. and McDonald, R.A. (2012), 'Monitoring and population estimation of the European badger Meles meles in Northern Ireland', Wildlife Biology, 18(1), 46–57, https://doi.org/10.2981/11-016; Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from Badger populations in Northern Ireland: a re-assessment with thermal technology, written communication to AgriSearch and other project funders, 4 September 2026; Dick, J.T.A. and QUB research team (2026), methodological clarification provided at Badger Population Assessments Project meeting, 8 September 2026. The work remains ongoing and does not establish a revised Northern Ireland-wide population estimate or directly comparable national trend. See Section 3.4 and Appendix 4; Childs, C. (Queen's University Belfast) (2026), field observation update from the mid-Down survey site, written communication to AgriSearch and project partners, 22 September 2026. The observation is an interim, site-specific direct count and does not constitute a revised Northern Ireland-wide population estimate.

[10] See Section 3.3 for the detailed assessment of badger infection prevalence, sampling coverage and diagnostic methods, and Section 11.2 for the proposed approach to contemporary population and infection surveillance.

6. retaining cattle disease outcomes as the principal epidemiological endpoint, reporting both herd-level and animal-level measures, including breakdown recurrence, duration and severity, alongside badger infection, population and behavioural indicators;
7. using comparator arrangements where feasible, making greater use of WGS and conventional epidemiology, publishing data and providing for independent evaluation;
8. defining in advance the criteria for continuing, intensifying, reducing, transitioning or ending an intervention; and
9. maintaining effective cattle controls and practical farm-level wildlife biosecurity alongside population-level wildlife intervention.

Implementation should be designed to reduce the present uncertainties rather than simply deliver a predetermined programme. A failure to achieve an expected outcome should be distinguishable from failure to deliver the intended coverage or intensity. Monitoring should therefore be capable of showing what was implemented, what happened to infection in badgers and cattle, whether the underlying epidemiology changed and whether the original assumptions remain valid.

Overall conclusion

AgriSearch considers that Northern Ireland needs effective action against infection in the wildlife reservoir as part of a comprehensive eradication programme, operating alongside effective cattle controls. Given the present disease burden and its consequences for farmers, cattle welfare and public expenditure, the objective should be to achieve a substantial and sustained reduction in bTB as rapidly as can reasonably be achieved, taking account of the available evidence, local epidemiology and wider policy considerations.

The uncertainties identified in this response are not, in AgriSearch's view, a reason for inaction. Rather, they strengthen the case for timely, targeted and adaptive intervention, with important assumptions tested, outcomes monitored and the approach changed where the evidence requires it.

The three principal interventions are not supported by equivalent evidence and are unlikely to act at the same speed under all starting conditions. Large-scale sustained non-selective culling has the strongest direct field evidence of reducing cattle bTB. TVR has valuable Northern Ireland operational and badger-level evidence but lacks equivalent direct cattle-outcome evidence. Vaccination has a strong biological evidence base and an important long-term role, but its use as an initial stand-alone

intervention under higher-prevalence Northern Ireland conditions is less directly supported and is likely to act more slowly. The appropriate intervention, or sequence of interventions, should therefore reflect the local source and intensity of infection, achievable coverage and the required speed of disease reduction.

The final decision may legitimately reflect welfare, ethical, environmental, public-acceptability, operational and economic considerations as well as epidemiological evidence. AgriSearch does not suggest that the intervention with the strongest direct scientific evidence must automatically be selected. It does, however, consider that the trade-offs must be explicit.

Where a preferred option is selected partly because it removes fewer badgers, presents lower welfare or ecological risks, or is considered more publicly acceptable, that should be stated as a multi-criteria policy judgement. It should not be presented as though the same option has the strongest direct cattle-outcome evidence or as though modelled outcomes have removed the underlying scientific uncertainty.

Ethical assessment should consider both the consequences of intervention and the consequences of delayed or insufficient disease reduction. Different approaches involve different potential trade-offs between the speed and certainty of disease reduction, badger welfare, cattle welfare, ecological effects, impacts on farming families, public acceptability and public expenditure. Where those considerations point in different directions, the basis for the resulting policy judgement should be made explicit, together with how the relevant risks and outcomes will be monitored. [11]

The objective should therefore be not simply to choose between culling, TVR and vaccination, but to establish a transparent, locally informed and adaptive wildlife programme focused on effective and timely disease reduction. It should operate alongside effective cattle controls, measure its effects on cattle disease, learn from implementation and change course where the evidence requires it.

Summary of recommendations

On the basis of the scientific and economic evidence considered, AgriSearch recommends that DAERA:

[11] The Andersons Centre (2026a), *Review of the indirect costs borne by farmers, as a result of bovine TB (bTB) – Final Report*, March 2026, particularly section 4.5, pp. 25–29, and section 5.6, pp. 50–54; Rural Support (2025), *Rural Support Helpline data relating to bovine tuberculosis, 2020–2024*, unpublished data supplied to The Andersons Centre; DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII, sections 7.4.4 and 7.4.6, including its assessment of cattle and human welfare. See also Sections 3.1, 6.6 and 9.2 of this response.

1. **Apply a consistent evidential framework** across all wildlife intervention options.
2. **Clearly distinguish demonstrated, observed, modelled and inferred outcomes** when describing expected intervention effects.
3. **Use contemporary Northern Ireland badger population information** when designing, costing and evaluating intervention.
4. **Base intervention decisions on locally resolved infection and transmission evidence**, rather than assuming that the same approach will be optimal everywhere.
5. **Give explicit consideration to the required speed of disease reduction** when comparing intervention options.
6. **Strengthen and publish the framework for selecting intervention areas**, including the epidemiological and operational criteria to be applied.
7. **Ensure wildlife intervention operates alongside effective cattle disease-control measures** as part of an integrated eradication programme.
8. **Interpret the Northern Ireland TVR evidence according to what the study was designed to demonstrate**, distinguishing its badger-level and operational findings from cattle-outcome evidence.
9. **Interpret vaccination evidence in the context in which it was generated**, including prior intervention and prevailing infection levels.
10. **Develop sequenced and adaptive intervention pathways**, rather than assuming that the initial intervention must remain unchanged throughout.
11. **Improve the transparency and sensitivity testing of the economic appraisal**, particularly for key assumptions affecting relative option costs and benefits.
12. **Revisit the economic value attributed to avoiding cattle breakdowns and clearly separate economic ranking from wider policy judgement**, including transparent justification and sensitivity testing of the weighting applied to economic, non-monetary and risk criteria.
13. **Undertake a separate and transparent assessment of funding arrangements** before determining how wildlife intervention costs should be shared.
14. **Design implementation to generate better evidence and provide for independent evaluation**, with clear baselines, outcome measures and predefined review points.

The detailed recommendations and supporting rationale are set out in **Section 12**.

2. Introduction

AgriSearch (The Northern Ireland Agricultural Research and Development Council) welcomes the opportunity to respond to the *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*. [12]

Bovine tuberculosis remains one of the most significant animal health, welfare and economic challenges affecting cattle farming in Northern Ireland. AgriSearch recognises that its eradication is a complex, long-term undertaking and that wildlife intervention cannot be considered in isolation from the wider measures required to address disease transmission and persistence. The *Blueprint for Eradication* is itself structured around the interconnected pillars of People, Cattle and Wildlife, and AgriSearch has therefore considered the wildlife proposals in the context of an integrated eradication programme. [13]

AgriSearch was formed in 1997 and is an independent, farmer-led research and innovation charity working across Northern Ireland's sheep, beef and dairy sectors. It provides a mechanism through which farmers can have direct involvement in production-orientated research and the application of science and evidence to practical farming challenges. Funds contributed to AgriSearch are used to commission and support research into the improvement and development of beef, sheep and dairy farming. Under its *2025–2030 Strategic Statement* [14], AgriSearch's vision is to drive farm profitability and sustainability through science, research and innovation. Its purpose is to equip farmers through the application of science, research and innovation to make a difference for the rural economy, environment and society, working with others to turn scientific possibilities into sound farm practice.

2.1 Scope and approach

AgriSearch has limited its response to those areas of the consultation that relate to its charitable objectives, particularly research, science, evidence, knowledge exchange, animal health and welfare and the practical improvement of sheep, beef and dairy

[12] Department of Agriculture, Environment and Rural Affairs (DAERA) (2026a), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication.

[13] TB Partnership Steering Group (2025), *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, particularly the framework of coordinated action across the People, Cattle and Wildlife pillars; see also DAERA (2025), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, which concludes that wildlife intervention and effective cattle controls are both required as components of an eradication strategy.

[14] AgriSearch Strategic Statement 2025 - 2030

farming in Northern Ireland. The principal focus is therefore the evidence base underpinning the proposed wildlife intervention options and the way in which scientific and economic evidence has been interpreted and applied. The response also considers the relevance of key assumptions to Northern Ireland conditions, the practical implications of implementation and monitoring, and aspects of the wider Blueprint where these are directly relevant to those issues. It does not seek to provide a response to every individual consultation question.

AgriSearch's role is not to advocate for a predetermined policy outcome, but to help ensure that major decisions affecting farmers are informed by balanced, proportionate and Northern Ireland-relevant science and evidence. Accordingly, AgriSearch has not approached this consultation with a predetermined view as to which wildlife intervention option should be adopted. Rather, it has sought to examine the strength, relevance and limitations of the evidence underpinning the different options; the consistency with which that evidence has been interpreted and weighted; and the extent to which the resulting assumptions and conclusions are applicable to Northern Ireland circumstances.

To support its consideration of the economic evidence, AgriSearch commissioned The Andersons Centre, under written Terms of Reference established by AgriSearch, to undertake an independent review of the economic assumptions and analysis underpinning the consultation. This review considers the transparency, robustness and consistency of the economic appraisal, including the assumptions used in estimating intervention costs and benefits. Its findings have informed the economic elements of this response. [15]

The scientific assessment presented in this response represents AgriSearch's own critical assessment of the available evidence. It is not intended to constitute a new systematic review; rather, it examines the evidence and interpretation most material to the consultation proposals, drawing where relevant on published research, official evaluations and emerging Northern Ireland evidence beyond the scope or cut-off date of DAERA's annotated bibliography. In undertaking that assessment, AgriSearch has sought to distinguish between findings demonstrated through field evidence, those supported by other forms of scientific evidence, and conclusions that remain dependent on modelling, inference or assumptions. It has also considered the relevance and transferability of evidence from other jurisdictions, the limitations of the Northern Ireland evidence base and material evidence that has emerged or been published beyond the scope or cut-off date of DAERA's annotated bibliography. [16]

[15] The Andersons Centre (2026), Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB, prepared for AgriSearch, September 2026.
[16] DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis for the period 1 January 2015 to 31 May 2024 (with later extension to 30 November 2024)*. The bibliography

AgriSearch's assessment is confined to the scientific, evidential, economic and implementation issues within its remit. It is not intended to constitute an assessment of the legal adequacy of the consultation process or the lawfulness of any future policy decision.

A central consideration throughout the response is therefore whether the available scientific and economic evidence has been represented, weighted and applied consistently across the different intervention options; whether uncertainty and limitations have been communicated proportionately; and whether the assumptions employed are sufficiently supported and appropriate to Northern Ireland conditions.

2.2 Structure of this response

The sections that follow consider the Northern Ireland disease and evidence context, the evidence relating to the principal wildlife intervention approaches, key issues affecting their application under Northern Ireland conditions, the economic appraisal and practical delivery considerations, and the monitoring and adaptive-management arrangements that would be required for any future intervention. The response concludes by identifying the areas in which AgriSearch considers the evidence sufficiently established to support decision-making and those in which further evidence, clarification or testing is required.

2.3 Relationship to DAERA's consultation questions

AgriSearch has deliberately structured this response around the principal scientific, economic and implementation issues rather than providing separate answers to each of the 18 consultation questions. This reflects the interrelated nature of many of the issues and avoids fragmenting evidence that is relevant to more than one question.

For ease of reference, Table 1 identifies the principal sections of this response in which matters relevant to each of DAERA's consultation questions are addressed. The table is intended as a navigation aid and should be read alongside the fuller analysis in the sections identified.

was confined principally to peer-reviewed badger-intervention literature within the stated search period; this response also considers relevant subsequently published research, official evaluations and other material evidence where pertinent to the assessment.

Table 1. Cross-reference between DAERA's consultation questions and the AgriSearch response

DAERA question	Subject	Principal relevant sections of this response
1	Equality and disability considerations	6.9; Appendix 6
2	Rural needs	8.8
3	Habitats Regulations Assessment	9.2
4	Strategic Environmental Assessment	11
5	Need for wildlife intervention	Executive Summary; 3.2; 3.5; 7.7; 13
6	Additional scientific evidence	2.1; 4; Appendix 1; Appendices 2–3; Section 14
7	Rating and scoring of options	8.9; 9.2; Recommendation 12
8	Private-sector delivery	8.2; 8.8
9	Funding of intervention	8.8; Recommendation 13
10	Non-selective cull – controlled shooting	5.1 AgriSearch assessment
11	Non-selective cull – baited cages	5.1 AgriSearch assessment
12	Non-selective cull – stopped restraints	5.1 AgriSearch assessment
13	TVR – baited cages	5.2 AgriSearch assessment
14	TVR – stopped restraints	5.2 AgriSearch assessment; 8.9
15	Vaccination-only – baited cages	5.3 AgriSearch assessment
16	Vaccination-only – stopped restraints	5.3 AgriSearch assessment
17	Lay vaccination	5.3 AgriSearch assessment
18	Blueprint for Eradication	10; 11; 13

3. The epidemiological and population context in Northern Ireland

3.1 The continuing cattle bTB burden

Bovine tuberculosis remains one of the most significant animal health challenges facing the Northern Ireland cattle sector. Although a statutory eradication programme has been in place since the late 1950s, [17] disease levels have deteriorated markedly in recent years. Annual herd incidence was 5.1% in 2010, generally remained between approximately 6% and 9% over the following decade, and has been around 10–11% since 2022. On a financial-year basis, DAERA reports annual herd incidence of 10.6% in 2024/25 and 9.6% in 2025/26 [18]. The latest statistics, to July 2026, report a 12-month herd-incidence rate of 9.62%, compared with 10.84% over the preceding 13–24 months. [19] This indicates some improvement relative to the preceding period, although disease incidence remains historically high.

The scale of the problem is also evident in the number of herds and animals affected. The Strategic Environmental Assessment records that 3,081 herds were affected by bTB during 2025, compared with 3,270 in 2024, and that 18,892 reactor animals were identified during 2025. [20] More recent DAERA statistics record 19,070 reactor animals in the 12 months to July 2026, during which approximately 1.76 million cattle were tested. [21] These figures illustrate both the continuing epidemiological burden and the very substantial testing and administrative effort required to operate the existing control programme. Herd incidence should, however, be interpreted carefully. It measures the proportion of new reactor herds disclosed with bTB infection over the preceding 12 months and does not represent the total proportion of herds experiencing restrictions associated with bTB. [22] At the time of the 2024 CVO Review, when herd incidence stood at 10.41%, approximately 12% of Northern Ireland herds were under bTB restriction, and these herds contained approximately 24% of the total cattle population, reflecting the disproportionate impact of bTB on larger herds and particularly dairy enterprises. [23]

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[17] DAERA (2026a), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, Chapter 2, p. 17. See also DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 7 and 10.
[18] DAERA (2026b), Annex VIII – Badger Intervention Options Analysis Paper, paras. 1.5.1–1.5.2, pp. 3–4; citing DAERA (2026), Tuberculosis: Monthly Statistics – March 2026 for the 2025/26 figure.
[19] DAERA (2026j), *Tuberculosis: Statistics for July 2026*, 10 September 2026.
[20] Tetra Tech (2026), *Annex IV – Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication*, section 3.2.7.3.2, pp. 78–79; drawing on DAERA monthly bTB statistics to March 2026.
[21] DAERA (2026j), *Tuberculosis: Statistics for July 2026*, 10 September 2026.
[22] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, p. 7.
[23] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, p. 9.

A further important feature of the Northern Ireland disease picture is the concentration of infection within herds experiencing prolonged or recurrent breakdowns. Recent Northern Ireland research has defined a prolonged breakdown as one lasting more than 12 months and a recurrent breakdown as an initial breakdown of less than one year followed by two further breakdowns within the following two years. Using these definitions, chronic breakdowns accounted for approximately 40% of all skin-test reactors in the study population. [24] The CVO Review also notes that the top 2% of bTB herd breakdowns contribute approximately one-quarter of all skin reactors, demonstrating the highly uneven distribution of disease burden between herds. [25]

Recurrence after apparent clearance remains a significant problem. The CVO Review records a 15% herd-breakdown recurrence rate at the six-month post-derestriction test, [26] and identifies residual infection not removed by existing diagnostic and control measures as an important driver of recurrent breakdowns. [27] This underlines that the epidemiology of bTB in Northern Ireland cannot be viewed simply in terms of the number of newly affected herds each year; persistence of infection within some herds and repeated breakdowns are also important components of the overall disease burden.

The financial consequences are similarly substantial. DAERA estimates that, allowing for the full economic cost of programme delivery, the bTB programme could cost Government approximately £78 million in 2026/27, with farmer compliance and other costs estimated by DAERA at a further £33 million [28]. However, a separate independent study undertaken by The Andersons Centre for the Livestock and Meat Commission, Dairy Council for Northern Ireland and Ulster Farmers' Union estimated the wider indirect costs borne by Northern Ireland farmers at approximately £96.1 million per year. When combined with DAERA direct expenditure at the time of that study, the total annual economic impact of bTB on Northern Ireland agriculture was estimated at approximately £156 million. [29] The two estimates are not directly comparable because

[24] Doyle, L.P., Courcier, E.A., Gordon, A.W., O'Hagan, M.J.H. and Menzies, F.D. (2016). "Bovine tuberculosis in Northern Ireland: Risk factors associated with duration and recurrence of chronic herd breakdowns." Preventive Veterinary Medicine, 131, 1–7. See also DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, p. 49.
[25] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 14 and 25.
[26] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, p. 23.
[27] Doyle, L.P., Courcier, E.A., Gordon, A.W., O'Hagan, M.J.H., Johnston, P., McAleese, E., Buchanan, J.R., Stegeman, J.A. and Menzies, F.D. (2022). "Northern Ireland farm-level management factors for recurrent bovine tuberculosis herd breakdowns." Epidemiology and Infection, 150, e176, 1–10; see also DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 26–27.
[28] DAERA (2026b), Badger Intervention Options Analysis Paper, Annex VIII, paras. 1.6.1–1.6.7, pp. 4–6; see also DAERA (2026c), Badger Intervention Analyses – Calculation Assumptions, section 3, particularly paras. 3.2–3.9 and Table 13.
[29] The Andersons Centre (2026a), Review of the indirect costs borne by farmers, as a result of bovine TB (bTB) – Final Report, March 2026, Executive Summary, pp. i–iii; section 6.3.1, p. 63; and section 7.2, pp. 87–88.

they use different cost definitions, methodologies and reference periods, but the Andersons work demonstrates that the burden borne by farmers extends substantially beyond the compliance and other farmer costs captured within DAERA's central estimate. The scale and valuation of these costs are considered further in Section 8.

The burden of bTB is not solely financial. The Andersons study identified significant effects on farmer and family wellbeing, including stress and anxiety associated with testing and breakdowns, prolonged uncertainty, loss of control, reduced confidence in the future of the business and strain on family relationships. [30] This is corroborated by evidence supplied directly by Rural Support: between 2020 and 2024, bTB was cited in approximately 12–15% of contacts to its helpline each year, averaging 13.9% over the five-year period. Rural Support also reported that financial and psychological pressures are closely linked and can contribute to wider family and generational tensions. [31] These impacts are difficult to express in monetary terms, but they form an important part of the overall burden of continuing high bTB incidence and reinforce the importance of achieving sustained disease reduction.

Against this background, the time taken for an intervention to produce a meaningful reduction in cattle disease is an important consideration alongside its eventual efficacy. [32] A measure capable of delivering benefit only over a relatively long period may still have an important role within an eradication strategy, but the consequences of delay are material where current disease incidence, recurrent breakdowns and programme costs remain high. [33] [34] Equally, speed of effect should not be considered in isolation from effectiveness, sustainability, welfare, environmental, operational and

[30] The Andersons Centre (2026a), Review of the indirect costs borne by farmers, as a result of bovine TB (bTB) – Final Report, section 4.5, pp. 25–29; section 5.6, pp. 50–54.
[31] Rural Support (2025), Rural Support Helpline data relating to bovine tuberculosis, 2020–2024, unpublished data supplied to The Andersons Centre; reported and analysed in The Andersons Centre (2026a), Review of the indirect costs borne by farmers, as a result of bovine TB (bTB) – Final Report, section 4.5, pp. 28–29, Figures 4-2 and 4-3 and accompanying text.
[32] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 6–7. The scientific opinion concludes that modelling generally indicates that interventions involving a lethal component may produce a faster bTB response than vaccination-only, while also stating that vaccination is comparatively slow to act and that sustained high-coverage vaccination over many years is likely to be required in endemic areas.
[33] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, sections 1.5–1.6. DAERA reports annual herd incidence of 10.6% in 2024/25 and 9.6% in 2025/26 and estimates that, with a full staff complement, the government cost of the bTB programme in 2024/25 would have been approximately £63 million.
[34] The Andersons Centre (2026), Review of the Indirect Costs Borne by Farmers, as a Result of Bovine TB (bTB) – Final Report, Executive Summary, pp. i–ii. The study estimates indirect costs to Northern Ireland farmers of £96.1 million per annum and an overall annual economic impact, when combined with direct public expenditure, of approximately £156 million.

economic considerations. [35] It is, however, one of the factors which should be assessed consistently across the different wildlife intervention options.

3.2 Evidence for a wildlife reservoir

There is now a substantial body of evidence that badgers form an important wildlife reservoir of *Mycobacterium bovis* within the cattle–badger disease system in Northern Ireland and elsewhere across the UK and Ireland. [36] *M. bovis* infection is established within the Northern Ireland badger population, and the same or closely related strain types have been identified in badgers and cattle occupying the same geographical areas. [37] DAERA's Chief Veterinary Officer Review consequently describes badgers as a reservoir host of *M. bovis* in Northern Ireland and an important contributor to the epidemiology of bTB in cattle. [38] The extent and spatial distribution of infection within the Northern Ireland badger population are considered separately in Section 3.3.

There is also evidence of a biological mechanism that may contribute to badger susceptibility to M. bovis infection. Bilham et al. (2017) found that macrophages derived from wild badgers failed to produce detectable nitric oxide, an important anti-mycobacterial effector molecule, following stimulation by a wide range of immune agonists, including mycobacterial antigens. The authors concluded that this feature of badger innate immunity would be expected to impair their capacity to resist bTB infection. This does not establish that badgers are quantitatively more susceptible than cattle, but it provides a plausible immunological mechanism contributing to susceptibility to M. bovis. [39]

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[35] DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, Chapters 3–8; see also DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII. The consultation assesses wildlife intervention options across scientific effectiveness, animal welfare, environmental implications, operational delivery and economic considerations rather than efficacy alone.

[36] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 28–30 and 61–62; see also DAERA (2025), Annotated Scientific Bibliography – badger intervention – bTB – 2015 to November 2024, particularly the transmission-dynamics conclusion at p. 17.

[37] Courcier, E.A., Menzies, F.D., Strain, S.A.J., Skuce, R.A., Robinson, P.A., Patterson, I.A.P., McBride, K.R., McCormick, C.M., Walton, E., McDowell, S.W.J. and Abernethy, D.A. (2018). "Monitoring Mycobacterium bovis in Eurasian badgers (Meles meles) killed by vehicles in Northern Ireland between 1998 and 2011." Veterinary Record, 182, 259–265. doi:10.1136/vr.103934; see also Byrne, A.W. et al. (2024). "Badger Ecology, Bovine Tuberculosis, and Population Management: Lessons from the Island of Ireland." Transboundary and Emerging Diseases, 2024, 8875146. https://doi.org/10.1155/2024/8875146.

[38] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, p. 29 and pp. 61–62.

[39] Bilham, K., Boyd, A.C., Preston, S.G., Buesching, C.D., Newman, C., Macdonald, D.W. and Smith, A.L. (2017), 'Badger macrophages fail to produce nitric oxide, a key anti-mycobacterial effector molecule', *Scientific Reports*, 7, 45470, doi:10.1038/srep45470. The study found no detectable nitric oxide production by macrophages derived from 33 wild badgers following a range of immune stimuli and

The epidemiological relationship between cattle and badgers is more complex than a simple one-way transmission pathway. Transmission occurs within both cattle and badger populations as well as between the two species, although the relative importance and direction of these pathways varies between locations. [40] Interspecies transmission may occur directly or indirectly through shared environments. Studies examining cattle–badger interactions indicate that direct contact is relatively uncommon, while indirect interactions and successive use of the same pasture or other environmental locations occur more frequently and may provide opportunities for transmission. [41]

Interim QUB observations provide further Northern Ireland-specific evidence relevant to this environmental pathway. The research team reports observation of badgers urinating and defecating across the wider landscape as well as at communal latrines, and reported detection of viable M. bovis in badger faecal samples using an emerging phage-based PCR approach, subject to further independent validation of the method for this application. These observations support the plausibility of environmental exposure occurring away from setts and latrines, but do not presently quantify shedding frequency, environmental persistence, cattle exposure or the proportion of cattle infection attributable to this pathway. [42]

The development of whole-genome sequencing (WGS) has significantly improved the ability to investigate these transmission relationships. Analysis of *M. bovis* genomes can identify closely related isolates and, when combined with epidemiological and spatial

concluded that this feature of badger macrophage biology would impair their capacity to resist bTB infection.

[40] DAERA (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 2 and 7; Akhmetova, A. et al. (2023), 'Genomic epidemiology of Mycobacterium bovis infection in sympatric badger and cattle populations in Northern Ireland', Microbial Genomics, 9, 001023, doi:10.1099/mgen.0.001023; Crispell, J. et al. (2019), 'Combining genomics and epidemiology to analyse bi-directional transmission of Mycobacterium bovis in a multi-host system', eLife, 8, e45833, doi:10.7554/eLife.45833.

[41] Ferreira, E.M., Duarte, E.L., Cunha, M.V., Mira, A. and Santos, S.M. (2023), 'Disentangling wildlife-cattle interactions in multi-host tuberculosis scenarios: systematic review and meta-analysis', Mammal Review, 53(4), 287–302, doi:10.1111/mam.12324; Campbell, E.L. et al. (2019), 'Interspecific visitation of cattle and badgers to fomites: a transmission risk for bovine tuberculosis?', Ecology and Evolution, 9(15), 8479–8489; Woodroffe, R. et al. (2016), 'Badgers prefer cattle pasture but avoid cattle: implications for bovine tuberculosis control', Ecology Letters, 19(10), 1201–1208, doi:10.1111/ele.12654; Woodroffe, R. et al. (2021), 'Successive use of shared space by badgers and cattle: implications for Mycobacterium bovis transmission', Journal of Zoology, 314(2), 132–142, doi:10.1111/jzo.12863.

[42] Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, written communication to AgriSearch, 4 September 2026, reproduced at Appendix 4; Dane, H., Gilbride, B., Thomas, M. and Grant, I.R. (2026), 'Evidence of mycobacteraemias and mycobacterial co-infections uncovered in cattle at slaughter using a novel phage-based PhMS-qPCR assay for viable *Mycobacterium bovis* and *Mycobacterium avium* subsp. *paratuberculosis*', *Irish Veterinary Journal*, 79, 2, https://doi.org/10.1186/s13620-025-00323-1

information, provide evidence about likely transmission pathways. [43] The accumulated WGS evidence supports bidirectional transmission between cattle and badgers, but also demonstrates that the relative contribution of each species can vary considerably between locations. [44] DAERA's updated scientific review similarly concludes that the contribution of different host species to maintaining *M. bovis* infection varies between bTB hotspots. [45]

This variation is important when interpreting individual studies. For example, genomic analysis of the Woodchester Park study population in England identified substantially more within-species than between-species transmission, while also detecting transmission in both directions between cattle and badgers. [46] By contrast, WGS analysis from the Northern Ireland TVR study area found that transmission there appeared to be dominated by cattle-associated spread. The CVO Review reports that **3**5 of 37 inferred direct transmission events were cattle-associated, with only two interspecies transitions and no badger-to-badger direct transmission events inferred. The annotated bibliography further records that, within this particular study area, cattle-to-badger transmission appeared more common than badger-to-cattle transmission. [47]

These findings should not be interpreted as evidence that badger-to-cattle transmission is unimportant. In a multi-host system, relatively infrequent transmission between species can still be epidemiologically significant. An infection introduced from a badger into a cattle herd can subsequently be amplified through cattle-to-cattle

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[43] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 50–51; Allen, A. *et al.* (2024), 'Whole-Genome sequencing in routine *Mycobacterium bovis* epidemiology – scoping the potential', *Microbial Genomics*, 10, 001185, doi:10.1099/mgen.0.001185.

[44] Crispell, J. *et al.* (2019), 'Combining genomics and epidemiology to analyse bi-directional transmission of *Mycobacterium bovis* in a multi-host system', *eLife*, 8, e45833, doi:10.7554/eLife.45833; Rossi, G. *et al.* (2022), 'Phylodynamic analysis of an emergent *Mycobacterium bovis* outbreak in an area with no previously known wildlife infections', *Journal of Applied Ecology*, 59(1), 210–222, doi:10.1111/1365-2664.14046; Akhmetova, A. *et al.* (2023), 'Genomic epidemiology of *Mycobacterium bovis* infection in sympatric badger and cattle populations in Northern Ireland', *Microbial Genomics*, 9, 001023, doi:10.1099/mgen.0.001023.

[45] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 2 and 7; see also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, pp. 16–17.

[46] Crispell, J., Benton, C.H., Balaz, D., De Maio, N., Akhmetova, A., Allen, A., Biek, R., Presho, E.L., Dale, J., Hewinson, G., Lycett, S.J., Nunez-Garcia, J., Skuce, R.A., Trewby, H., Wilson, D.J., Zadoks, R.N., Delahay, R.J. and Kao, R.R. (2019), 'Combining genomics and epidemiology to analyse bi-directional transmission of Mycobacterium bovis in a multi-host system', eLife, 8, e45833. doi:10.7554/eLife.45833; see also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, pp. 16–17.

[47] Akhmetova, A., Guerrero, J., McAdam, P., Salvador, L.C.M., Crispell, J., Lavery, J., Presho, E., Kao, R.R., Biek, R., Menzies, F., Trimble, N., Harwood, R., Pepler, P.T., Oravcova, K., Graham, J., Skuce, R., du Plessis, L., Thompson, S., Wright, L., Byrne, A.W. and Allen, A.R. (2023), 'Genomic epidemiology of Mycobacterium bovis infection in sympatric badger and cattle populations in Northern Ireland', Microbial Genomics, 9(5), 001023. doi:10.1099/mgen.0.001023; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 49–50; DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, p. 17.

transmission. [48] Infection can also pass from cattle back into badgers and contribute to persistence within the local system. [49] The CVO Review therefore cautions that, although interspecies transmission may be less frequent than transmission within cattle or badgers, spill-back from badgers can remain significant because of subsequent amplification in cattle. [50]

An important distinction is therefore required between the source that introduces or reintroduces infection into a herd and the subsequent transmission of that infection within the herd. Once M. bovis has entered a herd, cattle-to-cattle transmission may account for a substantial proportion of onward infection without identifying the upstream source responsible for the original introduction. For disease-control purposes it is useful to distinguish three related epidemiological components: amplification within infected herds; transmission of infection between herds, including through cattle movements; and introduction or reintroduction from infected wildlife. Effective regional control requires all three to be addressed. [51] The predominance of cattle-to-cattle transmission within an infected herd does not, in itself, demonstrate that wildlife sources are unimportant in initiating or reinitiating breakdowns.

The evidence therefore supports viewing bTB in Northern Ireland, in broad terms, as a two-host transmission system involving cattle and badgers rather than as a disease attributable exclusively to either host. [52] This has two important implications. First, the evidence that badgers contribute to the persistence and transmission of *M. bovis* provides a scientific basis for addressing infection within the wildlife reservoir as part of

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[48] Donnelly, C.A. and Nouvellet, P. (2013), 'The Contribution of Badgers to Confirmed Tuberculosis in Cattle in High-Incidence Areas in England', PLOS Currents Outbreaks, 5, doi:10.1371/currents.outbreaks.097a904d3f3619db2fe78d24bc776098; Brooks-Pollock, E. and Wood, J.L.N. (2015), 'Eliminating bovine tuberculosis in cattle and badgers: insight from a dynamic model', Proceedings of the Royal Society B: Biological Sciences, 282, 20150374, doi:10.1098/rspb.2015.0374.

[49] Akhmetova, A. et al. (2023), 'Genomic epidemiology of Mycobacterium bovis infection in sympatric badger and cattle populations in Northern Ireland', Microbial Genomics, 9, 001023, doi:10.1099/mgen.0.001023; Rossi, G. et al. (2022), 'Phylodynamic analysis of an emergent Mycobacterium bovis outbreak in an area with no previously known wildlife infections', Journal of Applied Ecology, 59, 210–222, doi:10.1111/1365-2664.14046; see also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, p. 17.

[50] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 29 and 61–62; Griffin, J., Aznar, I., Breslin, P., Good, M., Gordon, S.V., Gormley, E., McAloon, C.I., Menzies, F., More, S.J., Ring, S. and Wiseman, J. (2023), 'What is the proportional contribution of cattle-to-cattle, badger-to-cattle, and deer-to-cattle TB transmission to bovine TB in Ireland?', Food Risk Assess Europe, 1(2), 0009E, doi:10.2903/fr.efsa.2023.FR-0009.

[51] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 22–23 and 72–73; Doyle, L.P. et al. (2020), 'Northern Ireland Farm Level Management Factors for Prolonged Bovine Tuberculosis Herd Breakdowns', Epidemiology and Infection, doi:10.1017/S0950268820002241; Doyle, L.P. et al. (2022), 'Northern Ireland farm-level management factors for recurrent bovine tuberculosis herd breakdowns', Epidemiology and Infection, 150, doi:10.1017/S0950268822001479; see also Griffin et al. (2023), above.

[52] DAERA (2026), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 2–3 and 7; DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, p. 17.

an eradication programme. Second, wildlife intervention cannot be regarded as a substitute for effective cattle controls. DAERA's scientific opinion explicitly concludes both that badger intervention remains necessary and that strengthened cattle measures are equally critical, since wildlife intervention alone is unlikely to achieve eradication. [53]

Accordingly, AgriSearch considers that the key scientific question is not whether cattle or badgers are the sole cause of the Northern Ireland bTB problem, but how the relative contribution of each host varies between areas and how control measures can most effectively reduce transmission within and between both populations. This local variation is relevant not only to the case for wildlife intervention, but also to the selection and targeting of interventions within particular areas. [54]

3.3 Badger infection prevalence

The prevalence of *M. bovis* infection within the badger population is an important part of the epidemiological context for any wildlife intervention. DAERA's Road Traffic Accident (RTA) Survey provides the principal ongoing surveillance source of information on infection in badgers across Northern Ireland. Badgers reported as killed on roads are collected for post-mortem examination and testing for *M. bovis*. [55] The current consultation states that infection is present in approximately 20% of badgers collected through the survey and gives a 2025 estimated prevalence of 22.7% (95% confidence interval 18.3%-27.6%). [56] It also reports that strain types found in badgers are similar to those identified in local cattle and that badger prevalence is positively associated with local cattle bTB prevalence. [57]

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[53] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 7–9; see also DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, pp. 10–11.

[54] DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, p. 17; DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 2–5 and 8; DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, Chapter 4, pp. 26–27.

[55] DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, pp. 23–24; TB Strategic Partnership Group (2016), Bovine Tuberculosis Eradication Strategy for Northern Ireland, p. 52.

[56] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, p. 24.

[57] Akhmetova, A. et al. (2023), 'Genomic epidemiology of Mycobacterium bovis infection in sympatric badger and cattle populations in Northern Ireland', Microbial Genomics, 9, 001023, doi:10.1099/mgen.0.001023; Courcier, E.A., Menzies, F.D., Strain, S.A.J., Skuce, R.A., Robinson, P.A., Patterson, I.A.P., McBride, K.R., McCormick, C.M., Walton, E., McDowell, S.W.J. and Abernethy, D.A. (2018), 'Monitoring Mycobacterium bovis in Eurasian badgers (Meles meles) killed by vehicles in Northern Ireland between 1998 and 2011', Veterinary Record, 182, 259–265, doi:10.1136/vr.103934; see also DAERA (2026), Consultation on Potential Wildlife Intervention Options, p. 24.

The RTA Survey therefore provides valuable evidence that infection is established at a substantial level within the Northern Ireland badger population. However, the resulting figure should not be interpreted as a precise or spatially uniform measure of prevalence across Northern Ireland. The Chief Veterinary Officer's Review identifies limitations associated with the RTA survey, including its nature as a convenience sample and concerns around both the validity and precision of extrapolating results to the wider badger population. [58] Earlier Northern Ireland epidemiological evaluation of the RTA survey similarly concluded that it provides useful surveillance and spatial information but is constrained by the inherent limitations of passive sampling, including geographical and reporting biases. That work found a significant spatial association between infected badgers and bTB in surrounding cattle herds, but importantly did not establish the direction of transmission between the two species. [59] Earlier work by the TB Strategic Partnership Group also noted that geographical coverage is uneven and that the numbers sampled are sufficient to provide a reasonable broad estimate for Northern Ireland but are less capable of detecting regional or temporal differences unless these are relatively large. [60]

Interpretation of RTA prevalence estimates also requires consideration of diagnostic sensitivity *(how often the test detects animals that really are infected)*. The Northern Ireland RTA survey does not rely on visible lesions alone: the published protocol includes bacteriological culture of routinely collected lymph-node pools and other selected tissues. However, Courcier et al. concluded that the resulting prevalence estimate was likely to underestimate true infection because of limitations in tissue sampling, reliance on gross pathology for some additional sampling, imperfect diagnostic sensitivity and variable carcass condition. This is consistent with evidence from the Republic of Ireland. Murphy et al. (2010), using substantially more intensive post-mortem examination and comprehensive bacteriological culture, detected M. bovis in 36.3% of badgers compared with 12.1% identified from culture-confirmed visible lesions, with most infected badgers showing no visible lesions. The three-fold difference should not be applied directly to Northern Ireland RTA estimates because the Northern Ireland protocol already incorporates routine culture. Nevertheless, it demonstrates that apparent prevalence is sensitive to the diagnostic protocol

[58] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, p. 65.
[59] Abernethy, D.A., Walton, E., Menzies, F.D., Courcier, E.A. and Robinson, P.A. (2011), 'Mycobacterium bovis surveillance in European badgers (Meles meles) killed by vehicles in Northern Ireland: an epidemiological evaluation', Épidémiologie et Santé Animale, 59–60, pp. 216–218; Courcier, E.A., Menzies, F.D., Strain, S.A.J., Skuce, R.A., Robinson, P.A., Patterson, I.A.P., McBride, K.R., McCormick, C.M., Walton, E., McDowell, S.W.J. and Abernethy, D.A. (2018), 'Monitoring Mycobacterium bovis in Eurasian badgers (Meles meles) killed by vehicles in Northern Ireland between 1998 and 2011', Veterinary Record, 182, 259, doi:10.1136/vr.103934.
[60] TB Strategic Partnership Group (2016), Bovine Tuberculosis Eradication Strategy for Northern Ireland, p. 52.

employed and that RTA percentage-positive results should not automatically be interpreted as estimates of true population prevalence. [61]

Care is also required when comparing disease levels between cattle and badgers. DAERA frequently reports cattle bTB using herd-level incidence or prevalence, whereas badger infection is generally reported as the proportion of individual animals infected. These measures have different denominators and should not be interpreted as directly comparable indicators of infection burden. A cattle herd is counted as a breakdown whether one animal or many animals are affected. DAERA's latest data illustrate the distinction: in the 12 months to July 2026, herd incidence was 9.62%, while animal incidence was 1.084%. [62] By comparison, the 2023 Northern Ireland RTA survey estimated apparent M. bovis prevalence in individual badgers at 21.3%. [63]

The animal-level figures do not provide a direct like-for-like comparison: cattle animal incidence and apparent badger prevalence are different epidemiological measures, arise from different surveillance and diagnostic systems and relate to different reference periods. They should therefore not be used to infer the relative probability of infection, or the relative contribution to transmission, in cattle and badgers. They do, however, illustrate why comparisons between badger infection measured at individual-animal level and cattle disease measured only at herd level require particular caution. Where disease levels in the two host populations are presented together, DAERA should, where practicable, report both herd-level and animal-level cattle measures and clearly identify the denominator and type of measure being used.

There is evidence that infection prevalence can vary considerably between areas and badger social groups. [64] DAERA's calculation assumptions cite studies from across the island of Ireland reporting prevalence estimates ranging from 12% to 43%, depending partly on the surveillance and diagnostic protocols used. The Northern Ireland TVR pilot in the Banbridge area estimated a starting prevalence of approximately 14%, compared

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[61] Courcier, E.A., Menzies, F.D., Strain, S.A.J., Skuce, R.A., Robinson, P.A., Patterson, I.A.P., McBride, K.R., McCormick, C.M., Walton, E., McDowell, S.W.J. & Abernethy, D.A. (2018). 'Monitoring *Mycobacterium bovis* in Eurasian badgers (*Meles meles*) killed by vehicles in Northern Ireland between 1998 and 2011'. *Veterinary Record*, 182, 259. https://doi.org/10.1136/vr.103934; Murphy, D., Gormley, E., Costello, E., O'Meara, D. & Corner, L.A.L. (2010). 'The prevalence and distribution of *Mycobacterium bovis* infection in European badgers (*Meles meles*) as determined by enhanced post mortem examination and bacteriological culture'. *Research in Veterinary Science*, 88(1), 1–5. https://doi.org/10.1016/j.rvsc.2009.05.020.

[62] DAERA (2026j), *Tuberculosis: Statistics for July 2026*, 10 September 2026.

[63] DAERA (2025). *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 3.4, p. 8; DAERA (2024). *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 7 and 63.

[64] DAERA (2025), Scientific Opinion on the Peer Reviewed Evidence on Badger Intervention in Relation to the Control of Bovine Tuberculosis, Annex 1, pp. 23–24; Byrne, A.W. et al. (2015), 'Spatial and temporal analyses of metrics of tuberculosis infection in badgers (Meles meles) from the Republic of Ireland: trends in apparent prevalence', Preventive Veterinary Medicine, 122(3), 345–354; Carter, S.P. et al. (2012), 'BCG Vaccination Reduces Risk of Tuberculosis Infection in Vaccinated Badgers and Unvaccinated Badger Cubs', PLoS ONE, 7(12).

with the broadly 20% figure from the RTA survey. For the purposes of costing the intervention options, DAERA has therefore adopted a pragmatic starting prevalence assumption of 25%, while explicitly recognising that accurate prevalence estimates are difficult and that regional variation is likely. [65]

Evidence from the Republic of Ireland reinforces the importance of spatial variation. DAERA's scientific opinion notes that apparent prevalence among culled badgers varied at county level from below 3.5% in some areas to above 17% in others, and that heterogeneity in infection has also been observed between badger social groups. [66] The Northern Ireland CVO Review goes further in suggesting that prevalence in particular disease hotspots could potentially be considerably higher than the national RTA estimate, citing Republic of Ireland studies where levels of 40-50% have been detected in some hotspot areas. This should, however, be treated as a hypothesis about what might occur in some Northern Ireland hotspots rather than evidence that prevalence of this magnitude has actually been measured in Northern Ireland. [67]

This variation matters because the starting prevalence of infection is likely to influence both the operation and expected speed of effect of the different wildlife interventions. Under a non-selective cull, starting prevalence influences the proportion of animals removed that are infected rather than uninfected. Under TVR, prevalence affects the number of infected animals that need to be identified and removed and, together with the sensitivity and specificity of the diagnostic test, the proportion likely to be identified and removed. [68] Under vaccination-only, vaccination does not provide a therapeutic benefit to badgers already infected, meaning that the initial force of infection within the population is particularly relevant to the time required for vaccination to reduce transmission. DAERA itself acknowledges this issue in its options analysis, concluding that vaccination-only is likely to be less effective in areas of high infection prevalence unless infection pressure has first been reduced. [69]

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[65] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, para. 2.14.3, p. 15; Byrne, A.W. et al. (2024), 'Badger Ecology, Bovine Tuberculosis, and Population Management: Lessons from the Island of Ireland', Transboundary and Emerging Diseases, 2024, 8875146; Arnold, M.E. et al. (2021), 'A Bayesian analysis of a test and vaccinate or remove study to control bovine tuberculosis in badgers (Meles meles)', PLoS ONE, 16, e0246141.

[66] DAERA (2025), Scientific Opinion on the Peer Reviewed Evidence on Badger Intervention in Relation to the Control of Bovine Tuberculosis, Annex 1, pp. 23–24; Byrne et al. (2015), op. cit.; Carter et al. (2012), op. cit.

[67] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 63–64; Gormley et al. (2022), as discussed in DAERA (2025), Annotated Scientific Bibliography Relating to Badger Intervention and Bovine Tuberculosis, pp. 27–28.

[68] DAERA (2025), Scientific Opinion on the Peer Reviewed Evidence on Badger Intervention in Relation to the Control of Bovine Tuberculosis, Annex 1, pp. 23–24; DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, paras. 2.14.3–2.14.4 and Table 2, pp. 15–19; Arnold et al. (2021), op. cit.

[69] DAERA (2025), Scientific Opinion on the Peer Reviewed Evidence on Badger Intervention in Relation to the Control of Bovine Tuberculosis, pp. 7–8 and Annex 1, pp. 14–16; DAERA (2026), Badger Intervention –

There are differences in the prevalence assumptions used across DAERA's analysis. The main comparative outputs from the APHA model carried forward into Annex VIII are based on an Area 1 alternative-zone scenario with 10% background badger bTB prevalence, [70] whereas the economic costing assumptions use a starting prevalence of 25%. [71] The newly published 2019 APHA report also modelled a 40% background prevalence and found broadly similar relative patterns between intervention options, although the scale of the response and the rate at which disease returned after intervention differed. [72] This suggests that the relative model ranking was not simply an artefact of the 10% assumption, but it does not remove the importance of starting prevalence for operational delivery, particularly under TVR where prevalence influences the number of animals testing positive and being removed. [73] For AgriSearch, the principal implication is that a single Northern Ireland-wide prevalence estimate should provide context rather than determine intervention design. What matters operationally is the infection pressure within the areas in which intervention is actually proposed. RTA surveillance may contribute to that assessment, but should not in isolation be treated as a precise estimate of prevalence within a proposed intervention area. The selection and management of intervention areas should therefore draw, as far as practicable, on geographically resolved information on badger infection alongside cattle epidemiology, genomic evidence and local veterinary assessment. [74] This becomes particularly important if different intervention approaches, or different sequences of intervention, may be appropriate under low- and high-prevalence conditions. [75]

3.4 Badger population size and density

Reliable information on the size, density and spatial distribution of the Northern Ireland badger population is fundamental to the design and evaluation of any wildlife intervention. Population size affects the number of animals that must be captured,

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Options Analysis Paper, Annex VIII, pp. 12, 120 and 126; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 63–64; Robinson et al. (2012); Aznar et al. (2018)

[70] DAERA (2026), Annex VIII – Badger Intervention Options Analysis Paper, paras. 5.3.15–5.3.17, pp. 53–54.

[71] DAERA (2026), Annex IX – Badger Intervention Analyses: Calculation Assumptions, para. 2.14.3, p. 15.

[72] Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, APHA National Wildlife Management Centre, p. 2 and pp. 13–14.

[73] DAERA (2026), Annex IX – Badger Intervention Analyses: Calculation Assumptions, para. 2.14.3, p. 15 and Table 2, p. 19.

[74] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, sections 4.1–4.2, pp. 26–27; see also DAERA (2026), *Habitats Regulations Assessment*, para. 1.37–1.41, p. 7; Akhmetova, A. *et al.* (2023), 'Genomic epidemiology of *Mycobacterium bovis* infection in sympatric badger and cattle populations in Northern Ireland', *Microbial Genomics*, 9, 001023, doi:10.1099/mgen.0.001023.

[75] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 7–8; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 62–64

vaccinated or removed to achieve a specified level of coverage, while local density and population distribution influence trapping effort, intervention boundaries, operational costs and the potential for immigration from surrounding areas. [76] DAERA's own annotated scientific bibliography concludes that robust badger population data are required to inform the modelling and progression of interventions and that population modelling should take account of habitat characteristics and conditions in surrounding areas. [77]

The most recent published national survey of the Northern Ireland badger population was undertaken in 2007-08, repeating an earlier survey carried out between 1990 and 1993. The 2007-08 survey, subsequently published by Reid et al. (2012), estimated a Northern Ireland population of approximately 34,100 badgers in around 7,600 social groups (95% CI 6,200–9,000), equivalent to an average density of approximately 2.5 badgers per km^2. The survey also identified substantial geographical variation, with Counties Down and Armagh supporting relatively high badger densities. [78]

The age of this evidence is significant. The most recent published national population estimate available to the consultation in 2026 is based on fieldwork undertaken almost two decades previously. Badger populations are dynamic and can be affected by changes in habitat, food availability, land management, mortality, reproduction and previous management interventions. Consequently, the national estimate provides an important historical benchmark but cannot necessarily be assumed to represent current abundance or its spatial distribution. [79]

This issue is particularly relevant to the assumptions used in DAERA's economic appraisal. Annex IX assumes a starting population of 423 badgers within an indicative 100 km^2 intervention area, based on QUB/Reid model outputs. DAERA explicitly acknowledges that actual metrics will vary between areas according to factors

[76] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, sections 2.5, 2.7–2.12; DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 1–2.

[77] DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis for the period 1 January 2015 to 31 May 2024 (with later extension to 30 November 2024), Annex VI, pp. 5–11, particularly p. 11; see also DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 1–2.

[78] Reid, N., Etherington, T.R., Wilson, G.J., Montgomery, W.I. and McDonald, R.A. (2012), 'Monitoring and population estimation of the European badger Meles meles in Northern Ireland', Wildlife Biology, 18(1), 46–57, doi:10.2981/11-016; see also Tetra Tech/DAERA (2026), Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication, section 3.2.1.3.3, p. 44.

[79] Reid, N., Etherington, T.R., Wilson, G.J., Montgomery, W.I. and McDonald, R.A. (2012), 'Monitoring and population estimation of the European badger Meles meles in Northern Ireland', Wildlife Biology, 18(1), 46–57, doi:10.2981/11-016; DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, pp. 5–11; Byrne, A.W. et al. (2024), 'Badger Ecology, Bovine Tuberculosis, and Population Management: Lessons from the Island of Ireland', Transboundary and Emerging Diseases, 2024, 8875146, doi:10.1155/2024/8875146.

including residual badger density, population demographics, immigration, surrounding badger density, food availability and weather, and describes the figures as pragmatic assumptions rather than forecasts. [80]

The relationship between this working assumption and the published national population estimate would benefit from greater explanation. A starting population of 423 badgers per 100 km^2 corresponds to an indicative density of 4.23 badgers per km^2, whereas the Strategic Environmental Assessment cites the 2007–08 national mean of approximately 2.5 badgers per km^2. [81] This does not necessarily indicate that the 423-badger assumption is inappropriate: the figures serve different purposes and intervention is expected to be targeted towards areas where wildlife involvement and badger density are relevant considerations. [82] However, it would be helpful for DAERA to explain more clearly how the indicative population used in the appraisal was derived and how representative it is intended to be of the areas likely to be selected for intervention.

For context, the Banbridge TVR study estimated approximately 560 badgers within its 100 km^2 study area, equivalent to around 5.6 badgers per km^2. Menzies et al. cautioned that the capture–recapture estimate assumed a closed population and may have been affected by capture-related bias, but also reported that spatial outputs from the Reid model specific to the study area were approximately 5.3–6.3 badgers per km^2. This illustrates why the historic Northern Ireland-wide mean should not be treated as the expected density within a targeted intervention area, while reinforcing the need for the derivation and representativeness of the 4.23 badgers per km^2 planning assumption to be clearly explained and sensitivity-tested.

The population assumption has practical consequences across all three principal intervention approaches. Under non-selective culling, achieving a target percentage reduction depends upon having a sufficiently reliable estimate of the starting population. Under TVR, population size and density influence the number of badgers that must be trapped, tested and treated and the proportion of the population that remains unexamined in any year. Under vaccination-only, the denominator is similarly central to assessing whether the proportion of animals vaccinated is sufficient to achieve the intended population-level effect. [83] In Annex IX, for example, DAERA's

[80] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, paras. 2.14.1–2.14.2, pp. 14–15.
[81] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, para. 2.14.2, pp. 14–15; Tetra Tech/DAERA (2026), Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication, section 3.2.1.3.3, p. 44; Reid et al. (2012), op. cit.
[82] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, para. 2.7.2, pp. 9–10.
[83] DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, sections 5.2–5.4 and 8, pp. 29–30 and 62–64;

vaccination costing assumes a population of 423 badgers per 100 km^2 and that 233 unique badgers would be captured and vaccinated each year. [84]

Population uncertainty therefore also translates directly into economic uncertainty. The independent review undertaken for AgriSearch by The Andersons Centre identifies badger numbers as an important driver of intervention costs: if population densities are materially higher than assumed, more animals would have to be captured or removed to achieve target coverage, increasing labour and other deployment costs. Andersons consequently identifies contemporary population size as an assumption that should be subject to sensitivity analysis. [85]

Current research at Queen's University Belfast is seeking to address this evidence gap using thermal imaging and drone technology alongside established survey approaches. The project was specifically designed to reassess population estimates derived from the 1990-93 and 2007-08 surveys, examine variation across geographical areas and land uses, and provide more direct estimates of badger numbers and social-group size. [86] AgriSearch considers this work particularly timely given the reliance placed on badger population assumptions in both the scientific and economic assessment of the intervention options.

Fieldwork and analysis remain ongoing and the study has not yet produced a final estimate of the Northern Ireland badger population. However, interim research outcomes supplied by QUB on 4 September 2026 indicate substantial spatial variation in contemporary badger density. Across thermal surveys undertaken to date, observed densities have ranged from zero to 18 badgers per km^2. Four locations deliberately selected as known badger hotspots recorded particularly high densities of 12–18 badgers per km^2. Separately, QUB surveyed 50 randomly selected 1 km^2 areas during winter and spring, before cubs were born; within these random areas, observed densities ranged from zero to 12 badgers per km^2. These interim observations should not be interpreted as an estimate of average badger density across Northern Ireland. Badgers were recorded across all land-class types surveyed, including mountain habitats, and in several areas where the 2007–08 survey had recorded no badger presence. QUB also found significantly higher measured densities in locations where

DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, sections 2.14 and 2.21.

[84] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, section 2.21, Table 4, p. 28; see also section 2.14, Table 2, p. 19.

[85] The Andersons Centre (2026), Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB, prepared for AgriSearch, September 2026, Executive Summary, pp. i–ii; section 3.7, pp. 6–7.

[86] Dick, J. (Queen's University Belfast), Badger populations in N. Ireland: a re-assessment with thermal technology, project proposal to AgriSearch.

high badger activity had previously been reported locally than in randomly selected areas of similar habitat. [87]

Since those interim findings were supplied, a further QUB field survey at a mid-Down site on 21 September 2026 recorded 36 individual badgers within a 1 km^2 survey area, with care taken to avoid double-counting animals. [88] This is a site-specific minimum observation rather than a revised Northern Ireland-wide density estimate, but it provides further evidence of substantial local variation and reinforces the importance of testing higher-density scenarios when planning and costing intervention.

These interim findings do not demonstrate that DAERA's indicative planning assumption of 4.23 badgers per km^2 for a 100 km^2 intervention area is inappropriate. They do, however, show that densities within individual intervention areas may differ substantially from that central assumption, strengthening the case for testing the operational and economic consequences of both lower- and higher-density scenarios.

In concurrent comparisons, the emerging work also indicates that indirect badger-counting methods returned lower density estimates than direct thermal survey techniques. QUB researchers have emphasised, however, that these findings should not be interpreted as demonstrating a Northern Ireland-wide increase or decrease in badger abundance since 2007-08. The methodologies are substantially different: the thermal approach directly records free-ranging badgers and provides a minimum number observed within the survey area, whereas the earlier national survey inferred population abundance principally from indirect evidence and assumptions concerning social-group size. The defensible current conclusion is therefore that contemporary badger density varies markedly between locations and that historic national-average estimates may not adequately represent local conditions in areas being considered for intervention.

These interim findings reinforce AgriSearch's view that local population density is likely to be more relevant to intervention design than a single Northern Ireland-wide average. The consultation already anticipates targeting intervention towards cattle bTB hotspots and areas of relatively high badger social-group density and recognises the importance of physical boundaries, local veterinary epidemiology and land access in area selection. [89] Contemporary population data should therefore be incorporated into both

[87] Dick, J.T.A. (Queen's University Belfast) (2026), Interim research outcomes from the Northern Ireland badger population reassessment project, written communication to AgriSearch and other project funders, 4 September 2026, reproduced at Appendix 4.
[88] Childs, C. (Queen's University Belfast) (2026), field observation update from the mid-Down survey site, written communication to AgriSearch and project partners, 22 September 2026. The observation is an interim, site-specific direct count and does not constitute a revised Northern Ireland-wide population estimate. See also Appendix 4.
[89] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, section 2.7, particularly para. 2.7.2, pp. 9–10.

the selection of intervention areas and the setting and subsequent evaluation of coverage targets.

AgriSearch would consequently recommend that DAERA clearly sets out how contemporary badger population size and local density will be established before intervention begins, how uncertainty in those estimates will be reflected in coverage targets, and how the sensitivity of intervention costs and expected outcomes to different population assumptions has been assessed. [90]

3.5 Why starting conditions matter

The evidence considered in the preceding sections suggests that the effectiveness, speed of impact and cost of a wildlife intervention cannot be considered independently of the conditions that exist when intervention begins. In particular, badger infection prevalence, badger population density, achievable intervention coverage and the relative importance of different transmission pathways are likely to influence the performance of the available options. These conditions may also vary materially between different parts of Northern Ireland. [91]

Starting infection prevalence is particularly important because the three principal approaches act on infection in different ways. Non-selective culling reduces both the badger population and the number of infected animals within it, but does so without distinguishing between infected and uninfected badgers. TVR seeks to identify and remove infected animals while vaccinating those that test negative. Vaccination-only, by contrast, seeks gradually to reduce population susceptibility without removing existing infection. [92] DAERA's scientific opinion itself concludes that vaccination is likely to act more slowly in areas with high infection prevalence and that sustained high coverage would be required where infection is endemic. [93]

The implications for vaccination-only are particularly dependent on the starting infection burden. BCG vaccination reduces susceptibility to infection but does not

[90] The Andersons Centre (2026), Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB, prepared for AgriSearch, September 2026, Executive Summary, pp. i–ii and section 3.7, pp. 6–7; see also DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, para. 2.14.1, p. 14.

[91] DAERA (2026), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 2, 4–5 and 8; DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, pp. 33–35.

[92] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, sections 5.2–5.4, pp. 29–30; see also DAERA (2026), *Strategic Environmental Assessment*, sections 2.7.2.2.1–2.7.2.2.3, pp. 22–23.

[93] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 6–8; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, p. 12.

provide a therapeutic benefit to badgers that are already infected. Those animals therefore remain within the population following vaccination and may continue to contribute to infection pressure. [94] DAERA also notes that modelling estimates suggesting that vaccination of around 30-40% of the population annually could achieve herd-immunity or population-level disease-control effects were derived under assumptions in which previous culling had already reduced badger bTB prevalence. Required vaccination coverage is consequently dependent on the underlying prevalence within the area concerned. The annotated scientific bibliography similarly notes that the Irish vaccination evidence was generated in areas where reactive culling had already occurred for several years. [95]

TVR has a different dependency on starting conditions. Its ability to reduce the infected population depends not only on prevalence but on which badgers are captured and the performance of the diagnostic test applied to them. In the Northern Ireland TVR study, the DPP test using whole blood was estimated to have a sensitivity of approximately 69% and specificity of 98%. This means that some infected captured badgers will test negative and consequently be vaccinated and released rather than removed. [96] Capture itself is also incomplete: DAERA's costing assumptions use an annual cage-capture rate of approximately 55%, while evidence cited for stopped restraints indicates an annual capture rate of approximately 56-58%. Repeated annual trapping provides further opportunities to capture and identify animals previously missed, but the rate at which infection pressure can be reduced will therefore depend on the interaction between starting prevalence, capture probability, diagnostic sensitivity and repeated coverage over time. [97]

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[94] Robinson, P.A., Corner, L.A.L., Courcier, E.A., McNair, J., Artois, M., Menzies, F.D. and Abernethy, D.A. (2012), 'BCG vaccination against tuberculosis in European badgers (Meles meles): a review', Comparative Immunology, Microbiology and Infectious Diseases, 35(4), 277–287; DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, pp. 24–25; DAERA (2026), Consultation on Potential Wildlife Intervention Options, p. 62.

[95] DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, pp. 30 and 62–63; DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, pp. 25–28; Smith, G.C. and Delahay, R.J. (2018), 'Modeling as a Decision Support Tool for Bovine TB Control Programs in Wildlife', Frontiers in Veterinary Science, 5, 276, doi:10.3389/fvets.2018.00276; Aznar, I. et al. (2018), 'Quantification of Mycobacterium bovis transmission in a badger vaccine field trial', Preventive Veterinary Medicine, 149, 29–37, doi:10.1016/j.prevetmed.2017.10.010; Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (Meles meles) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland? A practical non-inferiority wildlife intervention study in the Republic of Ireland (2011–2017)', Preventive Veterinary Medicine, 179, 105004.

[96] Arnold, M.E., Courcier, E.A., Stringer, L.A., McCormick, C.M., Pascual-Linaza, A.V., Collins, S.F., Trimble, N.A., Ford, T., Thompson, S., Corbett, D. and Menzies, F.D. (2021), 'A Bayesian analysis of a test and vaccinate or remove study to control bovine tuberculosis in badgers (*Meles meles*)', *PLoS ONE*, 16, e0246141, doi:10.1371/journal.pone.0246141; DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, pp. 12–13.

[97] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, paras. 2.14.5 and 2.14.12–2.14.14, pp. 16, 18–19; Menzies, F.D. et al. (2021), 'Test and vaccinate or remove: methodology

DAERA's own costing example illustrates this interaction. On the assumptions of 423 badgers in a 100 km^2 area, 55% annual capture, 25% prevalence and approximately 70% DPP sensitivity, 233 unique badgers would be captured in the first year. Of an estimated 58 infected animals among those captured, approximately 41 would be expected to be true-positive on the DPP test. [98] This is an illustrative costing assumption rather than a prediction of TVR effectiveness, but it demonstrates why starting prevalence, population size, trapping success and test performance need to be considered together when assessing likely outcomes. [99]

Population density is similarly important across all intervention approaches. A percentage coverage target translates into very different absolute numbers of animals where badger densities differ. Higher-than-assumed densities could require substantially greater trapping, vaccination or removal effort to achieve the intended level of coverage, while also increasing labour, equipment and other delivery costs. Conversely, in low-density populations the principal challenge may be locating and capturing a sufficiently high proportion of the remaining animals. The independent economic review undertaken by The Andersons Centre has also identified badger population size as an important source of uncertainty in intervention costing. [100]

Local transmission dynamics add another layer of complexity. As discussed in Section 3.2, the available genomic and epidemiological evidence supports transmission in both directions between cattle and badgers, but the relative contribution of within- and between-species transmission can vary by locality. Wildlife intervention in an area where badger-associated infection is an important continuing source of cattle infection may therefore have different consequences from intervention in an area where cattle-to-cattle transmission is the predominant local driver. [101] This does not remove the need to address the wildlife reservoir, but it reinforces the importance of maintaining

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and preliminary results from a badger intervention research project', Veterinary Record, 189, e248, doi:10.1002/vetr.248; Byrne, A.W. et al. (2012), 'Population Estimation and Trappability of the European Badger (Meles meles): Implications for Tuberculosis Management', PLoS ONE, 7(12), e50807, doi:10.1371/journal.pone.0050807.

[98] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, paras. 2.14.5–2.14.7 and Table 2, pp. 16 and 19.

[99] DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, paras. 1.1.1 and 2.14.1–2.14.14.

[100] The Andersons Centre (2026), Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB, prepared for AgriSearch, September 2026, Executive Summary, pp. i–ii and section 3.7, p. 6; see also DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, para. 2.10.1, p. 11.

[101] Akhmetova, A. et al. (2023), 'Genomic epidemiology of Mycobacterium bovis infection in sympatric badger and cattle populations in Northern Ireland', Microbial Genomics, 9, 001023, doi:10.1099/mgen.0.001023; Crispell, J. et al. (2019), 'Combining genomics and epidemiology to analyse bi-directional transmission of Mycobacterium bovis in a multi-host system', eLife, 8, e45833; Rossi, G. et al. (2022), 'Phylodynamic analysis of an emergent Mycobacterium bovis outbreak in an area with no previously known wildlife infections', Journal of Applied Ecology, 59, 210–222; DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, p. 17.

effective cattle controls and using local epidemiological evidence when deciding where and how wildlife intervention is deployed. DAERA's scientific opinion similarly concludes that cattle and badgers form a two-host system and that wildlife intervention and effective cattle controls are both required. [102]

Taken together, these considerations suggest that no wildlife intervention should be assessed solely on the basis of its average or modelled performance under a single set of starting assumptions. The relevant question is how each option is likely to perform under the infection prevalence, badger density, landscape, capture conditions and transmission dynamics encountered in the areas where it would actually be used. [103] The same consideration applies to the choice between a single intervention maintained over time and a sequenced or adaptive approach in which intervention changes as infection pressure falls. [104]

AgriSearch therefore considers that the scientific assessment of the options should examine not simply "which intervention is best?", but:

Given the cattle disease burden, badger infection prevalence, badger population density and available evidence on local transmission pathways, which intervention, or sequence of interventions, is most appropriate for the circumstances of the area concerned?

This provides the basis for the comparative assessment of non-selective culling, TVR and vaccination-only in the sections that follow.

[102] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 7–10; see also DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, pp. 10–11.
[103] DAERA (2026), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 2–5 and 8; Tetra Tech/DAERA (2026), *Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication*, sections 2.7.2–2.7.2.1, pp. 20–21.
[104] DAERA (2026), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 7–9; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 62–64; Tetra Tech/DAERA (2026), *Strategic Environmental Assessment*, sections 2.7.2–2.7.2.2, pp. 20–22.

Key contextual considerations

The evidence therefore points to four important features of the Northern Ireland starting position: bTB remains at a high and costly level in cattle; M. bovis infection is established within the Northern Ireland badger population; both badger density and infection pressure are likely to vary substantially between locations; and the relative importance of cattle and badger transmission also varies locally. [105] These conditions should inform both the comparison of intervention options and decisions about where and how intervention is subsequently deployed.

[105] See Sections 3.1–3.5 above and the evidence cited therein; in particular DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, sections 1.5–1.6; DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 2–8; DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, section 2.14; Reid, N. et al. (2012), 'Monitoring and population estimation of the European badger Meles meles in Northern Ireland', Wildlife Biology, 18, 46–57; Akhmetova, A. et al. (2023), 'Genomic epidemiology of Mycobacterium bovis infection in sympatric badger and cattle populations in Northern Ireland', Microbial Genomics, 9, 001023.

4. How the scientific evidence should be assessed

The scientific evidence relevant to wildlife intervention for bTB is extensive but heterogeneous. It includes controlled field trials, observational studies, experimental and biological studies in badgers, operational research, mathematical modelling and expert interpretation. Each can contribute useful information, but they answer different questions and differ in how directly they inform the principal policy question: what effect is an intervention likely to have on bTB in cattle when deployed at scale in Northern Ireland? [106]

AgriSearch has therefore sought to distinguish between different types and directness of evidence rather than treating all published evidence as equivalent. This is consistent with DAERA's own scientific opinion, which, for example, distinguishes field-trial evidence from modelling, recognises that many vaccination studies concern logistics or effects in badgers rather than cattle outcomes, and explicitly notes that mathematical models are context-dependent abstractions rather than field trials. [107]

DAERA's annotated bibliography should also be interpreted within its stated search scope. It provides an extensive review of peer-reviewed badger-specific literature published to November 2024, but its search terms required reference to badgers or Meles and it did not seek systematically to capture official or other grey literature. [108] Its search strategy was therefore not designed systematically to capture the wider international evidence from multi-host systems in which wildlife reservoirs other than badgers are central to disease control. [109] Such evidence should not be treated as directly transferable evidence of efficacy in badgers, but it can provide useful comparative information on intervention design, targeting, population coverage, surveillance, wildlife-livestock interface management and adaptive management *(using*

[106] DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis for the period 1 January 2015 to 31 May 2024 (with later extension to 30 November 2024)*, Annex VI, pp. 4–5 and passim; DAERA (2026), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 1–6.
[107] DAERA (2026), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 3–6; see also DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, pp. 24–35.
[108] O'Hagan, M.J.H., Menzies, F.D., Skuce, R.A., Bishop, H., Looney, D., Fins, I. and Gray, R. (2025). Annotated scientific bibliography relating to badger intervention and bovine tuberculosis for the period 1 January 2015 to 31 May 2024 (with later extension to 30 November 2024). Final, 3 February 2025, p. 4 and 65–66, Annex VI to the DAERA consultation.
[109] O'Hagan et al. (2025), op. cit., p. 4 and Annex 1, pp. 65–66; Reis, A.C., Ramos, B., Pereira, A.C. and Cunha, M.V. (2021). 'The hard numbers of tuberculosis epidemiology in wildlife: A meta-regression and systematic review', Transboundary and Emerging Diseases, 68(6), 3257–3276, doi:10.1111/tbed.13948; see also the international programme examples cited in footnote 110.

monitoring results to change the approach under decision rules established in advance). [110]

This broader approach is consistent with recent international guidance. WOAH's 2024 MTBC control guidelines were developed using both peer-reviewed and relevant grey literature together with international expert input, and emphasise that disease-control strategies should be adapted to the epidemiological circumstances and resources of the setting in which they are to be applied. [111]

For the purposes of this response, AgriSearch has considered the evidence broadly under the categories set out in Table 2.

[110] Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente (MAPAMA) (2017). PATUBES: Plan de Actuación sobre Tuberculosis en Especies Silvestres. Madrid: MAPAMA; Gobierno de España (2020). Real Decreto 138/2020, de 28 de enero, por el que se establece la normativa básica en materia de actuaciones sanitarias en especies cinegéticas que actúan como reservorio de la tuberculosis (complejo Mycobacterium tuberculosis), Boletín Oficial del Estado, no. 38, BOE-A-2020-2109; Wobeser, G. (2009). 'Bovine tuberculosis in Canadian wildlife: an updated history', Canadian Veterinary Journal, 50(11), 1169–1176; Canadian Food Inspection Agency (2019). Riding Mountain Eradication Area is no longer required by the CFIA for the management of bovine tuberculosis.

[111] World Organisation for Animal Health (WOAH) (2024). Guidelines for the control of Mycobacterium tuberculosis complex in livestock: Beyond test and slaughter. Paris: WOAH, especially sections 1.1–1.2, pp. 7–10. doi:10.20506/woah.3538.

Table 2. Evidence categories used in AgriSearch's scientific assessment of wildlife intervention options

Evidence type	What it can most directly tell us	Important limitations when applied to policy
Replicated or controlled field evidence showing cattle outcomes	Whether an intervention has produced a measurable change in cattle bTB under field conditions	Transferability may still be affected by geography, badger ecology, cattle controls, intervention design and historical context
Observational cattle-outcome evidence	Whether cattle disease outcomes are associated with intervention under real-world deployment	Attribution is more difficult where intervention is non-randomised or other cattle and disease-control measures change concurrently
Badger-level biological evidence	Effects on badger infection, susceptibility, disease progression, prevalence, behaviour or transmission mechanisms	A beneficial effect in badgers does not, by itself, quantify the magnitude or timing of an effect on cattle herd incidence
Operational feasibility evidence	Whether an intervention can practically be delivered, including trapping, testing, vaccination and monitoring	Demonstrating that an approach can be implemented is not the same as demonstrating that it reduces cattle bTB
Mathematical modelling	Potential outcomes under alternative scenarios and assumptions, including questions that cannot readily be tested experimentally	Results depend on model structure, parameter values and assumptions and should not be interpreted as observed field outcomes
Expert inference and application of disease-control principles	Reasonable conclusions where direct evidence is incomplete and identification of plausible intervention strategies	The inferential basis and associated uncertainty should be made explicit, particularly where the proposed approach has not itself been field-tested

This is not intended to create a rigid hierarchy in which study design alone determines the value of evidence. Study quality, scale, relevance and applicability also matter. A well-conducted observational study may, for example, provide highly valuable evidence from large-scale operational deployment, while a controlled trial undertaken in materially different circumstances may require careful consideration before being extrapolated to Northern Ireland. Nevertheless, **t**he directness of the evidence to the outcome being claimed is important. Evidence that an intervention changes infection or susceptibility in badgers is not equivalent to evidence that it reduces cattle herd breakdowns, and evidence that an intervention is operationally feasible is not evidence of epidemiological effectiveness. [112]

This distinction is particularly relevant to the current evidence base. DAERA's scientific opinion notes that the evidence for proactive culling includes controlled field trials demonstrating reductions in cattle herd incidence, [113] whereas the Northern Ireland TVR study provided important evidence on feasibility, badger infection and behaviour but was conducted within a single intervention area and had important limitations in demonstrating an effect on cattle disease. [114] It similarly notes that much of the vaccination literature concerns biological efficacy in badgers and vaccination logistics, while the most directly relevant field evidence from the Republic of Ireland arose in areas with a substantial history of previous badger culling. [115] These differences do not predetermine which intervention should be selected, but they are relevant to the level of confidence that can reasonably be attached to different claims.

AgriSearch therefore considers that the key principle should be:

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[112] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 3–5; DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, pp. 23–35.
[113] Donnelly, C.A., Woodroffe, R., Cox, D.R., Bourne, F.J., Cheeseman, C.L., Clifton-Hadley, R.S., Wei, G., Gettinby, G., Gilks, P., Jenkins, H., Johnston, W.T., Le Fevre, A.M., McInerney, J.P. and Morrison, W.I. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', *Nature*, 439, 843–846; Griffin, J.M., Williams, D.H., Kelly, G.E., Clegg, T.A., O'Boyle, I., Collins, J.D. and More, S.J. (2005a), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', *Preventive Veterinary Medicine*, 67, 237–266; see also DAERA (2026), Annex VII, pp. 7 and 20–21.
[114] Menzies, F.D., McCormick, C.M., O'Hagan, M.J.H., Collins, S.F., McEwan, J., McGeown, C.F., McHugh, G.E., Hart, C.D., Stringer, L.A., Molloy, C., Burns, G., McBride, S.J., Doyle, L.P., Courcier, E.A., McBride, K.R., McNair, J., Thompson, S., Corbett, D.M., Harwood, R.G. and Trimble, N.A. (2021), 'Test and vaccinate or remove: methodology and preliminary results from a badger intervention research project', Veterinary Record, 189, e248, doi:10.1002/vetr.248; DAERA (2026), Annex VII, pp. 3, 5–7 and Annex 1, pp. 23–24.
[115] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, p. 4; DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, pp. 27–28; Martin, S.W., O'Keeffe, J., Byrne, A.W., Rosen, L.E., White, P.W. and McGrath, G. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (Meles meles) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland? A practical non-inferiority wildlife intervention study in the Republic of Ireland (2011–2017)', Preventive Veterinary Medicine, 179, 105004, doi:10.1016/j.prevetmed.2020.105004.

All of these are useful forms of evidence, but they are not interchangeable and should not be presented as carrying the same evidential weight for a particular claimed outcome.

4.1 A common basis for assessing the intervention options

To ensure that the comparison is as consistent as possible, AgriSearch has sought to apply the same questions to non-selective culling, TVR and vaccination-only. These reflect the issues identified during AgriSearch's preliminary consideration of the consultation, including field evidence, uncertainty, perturbation, transferability to Northern Ireland, speed of effect, population and prevalence assumptions and the limitations of the available evidence.

For each intervention, the assessment therefore considers scientific efficacy; evidence of an effect on cattle bTB outcomes; likely speed of effect; the degree and sources of uncertainty; transferability of evidence from other jurisdictions to Northern Ireland; evidence relating to perturbation and other behavioural responses; scalability from research or local deployment to wider implementation; sensitivity to starting badger infection prevalence and population density; and the principal remaining evidence gaps.

Particular care has also been taken to distinguish between demonstrated, modelled and inferred outcomes. Where the available evidence does not allow a conclusion to be drawn directly, this should be stated rather than presenting a plausible or modelled outcome as an established field effect. Conversely, uncertainty or limitations in an evidence base do not mean that the evidence has no value; rather, they should inform the degree of confidence attached to the conclusion.

Finally, scientific efficacy should be distinguished from the other legitimate considerations involved in policy choice. Animal welfare, environmental effects, public acceptability, operational deliverability and economic cost are all relevant to the eventual decision, but they should not alter the description or weighting of the underlying scientific evidence itself. DAERA's own scientific opinion similarly identifies broader political, environmental, legal, economic and social considerations as distinct from its assessment of scientific viability. [116]

On this basis, the following sections assess each of the principal intervention approaches against a common evidential framework before considering how the evidence has been brought together within the consultation.

[116] DAERA (2026), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, p. 1; see also pp. 8–9.

5. Assessment of the scientific evidence for the intervention options

5.1 Non-selective culling

Non-selective culling seeks to reduce transmission of *M. bovis* by substantially reducing the density of the badger population and, as a consequence, the number of infected badgers capable of maintaining or transmitting infection. Unlike TVR, it does not distinguish between infected and uninfected animals. Its principal evidential advantage is that the effect of large-scale proactive culling on cattle bTB outcomes has been examined directly in replicated field studies, as well as through subsequent operational programmes and modelling. [117]

The terminology requires some clarification. DAERA uses "non-selective" to distinguish this approach from TVR: individual badgers are not tested for infection before removal, so infected and uninfected animals within the intervention area may both be culled. It should not, however, be interpreted as meaning that the intervention itself is geographically indiscriminate or untargeted. DAERA's proposed proactive approach would be deployed within selected bTB hotspot areas, and experience in England and the Republic of Ireland has likewise involved geographically or epidemiologically targeted intervention rather than indiscriminate removal across the wider landscape. In this sense, a more precise descriptive term would be "geographically targeted, non-selective culling": targeted in the selection of the intervention area, but non-selective at the level of the individual badger. [118] Use of terms such as "non-selective" or "indiscriminate" without this distinction risks obscuring the fact that epidemiological targeting of the intervention area remains an important component of culling policy and design. AgriSearch retains DAERA's terminology throughout this review for consistency

[117] Donnelly, C.A., Woodroffe, R., Cox, D.R., et al. (2006). "Positive and negative effects of widespread badger culling on tuberculosis in cattle." Nature, 439, 843–846; Griffin, J.M., Williams, D.H., Kelly, G.E., et al. (2005a). "The impact of badger removal on the control of tuberculosis in cattle herds in Ireland." Preventive Veterinary Medicine, 67, 237–266; Brunton, L.A., Donnelly, C.A., O'Connor, H., et al. (2017). "Assessing the effects of the first 2 years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle in 2013–2015." Ecology and Evolution, 7, 7213–7230; Downs, S.H., Prosser, A., Ashton, A., et al. (2019). "Assessing effects from four years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle, 2013–2017." Scientific Reports, 9; Budgey, R. & Smith, G.C. (2019). A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland. Animal and Plant Health Agency.

[118] DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, definitions of proactive, reactive, selective and non-selective intervention, pp. 10–11; DAERA (2026), Strategic Environmental Assessment, Annex IV, sections 2.7.2.2 and 2.7.2.2.1; DAERA (2026), Consultation on Potential Wildlife Intervention Options, section 5.7. DAERA defines "non-selective" as removal regardless of individual disease status, while proactive intervention is undertaken across a selected bTB hotspot area. The English programme was concentrated in the High Risk Area, while Republic of Ireland operational culling has historically been targeted to areas of severe herd breakdown where epidemiological investigation implicated badgers.

with the consultation documents, but considers that this distinction is important when interpreting references to “non-selective” or “indiscriminate” culling.

DAERA's own analysis recognises this distinction. Annex VIII identifies the Randomised Badger Culling Trial (RBCT) in England and the Four Area Trial in the Republic of Ireland as the two large-scale replicated proactive culling studies against which cattle herd-breakdown outcomes can be benchmarked, noting that comparable large-scale replicated trials of TVR or vaccination have not been undertaken in Britain or Ireland. [119]

Randomised Badger Culling Trial

The RBCT, conducted in England between 1998 and 2005, provides some of the most important controlled evidence on the effect of badger removal on cattle bTB. It compared repeated proactive culling, localised reactive culling and no culling across replicated trial areas. The proactive component demonstrated a statistically significant reduction in confirmed cattle bTB incidence within the areas subjected to repeated widespread culling. [120] DAERA's 2025 scientific opinion consequently identifies the RBCT, together with the Irish Four Area Trial, as demonstrating a significant benefit from multi-annual proactive culling in reducing cattle herd bTB incidence. [121]

The RBCT also demonstrated an important adverse effect around the periphery of proactively culled areas. While cattle outbreaks declined within the treatment areas, confirmed cattle bTB incidence increased in an adjoining zone extending approximately 2 km from the cull boundary during the culling period. This has generally been interpreted as evidence of a perturbation effect, whereby disruption of badger social organisation can increase ranging behaviour and potentially increase opportunities for transmission. The precise biological mechanism remains uncertain, but the cattle

[119] DAERA (2026). Badger Intervention – Options Analysis Paper, Annex VIII to the Consultation on Potential Wildlife Intervention Options, paras 5.3.28–5.3.29. DAERA states that benchmarking against large replicated trials can only be undertaken for proactive non-selective culling because no comparable large-scale replicated research trial of TVR or vaccination has been conducted in Great Britain or on the island of Ireland, and identifies the RBCT and Four Area Trial as the two relevant large-scale replicated proactive culling studies.

[120] Donnelly, C.A., Woodroffe, R., Cox, D.R., Bourne, F.J., Cheeseman, C.L., Clifton-Hadley, R.S., Wei, G., Gettinby, G., Gilks, P., Jenkins, H., Johnston, W.T., Le Fevre, A.M., McInerney, J.P. & Morrison, W.I. (2006). ‘Positive and negative effects of widespread badger culling on tuberculosis in cattle’. Nature, 439, 843–846.

[121] DAERA (2025). DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII to the 2026 consultation. The opinion concludes that the RBCT and the Irish Four Area Trial demonstrate a significant benefit from multi-annual proactive culling in reducing cattle herd bTB incidence, citing Donnelly et al. (2006) and Griffin et al. (2005).

outcome observed around the RBCT areas is itself an important finding irrespective of the mechanism proposed to explain it. [122]

Follow-up analysis found that the adverse peripheral effect was temporary and disappeared after culling ceased, while the beneficial effect within proactively culled areas persisted for a period after the end of intervention. DAERA's evidence review records beneficial effects persisting for several years following cessation of the RBCT. [123]

The RBCT therefore provides evidence for both sides of the culling question: sufficiently large-scale and sustained proactive removal can reduce cattle bTB incidence within an intervention area, but culling-related disturbance was also associated with adverse effects around the margins of the RBCT treatment areas, reinforcing the importance of intervention scale and boundary design. [124] The interpretation of the RBCT has continued to be debated. Recent re-analyses have reached different conclusions depending on the choice of outcome measure and statistical model. Mills, Woodroffe and Donnelly (2024) continued to identify a reduction in confirmed cattle herd breakdowns within proactively culled areas. [125] By contrast, Torgerson et al. (2024; 2025) argued that alternative analyses, particularly using total herd breakdown incidence, provide little evidence of a culling effect. [126] The independent 2025 update of the Godfray review considered this dispute and concluded that the evidence for a beneficial effect is weaker than suggested by the original RBCT analysis but remains compatible

[122] Donnelly, C.A. et al. (2006). 'Positive and negative effects of widespread badger culling on tuberculosis in cattle'. *Nature*, 439, 843–846; Woodroffe, R., Donnelly, C.A., Jenkins, H.E., Johnston, W.T., Cox, D.R., Bourne, F.J., Cheeseman, C.L., Delahay, R.J., Clifton-Hadley, R.S., Gettinby, G., Gilks, P., Hewinson, R.G., McInerney, J.P. & Morrison, W.I. (2006). 'Culling and cattle controls influence tuberculosis risk for badgers'. *Proceedings of the National Academy of Sciences of the United States of America*, 103, 14713–14717. See also DAERA (2025), *Scientific Opinion*, Annex VII.

[123] Jenkins, H.E., Woodroffe, R. & Donnelly, C.A. (2010). 'The duration of the effects of repeated widespread badger culling on cattle tuberculosis following the cessation of culling'. *PLoS ONE*, 5, e9090; Donnelly, C.A., Jenkins, H.E. & Woodroffe, R. (2011). 'Analysis of further data (to 28 August 2011) on the impacts on cattle TB incidence of repeated badger culling', addendum to Jenkins et al. (2010). See also DAERA (2025), *Scientific Opinion*, Annex VII.

[124] Donnelly et al. (2006); Jenkins, Woodroffe & Donnelly (2010); DAERA (2025), *Scientific Opinion*, Annex VII. DAERA concludes that the evidence for a beneficial effect of multi-annual proactive culling is tempered by the potential for a peripheral perturbation effect and notes that geographical boundaries may help limit that risk.

[125] Mills, C.L., Woodroffe, R. and Donnelly, C.A. (2024), 'An extensive re-evaluation of evidence and analyses of the Randomised Badger Culling Trial (RBCT) I: Within proactive culling areas', *Royal Society Open Science*, 11, 240385. https://doi.org/10.1098/rsos.240385.

[126] Torgerson, P.R., Hartnack, S., Rasmussen, P., Lewis, F. and Langton, T.E.S. (2024), 'Absence of effects of widespread badger culling on tuberculosis in cattle', *Scientific Reports*, 14, 16326. https://doi.org/10.1038/s41598-024-67160-0; Torgerson, P.R., Hartnack, S., Rasmussen, P., Lewis, F.I., O'Donnell, P. and Langton, T.E.S. (2025), 'Randomised Badger Culling Trial, no effects of widespread badger culling on tuberculosis in cattle: comment on Mills, Woodroffe and Donnelly (2024a, 2024b)', *Royal Society Open Science*, 12, 241609. https://doi.org/10.1098/rsos.241609.

with a modest reduction in confirmed herd breakdowns. [127] This reinforces the need to present the RBCT as important direct field evidence while acknowledging continuing statistical uncertainty over the magnitude of effect.

Republic of Ireland Four Area Trial

The Four Area Trial provides a second major body of direct cattle-outcome evidence and is particularly relevant to Northern Ireland because it was conducted on the same island, under broadly comparable landscape and badger-ecology conditions. [128]

The study compared badger removal areas with reference areas across four geographically separate locations. DAERA's economic options analysis reports that, averaged across the four areas during the trial, the percentage of herds restricted in the removal areas was approximately 40% of that in the reference areas, equivalent to an approximately 60% lower breakdown rate. [129]

Importantly, the adverse peripheral cattle effect observed during the RBCT was not demonstrated in the Four Area Trial. DAERA suggests that the larger intervention areas and the greater use of hard geographical boundaries may have contributed to this difference. This does not establish that perturbation cannot occur in Ireland or Northern Ireland, but it does demonstrate that the RBCT experience should not automatically be assumed to occur to the same extent under all culling designs. [130]

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[127] Godfray, C., Hewinson, G., Silverman, B., Winter, M. and Wood, J. (2025), *Bovine TB Strategy Review Update*, Department for Environment, Food and Rural Affairs, pp. 74–76 and Annex 4.
[128] Griffin, J.M., Williams, D.H., Kelly, G.E., Clegg, T.A., O'Boyle, I., Collins, J.D. & More, S.J. (2005a). "The impact of badger removal on the control of tuberculosis in cattle herds in Ireland." *Preventive Veterinary Medicine*, 67(4), 237–266; Griffin, J.M., More, S.J., Clegg, T.A., Collins, J.D., O'Boyle, I., Williams, D.H., Kelly, G.E., Costello, E., Sleeman, D.P., O'Shea, F., Duggan, M., Murphy, J. & Lavin, D.P. (2005b). "Tuberculosis in cattle: the results of the four-area project." *Irish Veterinary Journal*, 58(11), 629–636; DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, para. 5.3.29. DAERA notes that Northern Ireland terrain is not dissimilar to that in the rest of Ireland and regards the Republic of Ireland as the most appropriate comparator.
[129] Griffin et al. (2005a), "The impact of badger removal on the control of tuberculosis in cattle herds in Ireland", Preventive Veterinary Medicine, 67(4), 237–266; Griffin et al. (2005b), "Tuberculosis in cattle: the results of the four-area project", Irish Veterinary Journal, 58(11), 629–636; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, paras 5.3.28–5.3.30. DAERA reports that, averaged across the four trial areas, the percentage of herds restricted in removal areas was approximately 40% of that in reference areas, which it expresses as an approximately 60% reduction in the breakdown rate.
[130] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, para. 5.3.18 and sensitivity-analysis conclusions; DAERA (2025), *Scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII; More, S.J., Clegg, T.A., McGrath, G., Collins, J.D., Corner, L.A.L. & Gormley, E. (2007). "Does reactive badger culling lead to an increase in tuberculosis in cattle?" *Veterinary Record*, 161, 208–209.

The Irish evidence therefore strengthens the conclusion that the epidemiological outcome of culling is dependent not simply on whether animals are removed, but on how, where, at what scale and for how long removal is undertaken. [131]

Later English field evidence

Since the RBCT, large areas of England have been subject to operational badger control. These programmes provide valuable real-world evidence, although they do not provide the same level of causal attribution as a randomised controlled trial because changes in cattle controls and other disease-management measures occurred alongside badger culling. [132]

Analysis of the first two years of industry-led culling found statistically significant reductions in confirmed cattle herd incidence associated with culling in Gloucestershire and Somerset compared with matched comparison areas. After four years, Downs et al. (2019) reported substantially lower incidence in the central intervention zones in both Gloucestershire and Somerset compared with their respective comparison areas. Dorset had entered the programme later and therefore had only two years of follow-up in the same analysis; no significant reduction in central-area OTF-W incidence was detected over that shorter period. The variation between areas is itself important, demonstrating that operational culling does not necessarily produce an identical effect in every location. [133]

More recent analysis of the wider English Badger Control Policy provides a substantially broader operational evidence base than the RBCT. Birch et al. (2024), using a difference-in-differences analysis across 52 Badger Control Policy areas, estimated a 56% reduction in OTF-W herd incidence by the fourth intervention year (95% CI 41–69%), with the largest reductions occurring in years two and three. [134] Interpretation is complicated, however, because enhanced cattle disease-control and biosecurity

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[131] Griffin et al. (2005a,b); Byrne, A.W., White, P.W., McGrath, G., O'Keeffe, J. & Martin, S.W. (2014). "Risk of tuberculosis cattle herd breakdowns in Ireland: effects of badger culling effort, density and historic large-scale interventions." *Veterinary Research*, 45, 109–119; DAERA (2025), *Scientific Opinion*, Annex VII.

[132] Godfray, C., Hewinson, G., Silverman, B., Winter, M. and Wood, J. (2025), Bovine TB strategy review update, Department for Environment, Food and Rural Affairs, Chapter 6, particularly paras 6.LI and 6.LXI–6.LXIV; see also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, 'Proactive badger culling – effect on bTB incidence', pp. 19–22.

[133] Brunton, L.A., Donnelly, C.A., O'Connor, H., Prosser, A., Ashfield, S., Ashton, A., Upton, P., Mitchell, A., Goodchild, A.V., Parry, J.E. and Downs, S.H. (2017), 'Assessing the effects of the first 2 years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle in 2013–2015', Ecology and Evolution, 7(18), 7213–7230, https://doi.org/10.1002/ece3.3254; Downs, S.H., Prosser, A., Ashton, A., et al. (2019), 'Assessing effects from four years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle, 2013–2017', Scientific Reports, 9, 14666, https://doi.org/10.1038/s41598-019-49957-6.

[134] Birch, C.P.D., Bakrania, M., Prosser, A., Brown, D., Withenshaw, S.M. and Downs, S.H. (2024), 'Difference in differences analysis evaluates the effects of the badger control policy on bovine tuberculosis in England', *Scientific Reports*, 14, 4849. https://doi.org/10.1038/s41598-024-54062-4; See also Godfray et al. (2025), paras 6.LXI–6.LXII.

measures were introduced concurrently. The 2025 Godfray review therefore concluded that the overall package of measures clearly reduced cattle bTB, but that the separate contribution of culling could not be statistically quantified. Taking account of the wider evidence for badger-to-cattle transmission, the panel nevertheless considered it reasonable to infer that culling made some positive contribution. The English evidence should therefore be treated as supportive of a disease-control effect from reducing infection pressure in badgers, but not as an unconfounded estimate of the effect of culling alone. [135]

Competing statistical interpretations

The interpretation of the English evidence remains contested. Langton et al. (2022), analysing routine surveillance data from the English High Risk Area between 2009 and 2020, did not identify a meaningful overall effect of badger culling on confirmed herd breakdowns and argued that contemporaneous improvements in cattle controls could explain much of the observed decline. The authors also pointed to reductions in cattle bTB in Wales during a period without widespread badger culling. [136]

Torgerson et al. (2024) subsequently reanalysed RBCT data using alternative statistical approaches and found that conclusions were sensitive to the model and outcome definition used, particularly whether analysis was restricted to confirmed breakdowns or included all breakdowns. [137]

These analyses have themselves been challenged. Mills et al. (2024) reassessed the RBCT using both frequentist and Bayesian models and reported results consistent with the original findings: a beneficial effect on confirmed breakdowns within proactively culled areas and an adverse effect in neighbouring areas during the culling period, with little peripheral effect once culling had ceased. [138]

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[135] Godfray, C., Hewinson, G., Silverman, B., Winter, M. and Wood, J. (2025), *Bovine TB strategy review update*, Department for Environment, Food and Rural Affairs, Summary and Conclusions, para. 42; Chapter 6, paras 6.LXI-6.LXIV, pp 73-74.

[136] Langton, T.E.S., Jones, M.W. and McGill, I. (2022), 'Analysis of the impact of badger culling on bovine tuberculosis in cattle in the high-risk area of England, 2009–2020', Veterinary Record, 190(6), e1384. https://doi.org/10.1002/vetr.1384. See also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, 'Proactive badger culling – effect on bTB incidence'.

[137] Torgerson, P.R., Hartnack, S., Rasmussen, P., Lewis, F. and Langton, T.E.S. (2024), 'Absence of effects of widespread badger culling on tuberculosis in cattle', *Scientific Reports*, 14, 16326. https://doi.org/10.1038/s41598-024-67160-0. See also DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*.

[138] Mills, C.L., Woodroffe, R. and Donnelly, C.A. (2024a), 'An extensive re-evaluation of evidence and analyses of the Randomised Badger Culling Trial (RBCT) I: Within proactive culling areas', Royal Society Open Science, 11(8). https://doi.org/10.1098/rsos.240385; Mills, C.L., Woodroffe, R. and Donnelly, C.A. (2024b), 'An extensive re-evaluation of evidence and analyses of the Randomised Badger Culling Trial II: In neighbouring areas', Royal Society Open Science, 11(8). https://doi.org/10.1098/rsos.240386.

AgriSearch does not consider that this statistical disagreement justifies either dismissing the culling evidence or presenting its effect size as beyond dispute. Rather, it illustrates the importance of clearly specifying the outcome being measured, the comparison population, the exposure to culling, the statistical model and the concurrent cattle measures. There is a legitimate scientific debate about the magnitude and attribution of the effect observed in England. This is different from concluding that no direct field evidence of an effect exists. [139]

Perturbation

The evidence on perturbation is particularly important to the practical design of any culling programme. Changes in badger ranging behaviour following population reduction have been demonstrated in experimental and observational studies. More recent telemetry work cited by DAERA has found increases in home-range size, movement distance and use of neighbouring territories among surviving badgers following culling. [140]

However, behavioural perturbation and an adverse epidemiological perturbation effect should not be treated as identical concepts. Increased movement has been demonstrated in a number of settings, but an associated increase in cattle bTB around intervention areas has been most clearly demonstrated in the RBCT and has not been consistently reproduced in Irish field experience. DAERA's scientific opinion itself states that the effect in Northern Ireland is unknown. [141]

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[139] Langton et al. (2022); Torgerson et al. (2024); Mills, Woodroffe and Donnelly (2024a, 2024b). See also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, 'Proactive badger culling – effect on bTB incidence'; and DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, p. 30.

[140] Ham, C., Donnelly, C.A., Astley, K.L., Jackson, S.Y.B. and Woodroffe, R. (2019), 'Effect of culling on individual badger *Meles meles* behaviour: Potential implications for bovine tuberculosis transmission', *Journal of Applied Ecology*, 56, 2390–2399. https://doi.org/10.1111/1365-2664.13512; Woodroffe, R., Donnelly, C.A., Jenkins, H.E., Johnston, W.T., Cox, D.R., Bourne, F.J., Cheeseman, C.L., Delahay, R.J., Clifton-Hadley, R.S., Gettinby, G., Gilks, P., Hewinson, R.G., McInerney, J.P. and Morrison, W.I. (2006), 'Culling and cattle controls influence tuberculosis risk for badgers', *Proceedings of the National Academy of Sciences*, 103, 14713–14717. See also DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, 'Ecology effects of pro-active culling'.

[141] Donnelly, C.A., Woodroffe, R., Cox, D.R., et al. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', Nature, 439, 843–846; Griffin, J.M., Williams, D.H., Kelly, G.E., et al. (2005a), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', Preventive Veterinary Medicine, 67, 237–266; More, S.J., Clegg, T.A., McGrath, G., Collins, J.D., Corner, L.A.L. and Gormley, E. (2007), 'Does reactive badger culling lead to an increase in tuberculosis in cattle?', Veterinary Record, 161, 208–209; DAERA (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, 'Perturbation and the Perturbation Effect' and Scientific Opinion Conclusion 5.

Scale, boundaries and coverage

The evidence from both England and the Republic of Ireland indicates that the outcome of non-selective culling depends materially on the scale, geographical configuration and completeness of the intervention. Culling should therefore not be considered simply in terms of the proportion of badgers removed; the area over which removal occurs and the relationship between that area and the surrounding badger population are also important. [142]

The RBCT demonstrated that proactive culling could reduce confirmed cattle bTB incidence within intervention areas, but also identified an adverse effect on cattle herds in an adjoining zone during the culling period. By contrast, a comparable adverse peripheral effect was not demonstrated in the Republic of Ireland Four Area Trial. Differences between the studies included the size and configuration of the intervention areas and the greater use in Ireland of geographical features capable of limiting badger movement. These findings support the use, wherever practicable, of hard or relatively impermeable boundaries, such as major rivers, coastlines or other significant landscape features, when defining intervention areas. [143]

Coverage is equally important. A target percentage reduction in the badger population can only be meaningfully assessed if the starting population is estimated with sufficient reliability and if access can be obtained across a sufficiently high proportion of the intervention area. Uneven land access or areas in which removal cannot be undertaken could reduce the effective population coverage achieved and allow continuing movement or subsequent recolonisation from untreated or surrounding areas. The effectiveness and potential perturbation risk of an intervention may therefore differ materially where coverage is incomplete. [144]

The required scale cannot be determined solely from a convenient administrative or economic unit. DAERA uses 100 km^2 as an indicative unit of analysis, but explicitly

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[142] DAERA (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, 'Proactive Culling' and Annex 1, 'Perturbation and the Perturbation Effect'; Jenkins, H.E., Woodroffe, R. and Donnelly, C.A. (2010), 'The duration of the effects of repeated widespread badger culling on cattle tuberculosis following the cessation of culling', PLoS ONE, 5, e9090; Griffin, J.M., Williams, D.H., Kelly, G.E., et al. (2005a), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', Preventive Veterinary Medicine, 67, 237–266.

[143] Donnelly, C.A., Woodroffe, R., Cox, D.R., et al. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', Nature, 439, 843–846; Griffin, J.M., Williams, D.H., Kelly, G.E., et al. (2005a), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', Preventive Veterinary Medicine, 67, 237–266; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, paras 5.3.17–5.3.18 and 6.1.1–6.1.2; DAERA (2025), Scientific Opinion, Annex VII, 'Perturbation and the Perturbation Effect'.

[144] Donnelly, C.A. and Woodroffe, R. (2015), 'Bovine tuberculosis: badger-cull targets unlikely to reduce TB', Nature, 526, 640; Smith, G.C. and Cheeseman, C.L. (2007), 'Efficacy of trapping during the initial proactive culls in the randomized badger culling trial', Veterinary Record, 160(21), 723–726; DAERA (2025), Scientific Opinion, Annex VII, 'Perturbation and the Perturbation Effect'; DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, paras 2.7.2 and 2.10.

describes this as a convenient basis for comparison rather than necessarily the optimal epidemiological scale for intervention. The appropriate operational area should instead reflect badger ecology, cattle epidemiology, population density, land access and the availability of suitable boundaries. [145]

This is particularly relevant to Northern Ireland, where emerging Queen's University Belfast work indicates substantial local variation in badger density, including considerably higher densities in some identified high-activity locations and detections in habitats and locations where previous indirect survey approaches had indicated low or absent badger presence. Subject to completion and confirmation of the research findings, contemporary spatial information on badger distribution could therefore help inform the design of intervention areas and boundaries as well as the population denominator against which coverage is assessed. [146] AgriSearch considers that, if non-selective culling were selected, DAERA should therefore specify in advance how intervention areas would be delineated, what minimum level of land access and population coverage would be required, how starting population size would be estimated, and how incomplete coverage or immigration from surrounding areas would be monitored and managed.

Duration, speed of effect and transition

The available evidence indicates that proactive culling is not an instantaneous intervention. English field evidence suggests that its effect on confirmed cattle incidence develops over time rather than being fully realised immediately, with later analyses finding the largest falls during the second and third years of operational programmes. [147] The optimum duration of intervention remains less certain. DAERA's 2025 scientific opinion carries forward an earlier departmental assessment that the

[145] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, paras 2.7.1–2.7.2. DAERA states that the RBCT and Four Area Trial operated over relatively large areas; that intervention areas of at least 100 km^2 are indicated by those experiences; that actual NI areas have not yet been selected; and that the 100 km^2 costing unit is simply a convenient basis for like-for-like comparison. Potential selection factors identified include cattle bTB hotspots, badger social-group density, physical boundaries, local veterinary epidemiological assessment and extent of land access.

[146] Dick, J. (Queen's University Belfast), unpublished preliminary results from the Northern Ireland badger population reassessment project, personal communication to AgriSearch, September 2026. Fieldwork and analysis ongoing at the time of writing; findings should not be interpreted as a final Northern Ireland-wide population estimate.

[147] Brunton, L.A., Donnelly, C.A., O'Connor, H., et al. (2017). 'Assessing the effects of the first 2 years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle in 2013–2015'. Ecology and Evolution, 7(18), 7213–7230. DOI: 10.1002/ece3.3254; Downs, S.H., Prosser, A., Ashton, A., et al. (2019). 'Assessing effects from four years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle, 2013–2017'. Scientific Reports, 9. DOI: 10.1038/s41598-019-49957-6; Birch, C.P.D., Bakrania, M., Prosser, A., Brown, D., Withenshaw, S.M. and Downs, S.H. (2024). 'Difference in differences analysis evaluates the effects of the badger control policy on bovine tuberculosis in England'. Scientific Reports, 14. DOI: 10.1038/s41598-024-54062-4.

transition point from proactive culling to vaccination probably lies somewhere between approximately four and ten years, based on indirect field evidence, while acknowledging a shortage of evidence on the metrics that should determine when culling can stop and transition to vaccination. [148] This reinforces the case for defining an exit or transition strategy before intervention begins. Sustained removal may be necessary initially, but indefinite population suppression need not necessarily be the long-term objective. Monitoring cattle outcomes, badger population density and infection prevalence should inform whether and when an area can transition to vaccination or another maintenance approach. [149]

Earlier Northern Ireland advice proposed four years as a minimum intervention period rather than a fixed duration. [150] The accompanying independent scientific peer review also cautioned that the intensity and duration of removal required before transition to vaccination were uncertain and could vary with starting infection prevalence. [151]

DAERA's current consultation instead assumes an initial five-year intervention period, subject to continuing review, with any subsequent approach to be informed by surveillance data, disease trends and emerging scientific evidence. [152]

AgriSearch therefore considers that the relevant question is not simply whether intervention should last four or five years, but what epidemiological and population-based criteria should determine whether removal has achieved its intended purpose and whether continuation or transition is warranted.

[148] Department of Agriculture, Environment and Rural Affairs (DAERA) (2025). *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII to the consultation, including Annex 1, *Scientific Opinion on the Available Evidence on Badger Intervention* (30 August 2019), section 'Options ii–iv followed by vaccination' and concluding comments on transition from culling to vaccination.
[149] Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Václavek, P. and Delahay, R.J. (2022). 'Defining and testing a wildlife intervention framework for exotic disease control'. Ecological Solutions and Evidence, 3(4). DOI: 10.1002/2688-8319.12192; DAERA (2025), Scientific Opinion, Annex VII; DAERA (2026), Strategic Environmental Assessment, Annex IV, section 2.7.2.1.2.
[150] Tuberculosis Strategic Partnership Group (TBSPG) (2016). Annex B: Wildlife & Vaccination, supporting the Bovine Tuberculosis Eradication Strategy for Northern Ireland, sections 1.2 and 1.5.
[151] More, S.J. (2016). The Bovine Tuberculosis Eradication Programme in Northern Ireland: Proposals from the Tuberculosis Strategic Partnership Group (TBSPG) – Scientific peer review: Additional comments. University College Dublin, 9 November 2016, pp. 4–6, paras 11–17, particularly para. 13.
[152] DAERA (2026). Strategic Environmental Assessment, Annex IV to the Consultation on Potential Wildlife Intervention Options, section 2.7.2.1.2, 'Intervention Period'.

Transferability to Northern Ireland

There has been no equivalent large-scale proactive culling trial in Northern Ireland. Consequently, any estimate of effect necessarily draws on evidence from England and the Republic of Ireland. [153]

Neither provides a perfect comparator. Badger density and ecology differ between jurisdictions, as do aspects of cattle epidemiology, disease-control history and previous wildlife management. DAERA's scientific opinion explicitly cautions that there cannot be a direct read-across from either England or the Republic of Ireland to Northern Ireland because ecological and practical differences create uncertainty around outcomes. [154]

The Republic of Ireland is nevertheless an especially relevant comparator because it is on the same island and has broadly comparable landscape conditions. DAERA's own options analysis states that Northern Ireland terrain is not dissimilar to that in the rest of Ireland and identifies the Republic of Ireland as the most appropriate comparator when considering the large replicated trials. At the same time, contemporary Northern Ireland badger density, infection prevalence and local transmission dynamics should be established rather than assumed to correspond to those in historic Irish trial areas. [155]

Transferability should therefore be treated as a source of uncertainty without applying a higher evidential standard to culling than to the alternative interventions. Where conclusion about TVR or vaccination rely on evidence generated in other jurisdictions, that evidence is subject to the same requirement to demonstrate relevance to Northern Ireland's badger population, infection prevalence, farming system and epidemiological circumstances. [156]

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[153] DAERA (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, Annex 1, 'Scientific Opinion on the Available Evidence on Badger Intervention', section 3 'Caveats'. DAERA notes that there is no published evidence from any long-term badger intervention in Northern Ireland and that most intervention evidence therefore derives from English and Irish experience. See also DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, paras 5.3.28–5.3.29.

[154] DAERA (2025), Scientific Opinion, Annex VII, Annex 1, section 3 'Caveats'; see also 'Modelling' in the updated opinion. DAERA states that there cannot be a direct read-across from English and Irish experience because of ecological and practical differences, and notes that modelled cattle bTB outcomes are influenced by factors including cattle movements, testing frequency and interspecies transmission rates. See also O'Connor et al. (2012), as cited by DAERA.

[155] DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, para. 5.3.29; DAERA (2025), Scientific Opinion, Annex VII, sections 'Badger Ecology', 'Transmission dynamics' and 'Modelling'. Annex VIII notes that the cattle and badger parameters in future Northern Ireland intervention areas will not necessarily correspond to those in trials conducted more than 20 years previously, while identifying Irish terrain as the most appropriate comparator.

[156] DAERA (2025), Scientific Opinion, Annex VII, 'Badger vaccination' and 'Modelling'; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 30–32. DAERA itself cautions that the Irish badger-vaccination evidence is highly context-dependent because it followed many years of reactive culling and questions whether those findings are directly generalisable to Northern Ireland. The

AgriSearch assessment

Taken as a whole, AgriSearch considers that large-scale, sustained proactive non-selective culling currently has the strongest direct field evidence among the wildlife intervention options for an effect on cattle bTB herd incidence. This conclusion is supported by two major field trials in England and the Republic of Ireland and by subsequent observational evidence from operational deployment. DAERA's own scientific assessment similarly concludes that field trials and modelling show that large-scale sustained culling can reduce bTB in both cattle and badgers. [157]

This should not, however, be interpreted as meaning that the magnitude of benefit is certain or that any form of culling undertaken at any scale will achieve the same result. The evidence demonstrates that intervention design matters, a point explicitly recognised in DAERA's own scientific and options analyses. Scale, duration, coverage, population estimation, boundaries, neighbouring areas and concurrent cattle controls can all materially influence the outcome. The RBCT also provides direct evidence of a temporary adverse effect on neighbouring cattle herds during culling, although this effect has not been demonstrated consistently in the Republic of Ireland. DAERA itself identifies the larger intervention areas and use of hard geographical boundaries in the Irish Four Area Trial as possible reasons for this difference, and suggests that similar design principles could help mitigate perturbation risk in Northern Ireland. These considerations should therefore be treated as operational design requirements to be tested in the Northern Ireland context, rather than as generic reasons for discounting the demonstrated epidemiological effect of well-designed proactive culling. [158]

CVO Review similarly states that direct extrapolation of Irish vaccination findings to Northern Ireland requires further consideration because of differing historical approaches to bTB control and ecological context.

[157] Donnelly, C.A., Woodroffe, R., Cox, D.R., et al. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', Nature, 439, 843–846; Griffin, J.M., Williams, D.H., Kelly, G.E., et al. (2005a), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', Preventive Veterinary Medicine, 67, 237–266; Brunton, L.A., Donnelly, C.A., O'Connor, H., et al. (2017), 'Assessing the effects of the first 2 years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle in 2013–2015', Ecology and Evolution, 7, 7213–7230; Downs, S.H., Prosser, A., Ashton, A., et al. (2019), 'Assessing effects from four years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle, 2013–2017', Scientific Reports, 9; Birch, C.P.D., Bakrania, M., Prosser, A., Brown, D., Withenshaw, S.M. and Downs, S.H. (2024), 'Difference in differences analysis evaluates the effects of the badger control policy on bovine tuberculosis in England', Scientific Reports, 14, 4849; DAERA (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, Scientific Opinion Conclusion 5.

[158] Donnelly et al. (2006); Griffin et al. (2005); Jenkins, H.E., Woodroffe, R. and Donnelly, C.A. (2010), 'The duration of the effects of repeated widespread badger culling on cattle tuberculosis following the cessation of culling', PLoS ONE, 5, e9090; Ham, C., Donnelly, C.A., Astley, K.L., Jackson, S.Y.B. and Woodroffe, R. (2019), 'Effect of culling on individual badger Meles meles behaviour: Potential implications for bovine tuberculosis transmission', Journal of Applied Ecology, 56, 2390–2399; DAERA (2025),

Non-selective culling also removes infected and uninfected badgers irrespective of individual infection status. The resulting animal welfare, ethical, ecological and public-acceptability considerations are legitimate and significant factors in the eventual policy decision. Consistent with the approach set out in Section 4, however, these considerations should be assessed transparently alongside, rather than used to redefine, the evidence concerning epidemiological efficacy. [159]

The key question for Northern Ireland is therefore not simply whether proactive culling has been shown to work elsewhere. It is whether a Northern Ireland intervention could be designed and delivered at sufficient scale, coverage and duration, within appropriate boundaries and alongside effective cattle controls, to reproduce the beneficial effects observed in the strongest field evidence while minimising the risks demonstrated elsewhere.

Where non-selective culling is selected, AgriSearch considers that controlled shooting of free-roaming badgers should remain among the deployment methods available for consideration. The experience in England demonstrates that controlled shooting can be delivered at scale within a highly structured and professional operational framework. The English programme was industry-led under licence, using trained marksmen operating to detailed best-practice requirements, with formal oversight and monitoring of effectiveness, safety and humaneness. Recent Natural England monitoring records that operations were conducted to agreed standards of public safety, supported by refresher training and continuing cooperation with the police, and reports high levels of discipline and compliance with best-practice guidance among contractors. [160]

The relevant lesson for Northern Ireland is therefore not simply that controlled shooting is technically available, but that successful deployment requires professional organisation and coordination. Any Northern Ireland model should provide for appropriately trained and competent personnel, clear operational command and coordination arrangements, liaison with the PSNI and other relevant authorities where required, appropriate monitoring and reporting, and the ability to coordinate activity

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Scientific Opinion, Annex VII, 'Proactive Culling'; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, paras 5.3.17–5.3.18.

[159] DAERA (2025), Scientific Opinion, Annex VII, Scientific Opinion Conclusions 5 and 8 and Opinion Summary; Gormley, E. and Corner, L.A.L. (2018), 'Wild Animal Tuberculosis: Stakeholder Value Systems and Management of Disease', Frontiers in Veterinary Science, 5, 327, https://doi.org/10.3389/fvets.2018.00327 ; Bennett, R. (2017), public attitudes to badgers and badger control in Great Britain, as summarised in DAERA's annotated bibliography; Ward et al. (2022), ecological effects of badger culling on bird populations, as summarised in DAERA's annotated bibliography.

[160] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, sections 5.5.1 and 6.a; DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, particularly section 4.2 and the operational-risk assessment. See also Natural England (2026), *Summary of 2025 badger control operations*. The English programme involved industry-led licensed delivery, trained operators, detailed best-practice guidance and monitoring of effectiveness, safety and humaneness. Natural England reports continuing cooperation with the police and refresher training as important elements of public-safety delivery.

across the intervention area so that the required population coverage is achieved. The most appropriate deployment method, or combination of methods, should reflect local terrain, operational practicality, achievable coverage and cost, with cage trapping or stopped restraints available to supplement controlled shooting where appropriate.

The epidemiological evidence for non-selective culling and the suitability of particular deployment methods should therefore be assessed as related but distinct questions.

Baited cage trapping should likewise remain among the deployment methods available where non-selective culling is selected, either as the principal capture method or to supplement controlled shooting where terrain, access or other local circumstances make free shooting less suitable. Cage trapping is an established method: it has been used under Northern Ireland conditions during the TVR project and in England as part of culling operations. DAERA reports that, when undertaken to a high professional standard, recorded injury rates are low; 97% of approximately 1,500 cage-trapped badgers in the Northern Ireland TVR work showed no signs of injury, while RBCT evidence found no detectable injury in 88% of trapped badgers. [161]

The principal practical consideration is therefore whether cage trapping can achieve the required population coverage efficiently across the intervention area. DAERA assumes an annual capture rate of around 55% from the Northern Ireland TVR experience and notes that approximately 10–13% of badgers may be cage-shy. Cage trapping is also relatively labour- and equipment-intensive because traps require siting, pre-baiting, daily checking and transport. Its use should therefore be determined by local terrain, access, operational capacity, cost and the ability to achieve the intended coverage, with trained operators, prompt daily checking, appropriate handling of non-target captures and routine monitoring of welfare and operational performance. [162]

Stopped restraints should likewise remain available for consideration as a means of delivering non-selective culling. They have been used extensively in the Republic of Ireland and offer potential operational advantages over cage trapping, including less preparation, lighter equipment and lower labour requirements. DAERA cites evidence from more than 18,500 badgers captured using stopped restraints in the Republic of Ireland in which no restraint-related deaths were recorded and 84% of animals had either no injury or only superficial hair or skin compression. Injury incidence

[161] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, sections 5.5.2 and 6.b. DAERA reports that 97% of approximately 1,500 cage-trapped badgers in the Northern Ireland TVR project showed no signs of injury following capture. Evidence from the RBCT found no detectable trap-related injury in 88% of badgers, with most recorded injuries being minor. See also DAERA (2026), *Strategic Environmental Assessment*, Annex IV, section 2.7.2.4.2.

[162] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, sections 5.5.2 and 6.b. DAERA uses an indicative annual cage-capture rate of approximately 55% based on the Northern Ireland TVR project and identifies cage-shyness in approximately 10–13% of badgers as a potential constraint on capture efficacy. Cage trapping requires trap placement, pre-baiting and early daily inspection.

nevertheless increased with time spent restrained, reinforcing the importance of appropriate restraint specification, competent deployment and prompt checking each morning. [163]

Their lower estimated cost should therefore be regarded as an economic advantage rather than, by itself, evidence that the method is suitable in every circumstance. Any use in Northern Ireland should be subject to defined operator-competence requirements, approved equipment and deployment protocols, prompt daily inspection, procedures for non-target captures and welfare incidents, and monitoring of achieved population coverage. Particular account should also be taken of the lower capture effectiveness of stopped restraints for smaller, younger badgers and the implications this may have for the intervention window or the need to supplement restraints with cage trapping. [164]

5.2 Test and Vaccinate or Remove

Test and Vaccinate or Remove (TVR) combines selective removal of badgers that test positive for *M. bovis* with vaccination of those that test negative. In principle, this offers a means of reducing infection pressure while retaining a larger proportion of the badger population than under non-selective culling. Northern Ireland has undertaken the only complete field evaluation of this approach to date, through a five-year research project conducted between 2014 and 2018 within a single intervention area of approximately 100 km^2. DAERA's annotated bibliography notes that, apart from modelling studies, there have been no other completed comparable TVR studies, although a similar approach has subsequently been piloted in France. [165]

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[163] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, sections 5.5.3 and 6.c; Murphy, D. et al. (2009), 'An assessment of injury to European badgers (*Meles meles*) due to capture in stopped restraints', *Journal of Wildlife Diseases,* 45(2), 481–490. DAERA reports that, among more than 18,500 badgers assessed following capture in stopped restraints in the Republic of Ireland, no restraint-related deaths were recorded and 84% showed either no injury or only superficial hair/skin compression; minor injury increased with duration of restraint.

[164] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, section 6.c; DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, section 2.13. DAERA notes that stopped restraints are less effective for smaller, younger badgers and that this may require supplementation with cage trapping or consideration of a different intervention window.

[165] Menzies, F.D., McCormick, C.M., O'Hagan, M.J.H., Collins, S.F., McEwan, J., McGeown, C.F., McHugh, G.E., Hart, C.D., Stringer, L.A., Molloy, C., Burns, G., McBride, S.J., Doyle, L.P., Courcier, E.A., McBride, K.R., McNair, J., Thompson, S., Corbett, D.M., Harwood, R.G. and Trimble, N.A. (2021). 'Test and vaccinate or remove: Methodology and preliminary results from a badger intervention research project'. Veterinary Record, 189, e248. https://doi.org/10.1002/vetr.248; DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, section 'Test and Vaccinate or Remove (TVR)'; Boschiroli, M.L. (2023). 'Animal tuberculosis control in a disease-free country, France: does the long and winding road really lead to eradication?' Irish Veterinary Journal, 76(Suppl. 1), 25. https://doi.org/10.1186/s13620-023-00258-5.

The Northern Ireland project has generated important evidence on the practical delivery of TVR, badger diagnostics, changes in estimated badger infection prevalence and badger behaviour. [166] Its principal limitation is that it comprised a single intervention area without replicated intervention or control areas and was not sufficient to establish a causal cattle-incidence effect. DAERA's earlier scientific opinion explicitly states that the project comprised one 100 km^2 intervention area, without replicate intervention or control areas, and that its principal comparator was before-and-after observation. [167] This distinction is important when comparing the evidence for TVR with the large-scale cattle-outcome trials considered under non-selective culling.

Operational feasibility

The TVR project provides strong Northern Ireland-specific evidence that the basic components of the intervention can be delivered in field conditions. Badgers were captured, anaesthetised, blood sampled and tested using a field-deployable diagnostic test; test-negative animals were vaccinated and released, while test-positive animals were removed. The project also generated detailed practical information on trapping, handling, staffing, equipment and other resources required for an intervention. DAERA's annotated review concludes that trap-side testing using whole blood was a viable real-time decision tool and that the project provided valuable information on the logistics and resources required for TVR. [168]

This is an important strength of the evidence base. TVR is therefore not simply a theoretical intervention: its constituent procedures have been demonstrated under

[166] Menzies et al. (2021); Arnold, M.E., Courcier, E.A., Stringer, L.A., McCormick, C.M., Pascual-Linaza, A.V., Collins, S.F., Trimble, N.A., Ford, T., Thompson, S., Corbett, D. and Menzies, F.D. (2021). 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (Meles meles)'. PLoS ONE, 16(1), e0246141. https://doi.org/10.1371/journal.pone.0246141; O'Hagan, M.J.H., Gordon, A.W., McCormick, C.M., et al. (2021). 'Effect of selective removal of badgers (Meles meles) on ranging behaviour during a "Test and Vaccinate or Remove" intervention in Northern Ireland'. Epidemiology and Infection, 149, e125. https://doi.org/10.1017/S0950268821001096; DAERA (2025), Annotated scientific bibliography, section 'Test and Vaccinate or Remove (TVR)'.

[167] DAERA (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, Annex 1, section 'Test and Vaccinate or Remove (TVR)'; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, section on selective culling via TVR. DAERA records that the NI TVR study took place in one 100 km^2 area, had no replicate intervention or control areas, and relied on a before-and-after design; it therefore was not of sufficient scale or design to demonstrate a statistically significant impact on cattle or badger bTB levels. Annex VIII likewise notes the lack of replicate and control areas and that cattle herd bTB incidence did not decline during the study period.

[168] Menzies, F.D., McCormick, C.M., O'Hagan, M.J.H., Collins, S.F., McEwan, J., McGeown, C.F., McHugh, G.E., Hart, C.D., Stringer, L.A., Molloy, C., Courcier, E.A., et al. (2021). 'Test and vaccinate or remove: methodology and preliminary results from a badger intervention research project'. Veterinary Record, 189, e248. https://doi.org/10.1002/vetr.248; see also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, section 'Test and Vaccinate or Remove (TVR)'.

Northern Ireland conditions. However, as set out in Section 4, demonstrating operational feasibility is different from demonstrating a reduction in cattle disease.

The project also illustrates the importance of trapping coverage. DAERA uses an annual capture rate of approximately **55%** based on the TVR experience. On that assumption, approximately 45% of the estimated badger population would not be captured in a particular year, although repeated annual trapping creates further opportunities to encounter previously uncaptured animals. [169]

Comparative evidence from other wildlife systems illustrates that capture coverage and frequency can influence the epidemiological performance of selective removal rather than being purely logistical considerations. Le Roex et al. (2016) evaluated a test-and-cull programme in African buffalo in South Africa and found that herds subjected to more intensive and frequent capture had lower per-capita bTB transmission risk and smaller increases in prevalence over time. The species, diagnostic method and epidemiological setting differ substantially from Northern Ireland, and the programme did not include vaccination or assess cattle outcomes, so the findings should not be treated as direct evidence of TVR efficacy in badgers. They do, however, reinforce the principle that the effectiveness of a selective-removal strategy depends partly on the proportion of the infected population that can be reached and the frequency with which intervention is repeated. [170]

Performance of the DPP diagnostic test

The effectiveness of TVR depends critically on the ability of the trap-side test to distinguish infected from uninfected badgers. The Dual Path Platform (DPP) test used with whole blood was estimated to have a median sensitivity of 69%, with a 95% credibility interval of 48–88%, and a median specificity of 98%, with a 95% credibility interval of 96–99%. [171]

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[169] DAERA (2026). Badger Intervention Analyses – Calculation Assumptions, Annex IX, para. 2.14.5 and paras 2.14.12–2.14.13; Menzies et al. (2021). DAERA assumes an annual cage-capture rate of 55%, based on experience from the NI TVR project. See also DAERA (2017), Test and Vaccinate or Remove (TVR) Wildlife Intervention Research Project – Year 4 Report, which reported that 46% and 54% of badgers were captured in consecutive years during 2015/16 and 2016/17.

[170] Le Roex, N., Cooper, D., van Helden, P.D., Hoal, E.G. and Jolles, A.E. (2016). Disease control in wildlife: evaluating a test and cull programme for bovine tuberculosis in African buffalo. Transboundary and Emerging Diseases, 63(6), 647–657. https://doi.org/10.1111/tbed.12329.

[171] Arnold, M.E., Courcier, E.A., Stringer, L.A., McCormick, C.M., Pascual-Linaza, A.V., Collins, S.F., Trimble, N.A., Ford, T., Thompson, S., Corbett, D. and Menzies, F.D. (2021). 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (Meles meles)'. PLoS ONE, 16(1), e0246141. https://doi.org/10.1371/journal.pone.0246141. See also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, section 'Test and Vaccinate or Remove (TVR)'.

The high specificity means that relatively few uninfected badgers would be incorrectly classified as positive and removed. The key limitation for disease control is sensitivity. At the estimated median sensitivity, approximately 31% of infected badgers that are captured would not be identified as positive by the DPP test at that testing event. These animals would consequently be treated as test-negative and vaccinated and released rather than removed. [172]

This does not mean that they could never subsequently be detected: repeated trapping and testing may provide additional opportunities to identify infected animals. Nevertheless, test sensitivity interacts with capture probability and starting prevalence in determining the rate at which TVR can remove infection from a population. As discussed in Section 3.5, these factors should therefore be considered together rather than independently. [173]

More recent evidence provides a further estimate of DPP diagnostic performance. Jinks et al. (2025), using Bayesian latent-class methods to address the absence of a perfect diagnostic reference test, estimated that visual interpretation of Band 1 using whole blood had a sensitivity of 79.9% (95% credible interval 66.1–91.4%) and specificity of 93.3% (90.7–95.7%). This represents a higher estimated sensitivity but lower specificity than the corresponding estimates reported by Arnold et al. (2021). The authors note methodological and study-population differences that may contribute to the different estimates, and the newer analysis should therefore not simply replace the earlier figures. It does, however, reinforce that diagnostic performance is an important source of uncertainty within TVR: higher sensitivity would increase the proportion of infected captured badgers identified for removal, while lower specificity would increase the proportion of uninfected badgers incorrectly removed. [174]

DAERA's consultation documents report slightly different rounded DPP performance assumptions: the consultation describes whole-blood sensitivity and specificity as 69% and 98% respectively, while Annex IX uses 70% and 97% for costing purposes. The

[172] Arnold et al. (2021); DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, section 'Selective culling via the Test and Vaccinate or Remove (TVR) approach'. DAERA explains that a median sensitivity of 69% implies that approximately 31 of every 100 infected badgers tested would be missed at that testing event, while a median specificity of 98% implies approximately two false-positive results per 100 uninfected badgers tested.

[173] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, paras 2.14.5–2.14.7; DAERA (2025), Scientific Opinion, Annex VII, discussion of TVR. Annex IX combines assumptions on annual capture rate, starting prevalence and DPP diagnostic performance when estimating the number of infected badgers detected and removed. DAERA's Scientific Opinion similarly notes that the imperfect DPP test and vaccine efficacy may affect the time required for TVR to achieve a disease-control endpoint.

[174] Jinks, R.C., Lesellier, S., Smith, F., Menzies, F.D., Ashford, R.T., Waring, L., Dave, D., Anderson, P., Stringer, L.A., Pascual-Linaza, A.V., Corbett, D., Thompson, S. and Arnold, M.E. (2025). 'Evaluating sensitivity and specificity of the DPP Vet TB assay in badgers using Bayesian latent class models'. PLoS ONE, 20(3), e0313825. https://doi.org/10.1371/journal.pone.0313825; see also Arnold et al. (2021) for the earlier TVR-derived estimates.

practical effect of this difference is likely to be small, but it illustrates that diagnostic performance is an input to both epidemiological and economic appraisal.

Badger test positivity and estimated infection prevalence

One of the most striking findings from the Northern Ireland study was the substantial downward trend in estimated badger *M. bovis* prevalence over the intervention period. Arnold et al. (2021) estimated that prevalence declined from approximately 14% at the outset (95% credible interval 10–20%) to 1.9% (0.8–3.8%), corresponding to an estimated annual decline of 39.1%. [175]

This provides important badger-level evidence consistent with declining infection pressure during the TVR project. DAERA's updated scientific opinion consequently concludes that the project significantly reduced estimated *M. bovis* prevalence within the study population. [176]

However, the interpretation requires care. The intervention took place in a single area without replicated untreated controls, and DAERA's own annotated bibliography specifically notes that the decline in DPP positivity/prevalence must be considered alongside this study-design limitation. It is therefore more precise to conclude that estimated badger prevalence declined substantially during the TVR intervention than to infer, without qualification, that the full decline was causally attributable to TVR. [177]

A further limitation is that the project combined two interventions simultaneously: selective removal of test-positive badgers and vaccination of test-negative animals. Because both components were applied together within the same intervention area, the study cannot directly quantify the separate contribution made by removal, vaccination or other temporal factors to the observed decline. [178]

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[175] Arnold, M.E., Courcier, E.A., Stringer, L.A., McCormick, C.M., Pascual-Linaza, A.V., Collins, S.F., Trimble, N.A., Ford, T., Thompson, S., Corbett, D. and Menzies, F.D. (2021). 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (Meles meles)'. PLoS ONE, 16(1), e0246141. https://doi.org/10.1371/journal.pone.0246141; see also DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, section 'Test and Vaccinate or Remove (TVR)'.

[176] DAERA (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, Scientific Opinion Conclusion 6; Arnold et al. (2021).

[177] DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, section 'Test and Vaccinate or Remove (TVR)'; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, section 'Selective culling via the Test and Vaccinate or Remove (TVR) approach'. DAERA's annotated review states that the significant year-on-year decrease in badger DPP test positivity must be considered alongside the lack of replicate and control areas; Annex VIII similarly notes that the reduction in badger prevalence must be interpreted alongside these design deficiencies and the absence of a reduction in cattle herd incidence.

[178] Menzies, F.D., McCormick, C.M., O'Hagan, M.J.H., et al. (2021). 'Test and vaccinate or remove: methodology and preliminary results from a badger intervention research project'. Veterinary Record,

Badger behaviour and perturbation

A significant concern surrounding removal-based wildlife intervention is the possibility that removing animals disrupts badger social organisation and increases movements in ways that could increase transmission. [179]

The Northern Ireland TVR findings are reassuring in this respect. The evidence reviewed by DAERA indicates that TVR did not produce a detectable sustained increase in badger ranging behaviour within the study area, and DAERA concluded that there was no evidence of disruption of social-group structure. DAERA's earlier review records that approximately 16.5% of captured badgers were removed during the first year, with no associated increase in ranging behaviour observed. [180]

This supports an important potential advantage of TVR: because substantially fewer badgers are removed than under proactive non-selective culling, the degree of population disruption may also be lower. [181]

Again, the scope of the evidence should be respected. The study demonstrates what occurred under the particular intensity of selective removal applied within one Northern Ireland area. It does not establish that perturbation could never arise under TVR if selective-removal intensity, starting prevalence, population density or spatial configuration differed materially from those in the study area. DAERA's own modelling identifies the presence or absence of perturbation as an important determinant of predicted TVR performance. [182]

189, e248. https://doi.org/10.1002/vetr.248; Arnold et al. (2021). See also DAERA (2026), Consultation on Potential Wildlife Intervention Options, Chapter 7, which describes TVR as the simultaneous removal of DPP-positive badgers and vaccination of test-negative animals.

[179] DAERA (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, Annex 1, section 'Perturbation and the Perturbation Effect'; Ham, C., Donnelly, C.A., Astley, K.L., Jackson, S.Y.B. and Woodroffe, R. (2019), 'Effect of culling on individual badger Meles meles behaviour: Potential implications for bovine tuberculosis transmission', Journal of Applied Ecology, 56, 2390–2399.

[180] O'Hagan, M.J.H., Gordon, A.W., McCormick, C.M., Collins, S.F., Trimble, N.A., McGeown, C.F., McHugh, G.E., McBride, K.R. and Menzies, F.D. (2021b). 'Effect of selective removal of badgers (Meles meles) on ranging behaviour during a "Test and Vaccinate or Remove" intervention in Northern Ireland'. Epidemiology and Infection, 149, e125. https://doi.org/10.1017/S0950268821001096; DAERA (2025), Scientific Opinion, Annex VII, Annex 1, TVR section.

[181] Smith, G.C., Delahay, R.J., McDonald, R.A. and Budgey, R. (2016). 'Model of selective and non-selective management of badgers (*Meles meles*) to control bovine tuberculosis in badgers and cattle'. *PLoS ONE*, 11, e0167206. https://doi.org/10.1371/journal.pone.0167206; DAERA (2025), *Scientific Opinion*, Annex VII, Annex 1, 'Summary on TVR'.

[182] O'Hagan et al. (2021b); Smith, G.C., Budgey, R. and Delahay, R.J. (2013), *A simulation model to support a study of Test and Vaccinate or Remove (TVR) in Northern Ireland*, AHVLA National Wildlife Management Centre report commissioned by DARD; Smith et al. (2016); DAERA (2025), *Scientific Opinion*, Annex VII, Annex 1, TVR section.

Evidence relating to cattle herd incidence

This is the area in which the distinction between the different forms of evidence is most important.

The Northern Ireland TVR project did not demonstrate a causal reduction in cattle bTB herd incidence. DAERA's annotated bibliography states that TVR had "no obvious impact" on cattle herd bTB levels, while its scientific opinion concludes that analysis did not demonstrate an impact on cattle herd incidence. [183]

The importance of this limitation had in fact been identified before fieldwork began. The modelling commissioned by DARD to support development of the TVR project identified a closely matched comparison area, ideally with random allocation, or a before-and-after-control-intervention design as approaches which would strengthen causal inference. It also noted that introducing additional changes to cattle controls at the same time could confound attribution of any observed effect. The subsequent Year 1 project report records that the cost of the five-year project prevented inclusion of an additional research/control area, although similarly sized 'hands-off' areas were identified for monitoring cattle disease levels. This provides important context for interpretation of the subsequent cattle findings: monitoring disease trends in comparison areas is useful, but is not equivalent to a replicated controlled cattle-outcome trial. [184]

The same limitation was subsequently recognised within Northern Ireland. In its 2019 advice to DAERA, the TB Eradication Partnership explicitly noted that the TVR research project had not been designed to investigate effectiveness against bTB in cattle and called for the project outputs to be published in peer-reviewed journals so that they could be assessed internationally, with particular attention to capture efficiency, diagnostic performance and ecological effects. Subsequent peer-reviewed work has filled important operational and badger-level evidence gaps, but it does not alter the original study design or convert the intervention into a controlled cattle-outcome trial. DAERA's 2019 scientific opinion similarly stated that the research study had not been designed to provide evidence of a statistically significant effect on badger or cattle bTB levels. The appropriate conclusion is therefore not that TVR has been shown to have no

[183] Doyle, L.P., Gordon, A.W., Molloy, C., O'Hagan, M.J.H., Georgaki, A., Courcier, E.A., Harwood, R.G. and Menzies, F.D. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', Epidemiology and Infection, 151, doi:10.1017/S0950268823001061; DAERA (2025a), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, Annex VI, p. 24; DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, pp. 7–8.

[184] Smith, G.C., Budgey, R. and Delahay, R.J. (2013), A simulation model to support a study of Test and Vaccinate or Remove (TVR) in Northern Ireland, AHVLA National Wildlife Management Centre, pp. 23–24; DARD (2014), The Test and Vaccinate or Remove (TVR) Wildlife Intervention Research Project: Year 1 Report – 2014, pp. 3 and 8.

effect on cattle bTB, but that a causal cattle-level benefit has not yet been directly demonstrated under field conditions in Northern Ireland. [185]

The project nevertheless provides strong Northern Ireland-specific evidence that TVR can be delivered operationally under a well-resourced research programme. Land access was approximately 94% in Year 1 and 96% in the final year, alongside the development of considerable practical experience in badger capture, handling, testing and vaccination. These achievements demonstrate operational feasibility, although equivalent coverage should not automatically be assumed for a substantially larger programme or under a different delivery model. [186]

The transmission evidence from the project also provides important context. Whole-genome sequencing of *M. bovis* isolates from cattle and badgers within the study area suggested that the local epidemic was dominated by cattle-associated transmission. Most inferred transmission occurred within cattle; interspecies transmission was comparatively rare, and models suggested that cattle-to-badger transmission occurred more commonly than badger-to-cattle transmission in this particular study area. The CVO Review records 35 of 37 inferred direct transmission events as cattle-associated, with two interspecies events and no badger-to-badger direct transmission events inferred. [187]

These results reinforce the importance of concurrent cattle controls. They also illustrate why intervention results from a single locality should not automatically be extrapolated across Northern Ireland: an area in which cattle-associated transmission dominates may respond differently to wildlife intervention from one in which spill-back from a highly infected badger population is a more important driver. [188]

The 2025 Godfray review also provides a useful independent comparator. It recognised the potential epidemiological advantage of TVR in immediately removing detected infected animals, but considered the approach operationally more complex than

[185] Northern Ireland TB Eradication Partnership (2019), Advice on Bovine Tuberculosis in Northern Ireland, May 2018–June 2019, pp. 22–24; DAERA (2025b), DAERA scientific opinion…, Annex VII, Annex 1, section 5(iii)(b); see also Menzies et al. (2021), Arnold et al. (2021), O'Hagan et al. (2021), Allen et al. (2022), Redpath et al. (2023) and Doyle et al. (2023).

[186] Menzies, F.D. et al. (2021), 'Test and vaccinate or remove: Methodology and preliminary results from a badger intervention research project', Veterinary Record, 189, e248, doi:10.1002/vetr.248; DARD (2014), pp. 3 and 11; DAERA (2019), The Test and Vaccinate or Remove (TVR) Wildlife Intervention Research Project: Year 5 Report – 2018, pp. 3 and 10.

[187] Akhmetova, A. et al. (2023), 'Genomic epidemiology of Mycobacterium bovis infection in sympatric badger and cattle populations in Northern Ireland', Microbial Genomics, 9(5), 001023, doi:10.1099/mgen.0.001023; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 49–50; DAERA (2025a), Annotated scientific bibliography…, Annex VI, pp. 16–17 and 24.

[188] Akhmetova et al. (2023); Crispell, J. et al. (2019), 'Combining genomics and epidemiology to analyse bi-directional transmission of Mycobacterium bovis in a multi-host system', eLife, 8, e45833, doi:10.7554/eLife.45833; DAERA (2025a), Annex VI, pp. 16–17; DAERA (2025b), Annex VII, pp. 2–3 and 7–8.

vaccination and concluded that further evidence on efficacy is required. The panel suggested that limited deployment, for example in emerging hotspots, may warrant exploration rather than assuming that the present evidence supports broad deployment. [189]

Modelled outcomes

The absence of direct cattle-outcome evidence has meant that much of the assessment of TVR's potential impact on cattle bTB depends upon mathematical modelling. [190]

Northern Ireland-specific modelling by Smith and colleagues predicted substantial reductions in infected badgers and cattle herd breakdowns where TVR was implemented without a perturbation effect. Earlier simulations suggested that TVR could perform at least as well as proactive culling under those assumptions. When a perturbation effect comparable with that observed in the RBCT was introduced into the model, the predicted advantage was substantially reduced or removed. [191]

DAERA's updated annotated bibliography summarises the Smith et al. (2016) modelling similarly: proactive culling, vaccination and TVR all reduced cattle herd breakdowns within the intervention area, but TVR produced the greatest predicted reduction when no perturbation was assumed. If perturbation was included, its comparative advantage disappeared. [192]

The more recent modelling used in Annex VIII also projects TVR outcomes relatively close to those of non-selective culling. For example, using the APHA model outputs, pro-rated to a 100 km^2 intervention area and applying DAERA's assumption of approximately seven cattle removals per unique herd breakdown, Annex VIII estimates that over the first four years non-selective culling would avoid the equivalent of 133

[189] Godfray, C., Hewinson, G., Silverman, B., Winter, M. and Wood, J. (2025), Godfray bTB Evidence Review Update 2025, Department for Environment, Food and Rural Affairs, p. 9, para. 45; see also p. 70, paras. 6.XLV–6.XLVI.
[190] Doyle, L.P., Gordon, A.W., Molloy, C., O'Hagan, M.J.H., Georgaki, A., Courcier, E.A., Harwood, R.G. and Menzies, F.D. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', Epidemiology and Infection, 151; DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII.
[191] Smith, G.C., Delahay, R.J., McDonald, R.A. and Budgey, R. (2016), 'Model of selective and non-selective management of badgers (Meles meles) to control bovine tuberculosis in badgers and cattle', PLoS ONE, 11(11), e0167206, https://doi.org/10.1371/journal.pone.0167206; Smith, G.C., Budgey, R. and Delahay, R.J. (2013), A simulation model to support a study of Test and Vaccinate or Remove (TVR) in Northern Ireland, National Wildlife Management Centre, Animal Health and Veterinary Laboratories Agency.
[192] DAERA (2025a), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, section 'Modelling – Impact of interventions on the bovine population', pp. 34–36; Smith et al. (2016).

premature cattle removals compared with 119 under TVR; over nine years the corresponding illustrative figures are 469 and 462. [193] These model outputs provide useful evidence about plausible relative performance, but they remain modelled rather than observed cattle outcomes. They depend on assumptions concerning transmission parameters, badger prevalence and density, capture rates, test performance, perturbation and the relationship between changes in badger infection and cattle herd breakdowns. DAERA's own annotated review cautions that model outputs are context-dependent abstractions and should not be treated as field trials. [194]

Publication of the underlying 2019 APHA report allows this comparison to be examined more directly. In the alternative-zone configuration used to place the interventions on a more comparable spatial basis, the model produced very similar cattle outcomes for non-selective culling and TVR within the intervention core. [195] At 10% background badger prevalence and with no perturbation, the model generated 150 unique OTW breakdowns over 12 years under culling and 152 under TVR, compared with 272 under business as usual; in the model set incorporating a full perturbation effect, the corresponding core-area outputs were 180 and 181, compared with 246 under business as usual. [196] The report's own conclusion was that there was very little to separate the intervention options involving lethal control within the core, while vaccination-only generally produced a slower and smaller response. [197] These are useful comparative model outputs, but they do not demonstrate empirical equivalence of cattle-level efficacy between culling and TVR.

The 2019 TVR modelling used the diagnostic-test characteristics available at the time. Given that DPP is the test proposed for operational TVR and estimates of its performance have subsequently developed, DAERA should explain explicitly how the original diagnostic assumptions relate to the model outputs carried into the current appraisal and demonstrate whether the comparative results remain robust across the range of DPP performance estimates now supported by Arnold et al. (2021) and Jinks et al. (2025). [198]

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[193] DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, paras 7.4.4.1–7.4.4.5 and Table 22; Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, APHA National Wildlife Management Centre.

[194] Budgey and Smith (2019), particularly pp. 3–9 and 18–20; DAERA (2025a), Annotated scientific bibliography, 'Modelling', pp. 33–36.

[195] Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, APHA National Wildlife Management Centre, p. 8 and pp. 18–20.

[196] Budgey and Smith (2019), Chart Appendix B, Table B2, p. 8 [PDF p. 51].

[197]Budgey and Smith (2019), pp. 18–20, particularly the conclusions on comparative intervention performance.

[198] DAERA (2025b), Scientific Opinion, Annex VII, section 'Test and Vaccinate or Remove (TVR)', which notes that the earlier TVR modelling used the test characteristics of the Brock-TB StatPak and discusses the subsequently available DPP VetTB performance estimates; Budgey, R. and Smith, G.C. (2019), A

Transferability and scalability

In one important respect, TVR has an advantage over the other principal interventions: much of its practical field evidence comes directly from Northern Ireland. This reduces uncertainty around whether trapping, testing and vaccination can be delivered under local conditions. [199]

However, scaling from one 100 km^2 research area to multiple operational intervention areas remains largely untested. DAERA's scientific opinion acknowledges that there has not yet been comprehensive operational deployment of TVR on this basis outside research. Scaling up would place additional demands on trapping labour, veterinary or appropriately trained personnel, DPP test availability, vaccine supply, logistics and sustained land access. Population density and starting prevalence may also vary substantially from those encountered in the Banbridge project, particularly where future intervention is targeted towards higher-burden areas because cattle disease, badger infection or badger density is elevated. [200]

The 2019 APHA report itself makes the same qualification. Its future-intervention simulations applied the land-access and trapping performance achieved during the Banbridge project. [201] However, the authors explicitly cautioned that the high level of landowner participation achieved there could not be assumed in other areas. [202] This reinforces the need to treat achievable operational coverage as a variable to be established locally rather than as a fixed characteristic of TVR.

The single-area nature of the study therefore creates a different transferability question from that applying to English or Republic of Ireland evidence. For TVR, the issue is less whether the intervention can be undertaken in Northern Ireland; it demonstrably can. The more important question is whether it can be delivered at sufficient scale and

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simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland; Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (Meles meles)', PLoS ONE, 16, e0246141; Jinks, R.C. et al. (2025), 'Evaluating sensitivity and specificity of the DPP Vet TB assay in badgers using Bayesian latent class models', PLoS ONE, 20(3), e0313825. The later estimates are not methodologically identical and should not simply be substituted for one another; the point is that the robustness of model conclusions should be tested across plausible contemporary diagnostic-performance assumptions.

[199] Menzies, F.D., McCormick, C.M., O'Hagan, M.J.H., et al. (2021), 'Test and vaccinate or remove: Methodology and preliminary results from a badger intervention research project', Veterinary Record, 189, e248, doi:10.1002/vetr.248; DAERA (2025a), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, section 'Test and Vaccinate or Remove (TVR)'.

[200] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Opinion Summary; DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, section 'Selective culling via the Test and Vaccinate or Remove (TVR) approach'; DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, sections 2.10–2.14.

[201] Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, APHA National Wildlife Management Centre, pp. 8–9.

[202] Budgey and Smith (2019), p. 19.

coverage, with acceptable diagnostic performance and repeated intervention over time, to produce the intended epidemiological effect. [203]

Current French experience provides a useful additional comparator, although not yet independent evidence of epidemiological efficacy. Since April 2023, ANSES and the French Biodiversity Agency (OFB) have been undertaking an experimental badger vaccination programme in Dordogne using an approach analogous to TVR [204]. The project initially covered approximately 100 km^2 and was extended in 2024 by a further 33 km^2. Badgers are trapped using cages or stopped restraints, tested for tuberculosis and, if negative, vaccinated and released; test-positive animals are euthanised. [205] Other badger interventions under the Sylvatub programme are suspended within the experimental areas in order not to compromise evaluation of the project. France's national 2024–2029 bovine TB roadmap describes the objective as verifying the efficacy and feasibility of badger vaccination before considering wider deployment, while separately retaining and seeking to improve targeted badger population reduction around infected cattle holdings. [206] AgriSearch has not identified published results demonstrating an effect of the French experiment on cattle bTB outcomes. [207] The French experience therefore provides useful evidence of the operational feasibility and active evaluation of a TVR-type approach in another European setting, but should not presently be interpreted as independent confirmation of its effect on cattle herd incidence.

AgriSearch assessment

AgriSearch considers the Northern Ireland TVR project to be a valuable and substantial contribution to the evidence base. It demonstrates that TVR can be operationally delivered under Northern Ireland field conditions, provides locally derived evidence on

[203] DAERA (2025b), Scientific Opinion, Annex VII, Scientific Opinion Conclusion 6 and Opinion Summary; DAERA (2026), Annex VIII, section 'Selective culling via TVR'; see also Arnold et al. (2021), Menzies et al. (2021), O'Hagan et al. (2021) and Doyle et al. (2023).
[204] Richomme, C., Artois, M., Desvaux, S., Lesellier, S., Payne, A. and Van de Wiele, A. (2025), 'Éco-épidémiologie et gestion sanitaire : de la rage vulpine à la tuberculose bovine chez les blaireaux, quels enseignements?', Bulletin de l'Académie Vétérinaire de France, 178, doi:10.3406/bavf.2025.71144; see also Préfecture de la Dordogne, relevant annual orders governing the vaccination experiment.
[205] Préfecture de la Dordogne (2025), *Arrêté préfectoral ordonnant la chasse particulière pour la capture du blaireau dans les zones à risque sanitaire de tuberculose bovine [Prefectural order authorising special hunting for the capture of badgers in areas at sanitary risk from bovine tuberculosis]*, Arrêté no. 24-2025-04-22-00002, 22 April 2025, Article 7 and Annex 3.
[206] Ministère de l'Agriculture, de l'Agro-alimentaire et de la Souveraineté alimentaire (2025), Une feuille de route nationale 2024–2029 pour lutter contre la tuberculose bovine [National roadmap 2024–2029 for the control of bovine tuberculosis], 1 July 2025, particularly Actions 13, 14 and 16.
[207] Richomme et al. (2025); Ministère de l'Agriculture (2025), Action 16. Richomme et al. describe evaluation of badger prevalence, feasibility and costs as objectives of the ongoing four-year programme, while the national roadmap continues to describe efficacy and feasibility as matters to be verified before wider deployment.

DPP diagnostic performance, records a substantial decline in estimated badger M. bovis prevalence during the intervention, and provides reassuring evidence that the selective level of removal undertaken did not produce a broad sustained increase in badger ranging behaviour or major disruption of social organisation. These are meaningful findings and provide TVR with a substantially stronger empirical basis than would exist from modelling alone. [208]

The interpretation of the prevalence decline nevertheless requires qualification. The intervention was undertaken in a single area without replicated untreated controls, and selective removal and vaccination were applied simultaneously. The study therefore cannot determine how much of the observed decline was attributable to selective removal, vaccination or other temporal factors, nor can the full decline be attributed causally to TVR without qualification. [209]

The evidence categories set out in Section 4 should therefore be applied consistently. The Northern Ireland project did not demonstrate a causal reduction in cattle bTB herd incidence and was comprised a single intervention area without replicated intervention or control areas and was not sufficient to establish a causal cattle-incidence effect. The decline in estimated badger prevalence and the absence of detected sustained perturbation should not be presented as equivalent to demonstrated cattle disease reduction. Failure to demonstrate such an effect is, however, different from demonstrating that TVR is ineffective in cattle. [210]

TVR performance also depends materially on the proportion of the badger population that can be repeatedly captured and on the performance of the diagnostic test. Incomplete annual capture means that some infected animals will not be encountered in a particular year, while imperfect DPP sensitivity means that some infected captured badgers will test negative and be vaccinated and released. More recent diagnostic

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[208] Menzies, F.D., McCormick, C.M., O'Hagan, M.J.H., et al. (2021), 'Test and vaccinate or remove: methodology and preliminary results from a badger intervention research project', Veterinary Record, 189, e248; Arnold, M.E., Courcier, E.A., Stringer, L.A., et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (Meles meles)', PLoS ONE, 16(1), e0246141; O'Hagan, M.J.H., Gordon, A.W., McCormick, C.M., et al. (2021), 'Effect of selective removal of badgers (Meles meles) on ranging behaviour during a "Test and Vaccinate or Remove" intervention in Northern Ireland', Epidemiology and Infection, 149, e125; Allen, A.R., Milne, G., McCormick, C., et al. (2022), 'European badger (Meles meles) responses to low-intensity, selective culling: using mark–recapture and relatedness data to assess social perturbation', Ecological Solutions and Evidence, 3(3), e12165; DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII.

[209] Arnold et al. (2021); Menzies et al. (2021); DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, section 'Test and Vaccinate or Remove'; DAERA (2025b), *Scientific Opinion*, Annex VII.

[210] Doyle, L.P., Gordon, A.W., Molloy, C., O'Hagan, M.J.H., Georgaki, A., Courcier, E.A., Harwood, R.G. and Menzies, F.D. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', Epidemiology and Infection, 151; DAERA (2025a), Annotated scientific bibliography, section 'Test and Vaccinate or Remove'; DAERA (2025b), Scientific Opinion, Annex VII, Scientific Opinion Conclusion 6.

estimates also reinforce uncertainty around the balance between sensitivity and specificity. These factors interact with starting prevalence, badger density and intervention frequency and should therefore be treated as components of epidemiological performance rather than solely as operational details. [211]

At present, the expectation that TVR can produce a substantial reduction in cattle bTB rests on a combination of biological plausibility, favourable badger-level field evidence and mathematical modelling rather than direct controlled field evidence of cattle outcomes. The modelling is encouraging, particularly where little or no perturbation occurs, but remains sensitive to assumptions concerning starting prevalence, population density, capture probability, diagnostic performance and transmission dynamics. [212]

The appropriate conclusion is therefore not that TVR has been shown either to "work" or "not work" in cattle. Rather, TVR has been demonstrated to be operationally feasible under the conditions of the Northern Ireland research project, and a substantial decline in estimated badger infection prevalence was observed during the intervention; whether this translates into a causal and sufficiently rapid reduction in cattle herd incidence remains to be demonstrated directly.

Where TVR is selected, AgriSearch considers that baited cage trapping remains an established and appropriate capture method for consideration, with the Northern Ireland TVR project providing direct local operational experience of its use. The additional welfare and delivery requirements of TVR arise not only from capture but from the sequence of anaesthesia, blood sampling, trap-side testing, vaccination and microchipping of test-negative badgers, or euthanasia of test-positive animals. These procedures require appropriately trained and authorised personnel, clear clinical and welfare protocols and sufficient professional capacity to ensure that captured animals are processed promptly and consistently. [213]

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[211] Arnold et al. (2021); Jinks, R.C., Lesellier, S., Smith, F., et al. (2025), 'Evaluating sensitivity and specificity of the DPP Vet TB assay in badgers using Bayesian latent class models', *PLoS ONE*, 20(3), e0313825; DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, particularly the assumptions relating to annual capture rate, starting prevalence and DPP diagnostic performance.

[212] Smith, G.C., Delahay, R.J., McDonald, R.A. and Budgey, R. (2016), 'Model of selective and non-selective management of badgers (Meles meles) to control bovine tuberculosis in badgers and cattle', PLoS ONE, 11(11), e0167206; Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, APHA National Wildlife Management Centre; DAERA (2025a), Annotated scientific bibliography, 'Modelling'; DAERA (2025b), Scientific Opinion, Annex VII.

[213] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 7, particularly sections 7a and the general TVR methodology. DAERA proposes that TVR badgers are anaesthetised, blood-sampled and tested using the DPP test; test-negative animals are vaccinated, microchipped and released, while test-positive animals are euthanised by lethal injection. The consultation states that trapping may be undertaken by trained operatives while anaesthesia, testing and subsequent treatment are subject to the relevant professional requirements.

Diagnostic uncertainty is also relevant to the practical operation of TVR. With estimated whole-blood DPP sensitivity of around 69% and specificity of around 98%, some infected captured badgers will test negative at a particular trapping event and be vaccinated and released. [214] That limitation is already considered in AgriSearch's assessment of epidemiological effectiveness, but it also reinforces the importance of accurate record-keeping, individual identification and repeat annual capture. Badgers released after testing and vaccination may be recaptured in subsequent years and undergo further handling, testing and vaccination; cumulative capture and handling should therefore form part of welfare and operational monitoring rather than being considered solely as a cost or epidemiological issue. [215]

Where TVR is selected, stopped restraints should remain among the available capture methods for consideration. The fact that restraint-based TVR is the highest-ranked option in DAERA's composite assessment should not, however, be interpreted as establishing stopped restraints as the preferred capture method in all circumstances. That ranking combines economic, non-monetary and operational-risk considerations and is sensitive to the weighting applied. The suitability of stopped restraints should therefore be assessed on the same basis as other capture methods, including operator competence, animal welfare, prompt checking, non-target risk, practical deployment, achievable population coverage and auditable recording. Their substantial operational use in the Republic of Ireland and potential logistical advantages are relevant strengths, but the recognised limitations in capturing smaller, younger badgers and any implications for the intervention window or supplementary cage trapping should also be taken into account. [216]

5.3 Vaccination-only

Vaccination-only seeks to reduce transmission of *M. bovis* by progressively reducing susceptibility within the badger population rather than removing infected or uninfected animals. All badgers captured within an intervention area are vaccinated and released

[214] Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (*Meles meles*)', *PLoS ONE*, 16, e0246141; DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 7. The DPP whole-blood test was estimated to have median sensitivity of approximately 69% and specificity of approximately 98%.

[215] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 7. DAERA proposes annual repeat intervention, with previously released test-negative badgers retested and revaccinated if recaptured in later years. See also DAERA (2026), Annex IX, sections dealing with TVR capture assumptions and repeat intervention.

[216] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 7b; DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII; DAERA (2026), *Strategic Environmental Assessment*, Annex IV. Stopped restraints have substantial operational precedent in the Republic of Ireland, with estimated annual capture rates of approximately 56–58%; DAERA also identifies reduced effectiveness for smaller, younger badgers and the potential need for supplementary cage trapping or a different intervention window.

without prior testing. The intended effect is therefore gradual: as the proportion of susceptible animals declines, transmission within the badger population should reduce and, in turn, the risk of transmission to cattle should fall. [217]

There is substantial evidence that BCG vaccination can protect badgers against *M. bovis* infection. [218] The principal uncertainty is not whether BCG has a biological effect, but the magnitude and speed with which repeated vaccination of a free-living badger population can translate into a reduction in cattle herd breakdowns, particularly where infection is already well established. DAERA's own scientific opinion recognises this distinction, noting that many vaccination studies relate to vaccination logistics or effects in badgers rather than directly measuring cattle outcomes. [219]

Individual BCG efficacy

Experimental and field studies provide consistent evidence that BCG reduces susceptibility to *M. bovis* infection and can reduce disease progression in vaccinated badgers. Carter et al. (2012) reported that intramuscular BCG vaccination reduced the risk of progressive infection by approximately 76% and the risk of any detectable infection by approximately 54%. DAERA's annotated bibliography additionally summarises the study as showing an approximately 74% reduction in the risk of seroconversion in vaccinated animals. [220]

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[217] DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, sections 5.4 and 8, 'Vaccination Only'; DAERA (2026), Strategic Environmental Assessment, Annex IV, section 2.7.2.6. DAERA defines vaccination-only as vaccination and release of all captured badgers without prior testing or removal, with the intended population-level effect arising through progressive reduction in susceptibility and infection pressure over time.

[218] Chambers, M.A., Rogers, F., Delahay, R.J., Lesellier, S., Ashford, R., Dalley, D., Gowtage, S., Davé, D., Palmer, S., Brewer, J. and Crawshaw, T. (2011), 'Bacillus Calmette-Guérin vaccination reduces the severity and progression of tuberculosis in badgers', Proceedings of the Royal Society B: Biological Sciences, 278(1713), 1913–1920; Carter, S.P., Chambers, M.A., Rushton, S.P., et al. (2012), 'BCG vaccination reduces risk of tuberculosis infection in vaccinated badgers and unvaccinated badger cubs', PLoS ONE, 7, e49833, doi:10.1371/journal.pone.0049833; Gormley, E., Ní Bhuachalla, D., O'Keeffe, J., et al. (2017), 'Oral vaccination of free-living badgers (Meles meles) with Bacille Calmette–Guérin (BCG) vaccine confers protection against tuberculosis', PLoS ONE, 12, e0168851.

[219] DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, 'Badger vaccination' and Scientific Opinion Conclusion 4; DAERA (2025a), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, section 'Badger vaccination', pp. 24–32. DAERA concludes that BCG reduces badger susceptibility but notes that many vaccination studies address logistics or badger-level outcomes rather than the effect of vaccination on cattle bTB. It also considers vaccination-only slower acting and likely to require sustained high coverage over many years where infection is endemic.

[220] Carter, S.P., Chambers, M.A., Rushton, S.P., Shirley, M.D.F., Schuchert, P., Pietravalle, S., Murray, A., Rogers, F., Gettinby, G., Smith, G.C., Delahay, R.J., Hewinson, R.G. and McDonald, R.A. (2012), 'BCG vaccination reduces risk of tuberculosis infection in vaccinated badgers and unvaccinated badger cubs', PLoS ONE, 7(12), e49833; see also DAERA (2025a), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, 'Badger vaccination – Context'.

Evidence from the Republic of Ireland is broadly consistent with this biological effect. Modelling analysis of the Kilkenny vaccination-trial data estimated vaccine efficacy against susceptibility at approximately 59% (95% CI 6.5–82%), indicating a significant reduction in the likelihood that vaccinated animals would become infected following exposure. [221]

BCG does not therefore provide complete or sterile immunity: vaccinated animals may still become infected. Nevertheless, the evidence that vaccination materially reduces susceptibility is reasonably strong and forms a credible biological basis for its use as a disease-control measure. [222]

Indirect protection within badger social groups

Vaccination may also provide protection beyond the animals directly vaccinated. Carter et al. reported that where more than one-third of a badger social group had been vaccinated, the risk of infection among **u**nvaccinated cubs was reduced by approximately 79%. [223]

This is important because it suggests that vaccination can generate a population-level effect even where every badger is not captured and vaccinated. Subsequent analysis of the Kilkenny trial also reported evidence consistent with indirect protection: no infection was detected among untreated badgers in the relevant study groups, which the authors interpreted as suggesting a protective effect from the surrounding vaccinated population. [224] However, the existence of an indirect effect should not be interpreted as establishing a universal coverage threshold. The level of vaccination required to suppress transmission will depend on starting prevalence, badger population density, recruitment of susceptible cubs, movement between social groups,

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[221] Aznar, I., Frankena, K., More, S.J., O'Keeffe, J., McGrath, G. and de Jong, M.C.M. (2018), 'Quantification of *Mycobacterium bovis* transmission in a badger vaccine field trial', *Preventive Veterinary Medicine*, 149, 29–37, https://doi.org/10.1016/j.prevetmed.2017.10.010; see also Gormley, E., Ní Bhuachalla, D., O'Keeffe, J., et al. (2017), 'Oral vaccination of free-living badgers (*Meles meles*) with Bacille Calmette-Guérin (BCG) vaccine confers protection against tuberculosis', *PLoS ONE*, 12(1), e0168851.

[222] Carter et al. (2012); Aznar et al. (2018); Gormley et al. (2017); DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, vaccination section.

[223] Carter, S.P., Chambers, M.A., Rushton, S.P., Shirley, M.D.F., Schuchert, P., Pietravalle, S., Murray, A., Rogers, F., Gettinby, G., Smith, G.C., Delahay, R.J., Hewinson, R.G. and McDonald, R.A. (2012), 'BCG vaccination reduces risk of tuberculosis infection in vaccinated badgers and unvaccinated badger cubs', PLoS ONE, 7(12), e49833; see also DAERA (2025a), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, 'Badger vaccination – Context'.

[224] **Gormley, E., Ní Bhuachalla, D., Fitzsimons, T., O'Keeffe, J., McGrath, G., Madden, J.M., Fogarty, N., Kenny, K., Messam, L.L.M., Murphy, D. and Corner, L.A.L. (2022), 'Protective immunity against tuberculosis in a free-living badger population vaccinated orally with *Mycobacterium bovis* Bacille Calmette–Guérin', *Transboundary and Emerging Diseases*, 69(4), e10–e19, doi:10.1111/tbed.14254; see also Gormley et al. (2017).**

vaccine efficacy, external sources of infection and the extent to which vaccination affects infectiousness as well as susceptibility. [225]

Limitations in already infected badgers

The principal limitation of vaccination-only is that BCG is preventative rather than therapeutic. It does not cure existing *M. bovis* infection. A badger which is already infected when vaccinated therefore remains within the population and may continue to contribute to infection pressure. [226]

DAERA's annotated bibliography notes that vaccination is likely to have little or no effect on the course of pre-existing infection. Further analysis of the Kilkenny trial by Gormley et al. (2022) found that infection prevalence was significantly lower among vaccinated than placebo-treated badgers, but that among infected animals there were no significant differences in the number of infected sites or disease-severity scores. [227]

Modelling based on the Kilkenny data similarly estimated substantial vaccine efficacy against susceptibility, but did not identify a significant reduction in the infectiousness of vaccinated badgers that subsequently became infected. [228]

This distinction is fundamental when considering vaccination-only in areas where badger infection prevalence is already high. Unlike non-selective culling or TVR, vaccination does not directly remove existing infected animals. Its immediate effect is instead to reduce the probability of susceptible animals acquiring infection and progressively alter the infection dynamics of the population over time. [229]

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[225] Aznar, I., Frankena, K., More, S.J., O'Keeffe, J., McGrath, G. and de Jong, M.C.M. (2018), 'Quantification of Mycobacterium bovis transmission in a badger vaccine field trial', Preventive Veterinary Medicine, 149, 29–37, doi:10.1016/j.prevetmed.2017.10.010; DAERA (2025a), Annotated scientific bibliography, 'Badger vaccination'; DAERA (2025b), Scientific Opinion, Annex VII.

[226] DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, 'Badger vaccination – Context'; DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, sections 5.4 and 8. DAERA notes that BCG vaccination is likely to have little or no effect on the course of pre-existing *M. bovis* infection and that, under vaccination-only, infected animals remain within the population.

[227] Gormley, E., Ní Bhuachalla, D., Fitzsimons, T., O'Keeffe, J., McGrath, G., Madden, J.M., Fogarty, N., Kenny, K., Messam, L.L.M., Murphy, D. and Corner, L.A.L. (2022), 'Protective immunity against tuberculosis in a free-living badger population vaccinated orally with *Mycobacterium bovis* Bacille Calmette–Guérin', *Transboundary and Emerging Diseases*, 69(4), e10–e19, https://doi.org/10.1111/tbed.14254; see also DAERA (2025a), *Annotated scientific bibliography*, 'Vaccine field trials and deployment'.

[228] Aznar, I., Frankena, K., More, S.J., O'Keeffe, J., McGrath, G. and de Jong, M.C.M. (2018), 'Quantification of Mycobacterium bovis transmission in a badger vaccine field trial', Preventive Veterinary Medicine, 149, 29–37, https://doi.org/10.1016/j.prevetmed.2017.10.010; DAERA (2025b), Scientific Opinion, Annex VII, vaccination section.

[229] Gormley et al. (2022); Aznar et al. (2018); DAERA (2025b), Scientific Opinion, Annex VII, Scientific Opinion Conclusion 4; DAERA (2026), Consultation on Potential Wildlife Intervention Options, Chapter 8.

Irish field evidence

The Republic of Ireland provides the most important field evidence relevant to large-scale badger vaccination. [230]

The Kilkenny trial, undertaken between 2009 and 2012 across more than 750 km^2, examined BCG vaccination in a naturally infected badger population. Vaccination significantly delayed the time to infection, and subsequent analysis found infection prevalence of 24% in vaccinated badgers compared with 52% in placebo-treated badgers. [231]

This provides useful field evidence that vaccination can reduce infection risk within a free-living badger population. The initial Kilkenny work did not, however, directly measure its impact on cattle bTB incidence. [232]

A subsequent large-scale non-inferiority study by Martin et al. (2020), which tested whether vaccination produced cattle outcomes that were not unacceptably worse than continued targeted culling, examined cattle herd outcomes across seven counties between 2011 and 2017. It compared areas moving from targeted badger culling to vaccination with areas continuing targeted culling. Vaccination was judged not inferior to continued targeted culling in four of the seven study areas, produced an ambivalent result in one, and was judged inferior in two. [233] s.

This study is important because it provides direct cattle-outcome evidence. However, its design and historical context need to be carefully understood. It demonstrated that moving from targeted culling to vaccination did not result in an unacceptable deterioration in cattle outcomes in most of the study areas; it was not a trial of

[230] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, 'Badger vaccination'; DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, section 'Vaccine field trials and deployment'.

[231] Gormley, E., Ní Bhuachalla, D., O'Keeffe, J., Murphy, D., Aldwell, F.E., Fitzsimons, T., Stanley, P., Tratalos, J.A., McGrath, G., Fogarty, N., Kenny, K., More, S.J., Messam, L.L.M. and Corner, L.A.L. (2017), 'Oral Vaccination of Free-Living Badgers (*Meles meles*) with Bacille Calmette Guérin (BCG) Vaccine Confers Protection against Tuberculosis', *PLoS ONE*, 12(1), e0168851, https://doi.org/10.1371/journal.pone.0168851; Gormley, E., Ní Bhuachalla, D., Fitzsimons, T., et al. (2022), 'Protective immunity against tuberculosis in a free-living badger population vaccinated orally with *Mycobacterium bovis* Bacille Calmette–Guérin', *Transboundary and Emerging Diseases*, 69(4), e10–e19, https://doi.org/10.1111/tbed.14254.

[232] Gormley et al. (2017); DAERA (2025a), *Annotated scientific bibliography*, 'Vaccine field trials and deployment'. DAERA notes that the initial Kilkenny study measured badger infection outcomes and did not directly assess its impact on cattle bTB rates.

[233] Martin, S.W., O'Keeffe, J., Byrne, A.W., Rosen, L.E., White, P.W. and McGrath, G. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (Meles meles) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland? A practical non-inferiority wildlife intervention study in the Republic of Ireland (2011–2017)', Preventive Veterinary Medicine, 179, 105004, https://doi.org/10.1016/j.prevetmed.2020.105004.

vaccination versus no wildlife intervention or vaccination versus proactive culling in a previously untreated badger population. [234]

The findings contributed to the subsequent expansion of badger vaccination within the Republic of Ireland. Routine injectable BCG vaccination was introduced into the national programme in 2018 and progressively expanded thereafter. Ryan et al. (2023) reported that by 2021 more than 20,000 km^2 had been designated as badger vaccination area, while DAERA's 2026 consultation reports that approximately 8,000 km^2 is currently covered by vaccination. These figures may reflect differences between designated and operational coverage, but both sources confirm that vaccination is now deployed at substantial scale. Targeted badger removal nevertheless remains part of the Irish programme where epidemiological circumstances warrant it. [235] The subsequent Republic of Ireland experience also requires careful interpretation. The transition should not be understood as a simple replacement of culling by vaccination-only. The current Irish wildlife programme uses a combination of vaccination and culling, with removal retained in higher-risk circumstances; the 2025 Bovine TB Action Plan also includes an action to test badgers before vaccination and remove test-positive animals. Recent Irish commentary has also highlighted the practical challenge of maintaining sufficiently high vaccination coverage and reports that focused culling has been reintroduced in some areas following cattle bTB outbreaks. This does not demonstrate that vaccination has failed: national cattle disease trends cannot be causally attributed to wildlife vaccination alone. Rather, it reinforces the distinction between the biological efficacy of BCG and the effectiveness of a vaccination programme as actually delivered, which depends on achievable coverage, starting infection pressure, cattle controls and continuing surveillance. [236]

Previous intervention history and starting conditions

Previous badger-management history is an important consideration when assessing how the Republic of Ireland vaccination evidence transfers to Northern Ireland.

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[234] Martin et al. (2020); DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger vaccination'; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–31.

[235] Ryan, E., Breslin, P., O'Keeffe, J., Byrne, A.W., Wrigley, K. and Barrett, D. (2023), 'The Irish bTB eradication programme: combining stakeholder engagement and research-driven policy to tackle bovine tuberculosis', *Irish Veterinary Journal*, 76(Suppl 1), 32, https://doi.org/10.1186/s13620-023-00255-8; DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, section 5.7 'Republic of Ireland'; Department of Agriculture, Food and the Marine (DAFM) (2026), *Wildlife Programme*, published 17 July 2025, updated 15 May 2026.

[236] More, S.J. (2024), 'Eradication of bovine tuberculosis in Ireland: is it a case of now or never?', Irish Veterinary Journal, 77, 22, https://doi.org/10.1186/s13620-024-00282-z, particularly the section 'Limiting infection within and from wildlife'; Ryan et al. (2023); DAFM (2025, updated 2026), Wildlife Programme, updated 15 May 2026; DAERA (2026), Consultation on Potential Wildlife Intervention Options, section 5.7 'Republic of Ireland'.

However, the immediate intervention history of the principal Irish studies was not identical. [237]

The Kilkenny vaccine trial was conducted within the wider context of an Irish bTB programme in which targeted badger removal was already established, and previous culling history was one of the factors considered in selecting the study area. The published trial-design and population studies provide additional detail: approximately one-third of the trial area had formed part of a reference area in the earlier Four Area Project, where breakdown-related badger culling had been limited, and the Kilkenny area was protected from culling for two years before the vaccine trial began. The Kilkenny study should therefore not be characterised simply as vaccination immediately following sustained culling. [238]

The later non-inferiority study by Martin et al. (2020) provides a clearer transition context. It directly compared areas moving from targeted badger culling to vaccination with areas continuing targeted culling. Previous removal is therefore integral to the interpretation of its cattle-outcome findings. [239]

DAERA's Scientific Opinion and the CVO Review nevertheless make an important broader programme-level point. The Republic of Ireland's move towards large-scale vaccination occurred against a background of established badger culling, and DAERA considers previous reduction of infection pressure and starting prevalence relevant to vaccination performance. That context is important when considering transferability to Northern Ireland, but it should not be treated as establishing identical starting conditions for every Irish vaccination study. [240]

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[237] DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, 'Badger vaccination' and Opinion Summary; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 30–32.

[238] 222 Aznar, I., McGrath, G., Murphy, D., Corner, L.A.L., Gormley, E., Frankena, K., More, S.J., Martin, W., O'Keeffe, J. and de Jong, M.C.M. (2011), 'Trial design to estimate the effect of vaccination on tuberculosis incidence in badgers', Veterinary Microbiology, 151(1–2), 104–111, https://doi.org/10.1016/j.vetmic.2011.02.032; Byrne, A.W., O'Keeffe, J., Green, S., et al. (2012), 'Population estimation and trappability of the European badger (Meles meles): implications for tuberculosis management', PLoS ONE, 7(12), e50807, https://doi.org/10.1371/journal.pone.0050807. The Kilkenny study area was selected partly with previous culling history in mind; approximately one-third had formed part of a Four Area Project reference area where breakdown-related culling was limited, and the area was protected from culling for two years before the vaccination trial began

[239] Martin, S.W., O'Keeffe, J., Byrne, A.W., Rosen, L.E., White, P.W. and McGrath, G. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (*Meles meles*) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland? A practical non-inferiority wildlife intervention study in the Republic of Ireland (2011–2017)', *Preventive Veterinary Medicine*, 179, 105004, https://doi.org/10.1016/j.prevetmed.2020.105004. The study compared vaccination with continued targeted badger culling and therefore provides evidence primarily about transition from an established culling programme rather than vaccination as an initial wildlife intervention.

[240] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 30–32; DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, 'Badger vaccination', Opinion Summary and

This distinction does not diminish the value of the Irish evidence; it clarifies what the different studies demonstrate. Kilkenny provides strong badger-level evidence that BCG vaccination can reduce susceptibility under conditions of natural transmission. Martin et al. provides direct cattle-outcome evidence that transition from targeted culling to vaccination did not result in unacceptable deterioration in cattle outcomes in most of the areas studied. Taken together, the evidence supports an important long-term role for vaccination, including following reduction of infection pressure. It provides less direct evidence about the speed and magnitude of cattle benefit where vaccination-only is introduced as the initial intervention in a previously untreated Northern Ireland badger population, particularly where starting infection prevalence is high. [241]

This distinction is particularly important in light of the variation in badger infection prevalence discussed in Section 3.3.

Vaccination coverage requirements

For vaccination to generate population-level protection, a sufficiently large proportion of the badger population must be vaccinated repeatedly over time. [242]

Modelling based on the Kilkenny trial estimated that vaccination coverage exceeding approximately 30% could reduce the reproduction of infection sufficiently to make elimination from the badger population feasible, provided existing cattle and wildlife controls remained in place. [243] DAERA's consultation also cites indicative estimates of approximately 30–40% annual vaccination coverage. [244]

Annex 1, section 'Options ii–iv followed by vaccination'. The CVO Review notes the Republic of Ireland's transition from a long period of badger culling and identifies existing disease incidence, population dynamics, vaccination coverage and vaccine efficacy as relevant to vaccination performance.

[241] Aznar, I., Frankena, K., More, S.J., O'Keeffe, J., McGrath, G. and de Jong, M.C.M. (2018), 'Quantification of *Mycobacterium bovis* transmission in a badger vaccine field trial', *Preventive Veterinary Medicine*, 149, 29–37; Martin et al. (2020); DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 4 and Opinion Summary; DAERA (2024), *CVO Review*, pp. 31–32

[242] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 8, 'Vaccination Only'; DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, 'Badger vaccination'; Robertson, A., Chambers, M.A., Smith, G.C., Delahay, R.J., McDonald, R.A. and Brotherton, P.N.M. (2025), 'Can badger vaccination contribute to bovine TB control? A narrative review of the evidence', *Preventive Veterinary Medicine*, 238, 106464, https://doi.org/10.1016/j.prevetmed.2025.106464.

[243] Aznar, I., Frankena, K., More, S.J., O'Keeffe, J., McGrath, G. and de Jong, M.C.M. (2018), 'Quantification of *Mycobacterium bovis* transmission in a badger vaccine field trial', *Preventive Veterinary Medicine*, 149, 29–37, https://doi.org/10.1016/j.prevetmed.2017.10.010; see also DAERA (2025a), *Annotated scientific bibliography*, 'Badger vaccination'.

[244] Smith, G.C. and Delahay, R.J. (2018), 'Modeling as a Decision Support Tool for Bovine TB Control Programs in Wildlife', *Frontiers in Veterinary Science*, 5, 276, https://doi.org/10.3389/fvets.2018.00276; Robertson et al. (2025); DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, sections 5.4 and 8.

These figures should not, however, be interpreted as a universal herd-immunity threshold. The Aznar et al. modelling was parameterised using the Kilkenny trial data, assumed badger infection prevalence of approximately 18% in endemic Irish areas and assumed that existing cattle and wildlife controls remained in place. DAERA's Scientific Opinion further records, following discussion with a co-author of the study, that it considered this modelling outcome to be predicated on the wider culling programme having reduced badger infection prevalence to the level used. Required vaccination coverage is therefore likely to depend on starting prevalence, population and transmission dynamics and the other controls operating alongside vaccination. The indicative 30–40% figure should not be transferred directly to Northern Ireland as a universal coverage threshold. [245]

Coverage also needs to be sustained. New susceptible cubs enter the population each year, vaccine-induced immunity may wane and not all badgers are equally likely to be trapped. Repeated vaccination over a sustained period is therefore expected to be necessary, although the optimum frequency of vaccination may depend on local epidemiological and population conditions. [246]

As with TVR, assessing whether an intended coverage level has actually been achieved also requires a sufficiently reliable estimate of the starting badger population. The population-density uncertainties discussed in Section 3.4 are therefore directly relevant to vaccination-only. [247]

Operational delivery and scalability

Evidence published since DAERA's literature review further strengthens the operational, rather than cattle-incidence, evidence for injectable badger vaccination. Robertson and Benton (2026), analysing sixteen years of vaccination delivery in England, found that cage-trap vaccination could be delivered safely across a range of landscapes, including areas recently subject to culling. However, trapping efficiency varied with season,

[245] DAERA (2026), Consultation on Potential Wildlife Intervention Options, Chapter 8; DAERA (2026), Strategic Environmental Assessment, Annex IV, section 2.7.2.6; Smith, G.C. and Budgey, R. (2025), 'Bovine tuberculosis model validation against a field study of badger vaccination with selective culling', PLoS ONE, 20(7), https://doi.org/10.1371/journal.pone.0320830.

[246] Godfray, H.C.J., Donnelly, C.A., Kao, R.R., et al. (2013), 'A restatement of the natural science evidence base relevant to the control of bovine tuberculosis in Great Britain', Proceedings of the Royal Society B, 280, 20131634; Godfray, H.C.J., Donnelly, C.A., Hewinson, R.G., Winter, M. and Wood, J.L. (2018), Bovine TB Strategy Review; Byrne, A.W., O'Keeffe, J., Green, S., et al. (2012), 'Population estimation and trappability of the European badger (Meles meles): implications for tuberculosis management', PLoS ONE, 7(12), e50807; Budgey, R. and Bird, M. (2026), 'A simulation model to predict the most efficient way to utilise operational resources when vaccinating badgers against bTB', PLoS ONE, 21(7), e0354329, https://doi.org/10.1371/journal.pone.0354329.

[247] DAERA (2025a), *Annotated scientific bibliography*, 'Vaccine models and badger population estimation'; Smith et al. (2020), study of vaccination coverage estimation in the Welsh Intensive Action Area, as summarised by DAERA; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger Ecology'.

location and recent culling history, and the authors concluded that current trapping-based vaccination is unlikely to be practicable as a landscape-wide intervention using current delivery methods because of its cost and logistical requirements. [248] This supports vaccination as a feasible targeted tool, while not resolving uncertainty over the scale or timeframe of any resulting reduction in cattle herd incidence.

BCG supply should be considered both as an operational dependency and as a matter of responsible procurement. DAERA's own risk assessment records vaccine-supply disruption during the Northern Ireland TVR project. UNICEF's October 2024 market assessment reported adequate aggregate global production capacity, but also identified significant supplier concentration and market fragility. These findings underline the need for a current assessment of the availability of the particular vaccine product and quantities required for a Northern Ireland programme. [249]

Any proposed use of BCG, whether within TVR, vaccination-only or subsequent maintenance vaccination, should therefore be supported by a proportionate supply and procurement assessment. DAERA should identify anticipated annual and longer-term requirements, including repeat vaccination and wastage, and seek assurance from suppliers and relevant public-health and procurement authorities about any potential competition with essential human immunisation programmes, particularly infant vaccination in high-TB-burden settings. AgriSearch considers that essential human immunisation needs should take priority where a genuine conflict over scarce supply is identified. The programme should also have contingency arrangements for supply interruption. These are requirements for responsible procurement and delivery planning, not evidence that Northern Ireland badger vaccination would necessarily displace human vaccination.

[248] Robertson, A. and Benton, C. (2026), 'Vaccinating wild badgers against bovine tuberculosis: an overview of sixteen years of vaccine delivery in England', *Frontiers in Veterinary Science*, 13, 1901413, https://doi.org/10.3389/fvets.2026.1901413. Based on 84,085 trap-nights and 25,692 vaccine doses administered in England between 2010 and 2025, the study found very low rates of serious adverse welfare events, variation in trapping efficiency by month, location and recent culling history, and concluded that trap-based vaccination is unlikely to become a landscape-wide tool because of cost and logistical constraints but can support targeted deployment.

[249] DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII, Table 28, p. 120, entry "Risk of a lack of non-labour availability (e.g. equipment/drugs)"; UNICEF Supply Division (2024), *Bacillus Calmette-Guérin (BCG): Market and Supply Update*, October 2024, Summary and section 3.2, "Global supply". The UNICEF assessment describes the market at the time of publication and should not be treated as assurance of supply for a future Northern Ireland programme.

Time to effect

Vaccination-only is expected to act more gradually than an intervention that removes infected animals. [250]

This follows from the mechanism itself. Existing infected animals remain in the population while vaccination progressively reduces the number of susceptible animals and protects successive cohorts. DAERA's consultation therefore concludes that interventions incorporating a lethal component generally provide a faster reduction in disease prevalence and transmission than vaccination-only. [251]

The updated scientific opinion similarly concludes that vaccination-only is likely to require many years of sustained high coverage, particularly where infection is endemic in badgers, and describes vaccination as potentially more suitable as an exit strategy following an intervention that first reduces infection pressure. [252]

Some modelling using Irish data suggests that elimination of M. bovis through vaccination could be achievable only over very long timescales, potentially measured in decades rather than years. [253]

The appropriate interpretation is not that vaccination is therefore ineffective. For a long-term eradication programme, an intervention capable of progressively suppressing infection while maintaining a stable badger population could have substantial value. However, where cattle bTB incidence and programme costs are currently high, the time required to achieve a material cattle-level benefit is itself an important policy consideration and should be compared consistently across interventions.

[250] DAERA (2026), Consultation on Potential Wildlife Intervention Options, Chapter 8, 'Vaccination Only'; DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, Opinion Summary.
[251] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 8; Smith, G.C. and Budgey, R. (2025), 'Bovine tuberculosis model validation against a field study of badger vaccination with selective culling', *PLoS ONE*, 20; see also DAERA (2026), *Strategic Environmental Assessment*, Annex IV, section 2.7.2.6.
[252] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 4 and Opinion Summary; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 62–64.
[253] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, p. 32; More (2019), as cited by DAERA; Chang et al. (2023), as cited by DAERA; see also DAERA (2025a), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, 'Vaccine models and badger population estimation'.

Modelling evidence

Mathematical modelling generally supports the biological plausibility of vaccination reducing infection in both badgers and cattle, but the predicted magnitude and timing of effect are highly dependent on assumptions. [254]

The Aznar et al. model based on Kilkenny trial data estimated that vaccination coverage above 30% could make elimination of infection from the badger population feasible where current controls were maintained. However, DAERA's annotated review notes important simplifying assumptions, including the absence of cattle-to-badger and environmental transmission and an assumption of homogeneity across the landscape. [255]

Other models have produced more cautious conclusions. Using Irish data in a two-host, multi-route transmission model, Chang and colleagues concluded that badger vaccination combined with the existing cattle test-and-removal programme may not be sufficient on its own to achieve eradication in the modelled region, and that additional measures addressing both hosts may be required. [256]

Northern Ireland-related modelling considered in DAERA's evidence review predicts reductions in cattle herd breakdowns from vaccination as well as from culling and TVR, but outcomes vary with assumptions concerning interspecies transmission, perturbation, host density and the starting epidemiological position. DAERA appropriately cautions that such models are context-dependent abstractions rather than field trials. [257]

Recent modelling also reinforces the importance of local epidemiological and population conditions in determining vaccination design. Budgey and Bird (2026) found that badger density, baseline infection prevalence and the duration of vaccine-induced immunity materially affected vaccination outcomes, with operational capture

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[254] DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, section 'Modelling', pp. 33–36; DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, 'Modelling'.

[255] Aznar, I., Frankena, K., More, S.J., O'Keeffe, J., McGrath, G. and de Jong, M.C.M. (2018), 'Quantification of *Mycobacterium bovis* transmission in a badger vaccine field trial', *Preventive Veterinary Medicine*, 149, 29–37, https://doi.org/10.1016/j.prevetmed.2017.10.010; see also DAERA (2025a), *Annotated scientific bibliography*, 'Badger vaccination' and 'Modelling'.

[256] Chang, Y., Widgren, S., de Jong, M.C.M., Tratalos, J.A., More, S.J. and Hartemink, N. (2025), 'Evaluating the effectiveness of badger vaccination combined with cattle test-and-removal in managing Bovine Tuberculosis: Insights from a two-host and multi-route transmission model', *Preventive Veterinary Medicine*, 235, 106386, https://doi.org/10.1016/j.prevetmed.2024.106386.

[257] Smith, G.C., Delahay, R.J., McDonald, R.A. and Budgey, R. (2016), 'Model of selective and non-selective management of badgers (*Meles meles*) to control bovine tuberculosis in badgers and cattle', *PLoS ONE*, 11(11), e0167206; Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*, APHA National Wildlife Management Centre; DAERA (2025a), *Annotated scientific bibliography*, 'Modelling'; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Modelling'.

assumptions also influencing the achievable delivery strategy. Under some modelled conditions, vaccination at intervals longer than one year remained effective and allowed finite field resources to be deployed across a larger area. This does not establish an optimal interval for Northern Ireland, but suggests that assumptions concerning annual treatment, coverage and programme duration should be tested against alternative scenarios using NI-specific population and infection data rather than treated as fixed parameters. [258]

AgriSearch therefore considers modelling useful for exploring likely vaccination trajectories and testing alternative starting conditions, but modelled cattle outcomes should be clearly distinguished from field-observed cattle outcomes.

Evidence on cattle outcomes

The direct cattle-outcome evidence for badger vaccination is more limited than the biological evidence in badgers. [259]

The Martin et al. non-inferiority trial is the most relevant field study because new cattle herd breakdown incidence was the outcome of interest. Its finding that vaccination was not inferior to ongoing targeted culling in most of the seven Irish study areas provides meaningful evidence that vaccination can play a role in maintaining disease control following previous culling. [260]

However, there was significant variation between sites, and non-inferiority was not demonstrated in every study area. Furthermore, because both the vaccination and comparison areas had a history of targeted culling, the study cannot directly answer how vaccination-only would perform compared with proactive culling, TVR or no intervention in an untreated, relatively high-prevalence Northern Ireland badger population. [261]

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[258] Budgey, R. and Bird, M. (2026), 'A simulation model to predict the most efficient way to utilise operational resources when vaccinating badgers against bTB', *PLoS ONE*, 21(7), e0354329, https://doi.org/10.1371/journal.pone.0354329.

[259] DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, section 'Badger vaccination – Vaccine field trials and deployment'; DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, 'Badger vaccination'.

[260] Martin, S.W., O'Keeffe, J., Byrne, A.W., Rosen, L.E., White, P.W. and McGrath, G. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (*Meles meles*) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland? A practical non-inferiority wildlife intervention study in the Republic of Ireland (2011–2017)', *Preventive Veterinary Medicine*, 179, 105004, https://doi.org/10.1016/j.prevetmed.2020.105004.

[261] Martin et al. (2020); DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger vaccination'; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–32.

DAERA's scientific opinion itself characterises the evidence as **h**ighly context-dependent and notes that ongoing analysis of the Republic of Ireland's large-scale vaccination programme is required to determine its actual effectiveness. [262]

There is therefore a stronger direct cattle-outcome evidence base for vaccination than exists for TVR, but it addresses a narrower and more specific policy question than might initially appear: whether vaccination can replace continuing targeted removal following previous infection reduction, rather than whether vaccination-only can rapidly suppress cattle bTB when introduced into a previously unmanaged wildlife reservoir. [263]

Recent international guidance provides a useful additional benchmark. WOAH's 2024 guidance on MTBC control recognises wildlife vaccination as a potentially valuable component of disease management, but states that, where bTB is endemic in a wildlife reservoir, a vaccination-only programme is not recommended and identifies vaccination combined with targeted removal as potentially improving the prospects for eventual disease elimination. [264] This is general international guidance rather than badger-specific field evidence and should not be interpreted as demonstrating the relative efficacy of particular interventions under Northern Ireland conditions. It is nevertheless consistent with the wider evidence that vaccination is slow to act where infection is already established and that its role may differ according to starting prevalence and whether infection pressure has first been reduced through removal. [265]

AgriSearch assessment

AgriSearch considers that there is strong biological and field evidence that BCG vaccination reduces badger susceptibility to *M. bovis* infection and can generate indirect protection within badger populations. There is also meaningful cattle-outcome evidence from the Republic of Ireland showing that, in most of the areas studied, replacing continuing targeted culling with vaccination was not associated with an unacceptable increase in cattle herd breakdown incidence. [266]

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[262] DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger vaccination'; see also DAERA (2025a), *Annotated scientific bibliography*, 'Vaccine field trials and deployment'.
[263] Martin et al. (2020); Doyle, L.P., Gordon, A.W., Molloy, C., et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151; DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 6.
[264] World Organisation for Animal Health (WOAH) (2024), Guidelines for the control of Mycobacterium tuberculosis complex in livestock: Beyond test and slaughter, Paris: WOAH, section 3.2.1.1, pp. 24–25, https://doi.org/10.20506/woah.3538.
[265] DAERA (2025b), Scientific Opinion, Annex VII, Scientific Opinion Conclusion 4 and Opinion Summary; DAERA (2026), Consultation on Potential Wildlife Intervention Options, Chapter 8.
[266] Carter, S.P. et al. (2012), 'BCG vaccination reduces risk of tuberculosis infection in vaccinated badgers and unvaccinated badger cubs', PLoS ONE, 7(12), e49833; Gormley, E. et al. (2017), 'Oral vaccination of free-living badgers (Meles meles) with Bacille Calmette–Guérin (BCG) vaccine confers protection against

However, the context in which that evidence was generated is critical. The principal Irish studies were undertaken in populations that had already experienced several years of badger removal and therefore cannot be assumed to represent the starting conditions that would apply to vaccination-only in Northern Ireland. [267]

The major scientific uncertainty is consequently not whether BCG vaccination has value, but how quickly and to what extent vaccination-only could reduce cattle disease where badger infection is already established at substantial prevalence and no preceding population reduction has taken place. [268]

The available evidence indicates that vaccination does not remove existing infection, requires sustained high coverage over multiple years, and is sensitive to starting prevalence and badger density. Modelling supports a population-level effect, but coverage thresholds and predicted outcomes remain context-dependent and some models indicate that vaccination combined with existing cattle controls may not be sufficient to achieve eradication without additional measures. [269]

On the evidence presently available, AgriSearch therefore considers that vaccination has a particularly strong evidence base as a long-term disease-control measure and as a potential post-removal or maintenance strategy. The evidence for using vaccination-only as the initial intervention in a previously untreated, high-infection-pressure Northern Ireland area is less direct, and its likely speed of effect and consequent cattle-level benefit remain more uncertain. [270]

This does not preclude vaccination-only from being appropriate in areas with different starting conditions, for example where badger infection prevalence is already low. It reinforces the broader conclusion from Section 3.5 that the choice of intervention

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tuberculosis', PLoS ONE, 12(1), e0168851; Gormley, E. et al. (2022), 'Protective immunity against tuberculosis in a free-living badger population vaccinated orally with Mycobacterium bovis Bacille Calmette–Guérin', Transboundary and Emerging Diseases, 69(4), e10–e19; Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (Meles meles) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland?', Preventive Veterinary Medicine, 179, 105004.

[267] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, 'Badger vaccination' and Opinion Summary; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–32; Martin et al. (2020); Gormley et al. (2017).

[268] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 4 and Opinion Summary; DAERA (2024), *CVO Review*, pp. 31–32 and 62–64.

[269] Aznar, I. et al. (2018), 'Quantification of *Mycobacterium bovis* transmission in a badger vaccine field trial', *Preventive Veterinary Medicine*, 149, 29–37; Chang, Y. et al. (2025), 'Evaluating the effectiveness of badger vaccination combined with cattle test-and-removal in managing Bovine Tuberculosis: Insights from a two-host and multi-route transmission model', *Preventive Veterinary Medicine*, 235, 106386; Budgey, R. and Bird, M. (2026), 'A simulation model to predict the most efficient way to utilise operational resources when vaccinating badgers against bTB', *PLoS ONE*, 21(7), e0354329; DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 8.

[270] DAERA (2025b), Scientific Opinion, Annex VII, Scientific Opinion Conclusions 4 and 7 and Opinion Summary; Martin et al. (2020); DAERA (2024), CVO Review, pp. 30–32.

should take account of local starting prevalence, population density, cattle epidemiology and the speed with which disease reduction is required, rather than treating any one intervention as uniformly appropriate across Northern Ireland.

AgriSearch does not consider that the current evidence provides a strong basis for vaccination-only as the initial wildlife intervention in an area where a substantial burden of infection is already established in the badger population. Vaccination does not remove existing infected animals and is expected to act progressively over a prolonged period. Its role is therefore likely to be most valuable once infection pressure has first been reduced through an intervention incorporating removal, or potentially in areas where surveillance demonstrates sufficiently low infection pressure for vaccination to provide an appropriate means of maintaining or consolidating disease control. [271]

Where vaccination is used in that subsequent or lower-infection setting, AgriSearch does not consider that the available evidence requires a blanket preference for either baited cages or stopped restraints as the sole capture method. The more important operational requirement is the ability to achieve and sustain the necessary population coverage over the required period. Cage trapping has direct Northern Ireland operational precedent and can capture badgers across age and size classes, but requires pre-baiting, substantial labour and equipment and is affected by cage-shyness. Stopped restraints can be deployed with less preparation and have extensive operational precedent in the Republic of Ireland, but are less effective for smaller, younger badgers. [272]

Whichever method, or combination of methods, is used should therefore be judged against common requirements: appropriately trained and competent operators; compliance with welfare and licensing requirements; prompt checking; appropriate procedures for non-target captures; reliable marking and recording of vaccinated animals; monitoring of repeat capture and revaccination; and evidence that the intended population coverage is actually being achieved. Where one method alone cannot deliver the required coverage efficiently and acceptably, the programme should retain flexibility to use methods in combination.

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[271] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 4 and Opinion Summary; DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 8; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 62–64. DAERA concludes that vaccination is slow to act and less effective where infection prevalence is high unless preceded by a reduction in infection pressure, and identifies vaccination as potentially more suitable as an exit strategy following an intervention incorporating removal.

[272] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, Chapter 8, sections 8.a–8.b; DAERA (2026), *Strategic Environmental Assessment*, Annex IV, sections 2.7.2.6.1–2.7.2.6.2. DAERA estimates first-year cage capture at approximately 55% based on the Northern Ireland TVR experience and reports approximately 56–58% annual capture using stopped restraints in the Republic of Ireland. The two methods have different operational and age-related capture characteristics.

The proposal to enable trained and licensed lay vaccinators should be considered separately from the choice and sequencing of wildlife intervention. AgriSearch supports in principle the development of an appropriately regulated lay-vaccination capacity in Northern Ireland. Such capacity could become particularly important where vaccination is used to maintain or consolidate reductions in wildlife infection achieved through an earlier intervention, or where local epidemiological evidence supports vaccination as an appropriate intervention. Enabling that capacity now would help ensure that workforce availability does not become a constraint if and when vaccination is required at greater scale.

Any such arrangement should retain clear requirements for approved training and demonstrated competence, appropriate licensing, veterinary prescription and direction, animal-welfare and biosecurity standards, reliable recording and quality assurance. Support for enabling lay vaccination should not be interpreted as AgriSearch endorsing vaccination-only as the preferred initial wildlife intervention. Nor should it be interpreted as support for extending lay authority to other veterinary procedures associated with TVR, such as anaesthesia, diagnostic blood sampling and testing or euthanasia, which should remain subject to the appropriate professional requirements.

5.4 Sequenced or adaptive approaches

The three principal intervention approaches considered in the consultation are generally presented as discrete options. In practice, however, wildlife intervention need not involve selecting one method and applying it unchanged for an indefinite period. A scientifically plausible, and explicitly recognised by DAERA, alternative is a sequenced or adaptive approach. In a sequenced approach, an intervention containing a removal component may initially be used to reduce infection pressure, followed by vaccination as prevalence falls; in an adaptive approach, the intervention may be modified in response to surveillance, epidemiological evidence and measured outcomes. In practice, the two approaches may overlap, with a planned progression towards vaccination but the timing and nature of transition determined by evidence collected during implementation. [273]

There is a clear biological rationale for such an approach. As discussed in Sections 5.1–5.3, interventions containing a removal component can reduce the infection pressure more rapidly, whereas vaccination provides a non-lethal means of progressively

[273] DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 64–65; Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Václavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', Ecological Solutions and Evidence, 3(4).

protecting the remaining and newly recruited susceptible population. DAERA's scientific opinion consequently concludes that vaccination is likely to be slower and less effective where starting prevalence is high unless preceded by a reduction in infection pressure through culling or selective removal. It identifies vaccination as potentially more appropriate as a long-term or exit strategy following an intervention containing a removal component. [274]

Evidence supporting sequencing

The clearest real-world example comes from the Republic of Ireland. Badger management there initially relied extensively on targeted removal. Following several years of culling, a well-controlled non-inferiority study found that replacing targeted culling with vaccination was not inferior in most, although not all, trial areas. This evidence contributed to a wider transition towards large-scale vaccination, while retaining the ability to undertake targeted removal in disease hotspot areas. [275]

The Irish experience does not provide a direct field trial of a predetermined sequence of proactive culling followed by vaccination. Nevertheless, it provides practical evidence that a transition from removal towards vaccination can be made after infection pressure has previously been reduced, while maintaining targeted removal as an option where epidemiological circumstances warrant it. [276]

Mathematical modelling provides additional support for the general concept. The CVO Review reports modelling in which cattle herd breakdowns and badger infection prevalence were reduced more effectively where a proactive intervention was introduced before transition to vaccination or continued removal. Without that initial

[274] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusions 4 and 7 and Opinion Summary; DAERA (2024), *CVO Review*, pp. 62–65; Smith, G.C. and Budgey, R. (2021), 'Simulating the next steps in badger control for bovine tuberculosis in England', *PLoS ONE*, 16(3), e0248426; Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (*Meles meles*) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland?', *Preventive Veterinary Medicine*, 179, 105004.

[275] Martin, S.W., O'Keeffe, J., Byrne, A.W., Rosen, L.E., White, P.W. and McGrath, G. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (*Meles meles*) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland? A practical non-inferiority wildlife intervention study in the Republic of Ireland (2011–2017)', *Preventive Veterinary Medicine*, 179, 105004; Ryan, E., Breslin, P., O'Keeffe, J., Byrne, A.W., Wrigley, K. and Barrett, D. (2023), 'The Irish bTB eradication programme: combining stakeholder engagement and research-driven policy to tackle bovine tuberculosis', *Irish Veterinary Journal*, 76(Suppl 1), 32; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger vaccination'; DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, section 5.7.

[276] Martin et al. (2020); Ryan et al. (2023); DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–32; DAERA (2025a), *Annotated scientific bibliography*, 'Badger vaccination'.

reduction in infection pressure, vaccination-only required substantially longer to achieve comparable effects. [277]

The earlier DAERA scientific assessment similarly identified options involving non-selective culling, selective removal or enhanced TVR **followed by vaccination-only** as scientifically plausible intervention pathways. [278]

Taken together, the evidence therefore provides a reasonable scientific basis for the broad sequence:

reduce existing infection pressure → transition towards vaccination → maintain surveillance and adapt where necessary. [279]

The evidence is considerably less certain, however, about the precise intervention that should be used initially, the point at which transition should occur, or whether the same sequence would be appropriate in every intervention area. [280]

An adaptive approach

An adaptive approach goes further than a predetermined sequence by allowing the intervention to change in response to evidence collected during implementation. [281]

The CVO Review proposes one possible Northern Ireland model in which TVR is undertaken during the first year. The resulting information on badger density and the density of DPP test-positive badgers could then be used to differentiate subsequent interventions between sub-areas. Areas with relatively high numbers of test-positive animals might continue with TVR or move to proactive culling, while lower-prevalence areas could move towards vaccination-only. Annual review could subsequently allow

[277] Smith, G.C. and Budgey, R. (2021), 'Simulating the next steps in badger control for bovine tuberculosis in England', *PLoS ONE*, 16(3), e0248426, https://doi.org/10.1371/journal.pone.0248426; DAERA (2024), *CVO Review*, pp. 63–64.
[278] DAERA (2025b), *Scientific Opinion*, Annex VII, Annex 1: *Scientific Opinion on the Available Evidence on Badger Intervention* (30 August 2019), section 5 'Options', particularly option (v), and 'Summary on Options ii–iv followed by vaccination'.
[279] DAERA (2025b), *Scientific Opinion*, Scientific Opinion Conclusion 7 'Hybrid strategies are conceptually strong'; DAERA (2024), *CVO Review*, pp. 64–65; Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Václavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192.
[280] DAERA (2025b), Scientific Opinion, Annex VII, Annex 1, 'Summary on Options ii–iv followed by vaccination'; DAERA (2024), CVO Review, pp. 63–65.
[281] Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Václavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 64–65; DAERA (2026), *Strategic Environmental Assessment*, Annex IV, section 2.7.2.

vaccination to be extended into removal areas, or removal to be reconsidered where disease indicators deteriorate. [282]

The proposal has a coherent epidemiological rationale. It recognises the spatial heterogeneity discussed in Section 3 and attempts to match intervention intensity to local infection pressure rather than imposing one approach uniformly across an entire area. First-year TVR would also have the immediate effect of removing detected test-positive animals while vaccinating part of the remaining population. The resulting surveillance information could potentially provide a more informed basis for subsequent intervention than relying solely on historic population estimates or NI-wide prevalence averages. [283]

This approach is also consistent with DAERA's wider conclusion that there is no one-size-fits-all solution and that effective policy needs to be capable of responding to local conditions. [284]

The scientific opinion also cautions, however, that this particular adaptive strategy has not yet been trialled as an integrated intervention and does not currently have direct modelling or field evidence demonstrating its cattle-level outcome. [285]

The evidential limitations of the proposed hybrid model

The distinction established in Section 4 is particularly important here. There is a difference between the general scientific logic of sequencing interventions and evidence that a particular adaptive programme will achieve the intended cattle disease outcome. [286]

DAERA explicitly acknowledges that the specific CVO hybrid proposal is novel, has not previously been deployed and has no modelling or field-data support in its proposed integrated form. For this reason, the adaptive hybrid option was included among the

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[282] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 64–65, section 'Alternative Next Steps'. The CVO proposes first-year TVR to estimate apparent *M. bovis* prevalence and the density of DPP-positive badgers, followed by differentiated intervention between sub-areas: proactive culling or continued TVR where DPP-positive density is relatively high and vaccination-only in lower-risk areas, with annual review allowing subsequent modification.
[283] DAERA (2024), *CVO Review*, pp. 64–65; Menzies, F.D. et al. (2021), 'Test and vaccinate or remove: methodology and preliminary results from a badger intervention research project', *Veterinary Record*, 189, e248; Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (*Meles meles*)', *PLoS ONE*, 16(1), e0246141.
[284] DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, Scientific Opinion Conclusions 7 and 9 and Opinion Summary; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, Box 1b.
[285] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary.
[286] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary.

wider range of approaches considered but was not shortlisted in the current options analysis; DAERA concluded that its design would require substantial further exploratory work. [287]

DAERA's scientific opinion similarly describes hybrid strategies as "conceptually strong", while stating that the particular flexible TVR-led approach has neither field-trial nor modelling support in its proposed form. [288]

This qualification is important. Evidence supporting culling followed by vaccination, the Northern Ireland TVR findings, and evidence that disease prevalence varies spatially can reasonably be combined to generate a scientific hypothesis that adaptive management may be effective. They do not demonstrate that the proposed combination, sequence, geographical subdivision or decision rules will necessarily produce better cattle outcomes than one of the established interventions.

The evidential basis for the proposed hybrid model is therefore one of scientific plausibility and evidence supporting its individual components, rather than demonstrated efficacy of the integrated strategy itself. [289]

The importance of predefined monitoring and transition criteria

"If a sequenced or adaptive approach were adopted, AgriSearch considers that its credibility would depend heavily on establishing clear objectives, monitoring measures and predefined decision criteria before implementation begins." [290]

For example, DAERA would need to define which measures would determine whether an area should continue with removal, transition to vaccination or require renewed intervention. Relevant indicators could include:

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[287] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, 'Hybrid strategy'; DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary. Annex VIII records that the hybrid option was included in the long list but was not shortlisted at this stage because it would be novel, its design complex and significant further exploratory work would be required. Annex VII states that the adaptive strategy has not yet been trialled and has no modelling or field-data support, and that the concept has not previously been deployed or subjected to detailed specific modelling.
[288] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary.
[289] Smith, G.C. and Budgey, R. (2021), 'Simulating the next steps in badger control for bovine tuberculosis in England', PLoS ONE, 16(3), e0248426; Menzies, F.D. et al. (2021), 'Test and vaccinate or remove: methodology and preliminary results from a badger intervention research project', Veterinary Record, 189, e248; Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (Meles meles)', PLoS ONE, 16(1), e0246141; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 63–65; DAERA (2025b), Scientific Opinion, Annex VII, Scientific Opinion Conclusions 4, 6 and 7.
[290] Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Václavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192; DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, section 'Reactive badger culling'.

- badger infection prevalence, test positivity and/or density of test-positive animals;
- estimated badger population density;
- achieved trapping/removal/vaccination coverage;
- cattle herd incidence and recurrent breakdown patterns;
- WGS and other epidemiological evidence on transmission;
- immigration or recolonisation from neighbouring badger populations; and
- the duration over which trends would need to be observed before a change in strategy was made. [291]

The need for this is recognised elsewhere in DAERA's supporting assessments. The Strategic Environmental Assessment records that DAERA proposes continuous review of wildlife intervention, with any approach following the initial period to be informed by surveillance data, disease trends and emerging scientific evidence. It also notes that culling may be followed by vaccination as an exit strategy depending on the local disease situation, while recommending further clarification of how interim monitoring and review would operate. [292] Without predefined criteria, an “adaptive” policy could risk becoming an intervention whose direction changes largely through judgement after the event. By contrast, a genuinely evidence-led adaptive programme would establish the objectives, measures, review intervals and decision thresholds in advance, while retaining the flexibility to respond to new evidence. [293]

There would also need to be adequate surveillance to detect whether the intervention was working. This reinforces the importance of contemporary population estimates, geographically resolved infection information and reliable cattle epidemiological data discussed in Section 3.

AgriSearch assessment

AgriSearch considers that there is a strong scientific rationale for considering sequenced wildlife rather than assuming a single method should necessarily be maintained over the long term. Where infection pressure is high, an intervention

[291] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 64–65; Smith et al. (2022); DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusions 7 and 9. See also Sections 3.3–3.5 and 7 of this review for the evidence relating to badger infection prevalence, population density, WGS, cattle epidemiology and intervention coverage.
[292] DAERA (2026), *Strategic Environmental Assessment*, Annex IV, sections 2.7.2.1.2 and 8.2.1–8.2.2, including Table 8-1.
[293] Smith et al. (2022); DAERA (2025a), *Annotated scientific bibliography*, p. 23; DAERA (2024), *CVO Review*, pp. 64–65.

containing a removal component may provide a more rapid initial reduction in infected animals, while vaccination offers a plausible longer-term means of maintaining reduced infection pressure without continuing substantial removal indefinitely. Experience in the Republic of Ireland and mathematical modelling provide support for this general principle. [294]

An adaptive approach goes further by allowing the intervention, its geographical application or the timing of transition to respond to local prevalence, population density and transmission evidence. This is consistent with the substantial spatial heterogeneity identified elsewhere in the evidence base and with DAERA's own conclusion that there is no one-size-fits-all solution to wildlife intervention. [295] However, AgriSearch considers it important to distinguish this general principle from the specific adaptive hybrid intervention proposed in the CVO Review. That proposal is scientifically plausible and draws on evidence supporting its individual components, but the integrated strategy has not itself been field-tested and DAERA acknowledges that it has no direct modelling or field-data support in its proposed form. It should therefore be described as a conceptually promising approach requiring further development and evaluation rather than as an established intervention with demonstrated efficacy. [296] If DAERA wishes to develop a sequenced or adaptive approach further, AgriSearch considers that this would warrant specific modelling using contemporary Northern Ireland population and prevalence parameters, clear objectives and predefined criteria for continuation, transition or renewed intervention, robust baseline and ongoing surveillance, and transparent evaluation of cattle as well as badger outcomes. [297]

The ultimate objective should not simply be to select between culling, TVR and vaccination at the outset, but to establish an intervention pathway capable of reducing infection pressure sufficiently quickly, transitioning towards less removal-intensive intervention where the evidence permits, and responding if disease indicators subsequently deteriorate.

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[294] Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (*Meles meles*) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland?', *Preventive Veterinary Medicine*, 179, 105004; Smith, G.C. and Budgey, R. (2021), 'Simulating the next steps in badger control for bovine tuberculosis in England', *PLoS ONE*, 16(3), e0248426; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–32 and 62–65; DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Scientific Opinion Conclusions 4 and 7.

[295] DAERA (2024), *CVO Review*, pp. 64–65; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Transmission dynamics', 'Modelling' and Scientific Opinion Conclusions 7 and 9.

[296] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary; DAERA (2024), *CVO Review*, pp. 64–65.

[297] Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Václavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192; DAERA (2024), *CVO Review*, pp. 64–65; DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusions 7 and 9.

Overall scientific evidence position

Taken together, the evidence indicates that each of the principal wildlife intervention approaches has a scientific basis. However, the nature, strength and directness of the evidence differ materially between interventions and between the outcomes being considered. Evidence of biological effect, badger-level disease response, operational feasibility, modelled cattle benefit and directly observed cattle herd-incidence effects should therefore not be treated as interchangeable. [298] Proactive non-selective culling has the strongest direct replicated field evidence among the principal options for reducing cattle bTB herd incidence. However, the magnitude of benefit is not fixed and the evidence also demonstrates that intervention design matters. Scale, duration, population estimation, coverage, boundaries, neighbouring areas, perturbation risk and concurrent cattle controls can materially affect the outcome. [299] TVR has strong Northern Ireland-specific evidence of operational feasibility and encouraging badger-level outcomes. A substantial decline in estimated badger M. bovis prevalence was observed during the intervention, and the selective removal intensity used did not produce evidence of a broad sustained increase in badger ranging behaviour or major disruption of social organisation. However, the prevalence decline occurred within a single intervention area without replicated untreated controls and with removal and vaccination applied simultaneously, so the full decline cannot be attributed causally to TVR without qualification. The Northern Ireland project did not demonstrate a causal reduction in cattle herd incidence, and expectations of cattle-level benefit therefore rely to a greater extent on biological plausibility and modelling. [300] Vaccination has strong biological and field evidence of reducing badger susceptibility to M. bovis and can generate indirect protection within badger populations. There is also meaningful direct cattle-outcome evidence from the Republic of Ireland, but this principally supports vaccination following previous reduction of infection pressure through badger removal.

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[298] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Scientific Opinion Conclusions 4–7 and Opinion Summary; DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*.

[299] Donnelly, C.A., Woodroffe, R., Cox, D.R., et al. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', *Nature*, 439, 843–846; Griffin, J.M., Williams, D.H., Kelly, G.E., et al. (2005a), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', *Preventive Veterinary Medicine*, 67, 237–266; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Proactive Culling' and Scientific Opinion Conclusion 5; DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, particularly the discussion of perturbation, scale and boundaries.

[300] Menzies, F.D. et al. (2021), 'Test and vaccinate or remove: methodology and preliminary results from a badger intervention research project', *Veterinary Record*, 189, e248; Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (*Meles meles*)', *PLoS ONE*, 16(1), e0246141; O'Hagan, M.J.H. et al. (2021), 'Effect of selective removal of badgers (*Meles meles*) on ranging behaviour during a "Test and Vaccinate or Remove" intervention in Northern Ireland', *Epidemiology and Infection*, 149, e125; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151; DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 6.

The evidence for vaccination-only as the initial intervention in a previously unmanaged Northern Ireland badger population with substantial existing infection pressure is less direct, and its likely speed of cattle-level benefit remains uncertain. The available evidence therefore provides a particularly strong rationale for vaccination as a long-term, post-removal or maintenance intervention, while leaving greater uncertainty around vaccination-only as the initial response in higher-prevalence areas. [301] There is also a credible scientific rationale for sequenced intervention, particularly where an initial reduction in infection pressure is followed by vaccination and ongoing surveillance. An adaptive approach may additionally allow intervention to respond to local prevalence, population density and transmission evidence. The broader principle of sequencing is supported by field experience and modelling, but it should be distinguished from the specific flexible hybrid model proposed in the CVO Review. DAERA itself describes that model as conceptually strong but acknowledges that the integrated strategy has not yet been field-tested and has no direct modelling or field-data support in its proposed form. [302] The evidence therefore does not support reducing the policy choice to a simple ranking of interventions independent of context. Starting badger infection prevalence, population density and spatial distribution, achievable coverage, local cattle and badger transmission dynamics, intervention scale and boundaries, diagnostic performance where relevant, concurrent cattle controls and the required speed of disease reduction can all influence likely performance. Where sequenced or adaptive approaches are considered, predefined monitoring and transition criteria are also required. These factors should be considered consistently when comparing the available options and when determining whether different approaches may be appropriate in different areas or at different stages of an eradication programme. [303]

[301] Carter, S.P. et al. (2012), 'BCG vaccination reduces risk of tuberculosis infection in vaccinated badgers and unvaccinated badger cubs', *PLoS ONE*, 7(12), e49833; Gormley, E. et al. (2017), 'Oral vaccination of free-living badgers (*Meles meles*) with Bacille Calmette–Guérin (BCG) vaccine confers protection against tuberculosis', *PLoS ONE*, 12(1), e0168851; Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (*Meles meles*) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland?', *Preventive Veterinary Medicine*, 179, 105004; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–32 and 62–64; DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 4.

[302] Martin et al. (2020); Smith, G.C. and Budgey, R. (2021), 'Simulating the next steps in badger control for bovine tuberculosis in England', *PLoS ONE*, 16(3), e0248426; Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Václavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192; DAERA (2024), *CVO Review*, pp. 64–65; DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary.

[303] DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger Ecology', 'Transmission dynamics', 'Modelling' and Scientific Opinion Conclusions 3, 7 and 9; DAERA (2024), *CVO Review*, pp. 64–65; Smith et al. (2022).

6. Consistency in DAERA's interpretation and presentation of the evidence

DAERA has assembled a substantial scientific evidence base and, in many places, its supporting documents explicitly recognise important limitations and uncertainties. The Scientific Opinion, for example, acknowledges that proactive culling has direct field evidence of cattle benefit; that the Northern Ireland TVR project had no replicate intervention or control areas and did not demonstrate an impact on cattle herd incidence; that the most relevant vaccination evidence from the Republic of Ireland is highly context-dependent; and that mathematical models are abstractions rather than field trials. It also concludes that vaccination-only is likely to act more slowly in areas of high infection prevalence and may be more suitable following an intervention containing a removal component. [304]

AgriSearch does not seek to draw conclusions about the intent behind the way in which the evidence has been presented. The relevant question for this assessment is whether the level of qualification, evidential weight and interpretive emphasis remains consistent as evidence of different types and strengths is carried through from the scientific review into the comparative options analysis and consultation narrative.

6.1 Field evidence and modelling

The clearest difference between the intervention options concerns the directness of evidence relating to cattle outcomes.

As discussed in Section 5, proactive non-selective culling is supported by replicated field evidence in which cattle herd incidence was an observed outcome. DAERA's earlier scientific opinion itself described this as a "relatively strong evidence base" based on two independent controlled field trials. [305]

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[304] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly pp. 3–9. The Scientific Opinion records that most proactive-culling studies report beneficial effects in cattle and badgers; that the NI TVR project lacked replicate and control areas and that cattle-incidence analysis did not demonstrate an impact; that the principal Irish vaccination evidence is highly context-dependent because of preceding culling; and that mathematical models are context-dependent, highly abstracted constructs rather than field trials. Scientific Opinion Conclusions 4–6 and the Opinion Summary further state that vaccination-only is slower to act at high prevalence and may be more appropriate as an exit strategy following an intervention with a removal component.

[305] DAERA (2019), *Scientific Opinion on the Available Evidence on Badger Intervention*, reproduced in DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Annex 1, 'Summary points of the scientific evidence – Proactive culling', points 5–6. DAERA states that multi-annual proactive culling is the only intervention

TVR has valuable Northern Ireland field evidence, but this relates primarily to operational feasibility, badger infection indicators and behaviour. The updated Scientific Opinion explicitly states that the Northern Ireland project did not demonstrate an impact on cattle herd incidence. Vaccination has strong badger-level evidence and some direct cattle-outcome evidence from the Republic of Ireland, but the direct cattle-outcome evidence arose largely in areas previously subjected to badger culling. [306]

Despite these differences, the options analysis necessarily relies on the same APHA model to compare the likely cattle effects of culling, TVR and vaccination. Under the no-perturbation scenario used in the main analysis, Annex VIII derives average modelled herd breakdowns avoided of approximately 7.5 for non-selective culling, 7.3 for TVR and 2.3 for vaccination per 100 km^2 per year over a nine-year benefit period. [307] DAERA does acknowledge that this modelling was undertaken in 2019, reflects cattle disease levels at that time, assumes a four-year initial intervention followed by three years of vaccination rather than the five-year intervention now proposed, and is being used primarily to indicate relative performance. [308]

AgriSearch considers modelling entirely appropriate for exploring intervention options where direct field evidence is incomplete. The concern is that modelled outcomes should remain visibly distinguishable from observed outcomes throughout the subsequent analysis. A modelled prediction that TVR could produce a similar cattle outcome to culling should not acquire the same evidential status as cattle outcomes observed during replicated field trials simply because both appear subsequently as numerical estimates in the same tables.

Northern Ireland's TVR experience provides a useful illustration of the distinction between modelled and demonstrated outcomes. Pre-study modelling projected potentially substantial reductions in cattle herd breakdowns under some TVR scenarios, particularly where selective removal did not generate perturbation; where perturbation was assumed, benefits were substantially reduced and short-term adverse

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with published field evidence of reduced cattle bTB incidence and describes the evidence base as "relatively strong" on the basis of two independent controlled field trials.

[306] DAERA (2025b), *Scientific Opinion*, Annex VII, sections 'Test and Vaccinate or Remove (TVR)' and 'Badger vaccination', and Scientific Opinion Conclusions 4 and 6; Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (*Meles meles*) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland?', *Preventive Veterinary Medicine*, 179, 105004.

[307] DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, paras 5.3.12–5.3.25, particularly Table 7 and Table 8; Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*, APHA National Wildlife Management Centre.

[308] DAERA (2026b), Annex VIII, paras 5.3.6 and 5.3.12–5.3.21; Budgey and Smith (2019). DAERA notes that the model was undertaken in 2019, reflects cattle disease levels at that time, models a four-year initial intervention followed by three years of vaccination rather than the five-year intervention now proposed, and should be used principally to indicate the relative performance of the options rather than as a prediction.

effects were possible. The subsequent field project did not demonstrate a causal reduction in cattle herd incidence, but neither was it designed as a definitive replicated controlled cattle-outcome trial. This should not be interpreted simply as the model having been 'wrong'. Rather, it demonstrates why model projections and field-observed outcomes should remain distinct evidential categories, with their respective assumptions and study limitations clearly stated. [309]

This distinction becomes particularly important when model outputs are used not only to compare scientific performance but also to derive economic benefits, cattle-welfare estimates, GHG-related environmental scores, human-welfare estimates and, ultimately, overall option rankings. [310] AgriSearch considers that DAERA should therefore clearly identify throughout the appraisal whether each claimed benefit is observed, modelled or inferred.

AgriSearch welcomes DAERA's publication during the consultation of the underlying 2019 APHA modelling report. [311] Its release provides materially greater transparency around the assumptions, scenarios and limitations underlying numerical outputs already used in Annex VIII. [312] Given the role these outputs subsequently play in economic, welfare and comparative option assessments, AgriSearch considers that supporting technical material of this significance should, where practicable, be available alongside the main consultation documentation from the outset.

6.2 Treatment of uncertainty

Uncertainty is unavoidable in this field. The intervention options depend upon uncertain or locally variable parameters including badger density, infection prevalence, capture

[309] Smith, G.C., Budgey, R. and Delahay, R.J. (2013), A simulation model to support a study of Test and Vaccinate or Remove (TVR) in Northern Ireland, pp. 3, 15–17 and 22–24; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', Epidemiology and Infection, 151; DAERA (2025a), Annotated scientific bibliography, section 'Test and Vaccinate or Remove'; DAERA (2025b), Scientific Opinion, Annex VII, TVR section and Scientific Opinion Conclusion 6.

[310] DAERA (2026b), Annex VIII, para. 5.3.25 and Table 8 (economic benefits); paras 7.4.4–7.4.6 and Tables 22–25 (cattle welfare, GHG-related environmental impact and human welfare); and section 9.3 and Table 29 (overall option rankings).

[311] DAERA (2026d), 'Consultation on wildlife intervention options to tackle bTB in Northern Ireland extended', News Release, 3 September 2026, particularly Note to Editors 3. DAERA states that the previously unavailable Budgey and Smith (2019) report referenced within Annex VIII had now been made available on the consultation webpage.

[312] Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, APHA National Wildlife Management Centre, particularly the Executive Summary and Appendices A–B; DAERA (2026b), Annex VIII, paras 5.3.12–5.3.21 and the subsequent economic and non-monetary analyses drawing on the NI-parameterised model.

probability, diagnostic performance, transmission rates, intervention coverage and perturbation. [313]

DAERA acknowledges much of this uncertainty. Its Scientific Opinion cautions that modelling is context-dependent, that infection and transmission are heterogeneous and that generalisation between areas is difficult. Annex VIII similarly sets out a number of caveats surrounding the APHA model and explicitly recognises differences between the intervention represented in the model and the intervention currently proposed. [314] DAERA's own 2019 internal review of the APHA model expressed an even stronger caution. As reproduced in Annex VIII, the reviewers noted that the point estimates presented did not show the uncertainty surrounding them; that confidence intervals would likely be wide and could encompass the other options; and that, because of the large uncertainty surrounding the model outputs, statistically significant differences between the interventions and business as usual were unlikely. The reviewers therefore considered the model useful principally as a broad indication of relative performance rather than as a set of precise comparative predictions. [315]

Nevertheless, once model outputs are incorporated into subsequent analyses, the degree of uncertainty around them is not always as prominent as the point estimates themselves. For example, modelled herd breakdowns avoided are carried into calculations of economic benefit and estimates of cattle prematurely removed, even though Annex VIII explicitly states that the number of breakdowns that would be avoided in a Northern Ireland intervention area specifically as a result of badger intervention is not known. [316]

The 2019 APHA report does include an uncertainty analysis, but its scope should be understood carefully. For each specified scenario, the model was run 100 times and the analysis recorded how often each intervention produced the fewest unique OTW herd breakdowns. The authors describe this as a measure of the certainty that the nominally best-performing option was not simply in that position because of stochastic variation in the model. [317] This is not the same as a comprehensive parameter- or structural-uncertainty analysis. Some major uncertainties were explored through separate

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[313] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, 'Badger Ecology', 'Transmission dynamics' and 'Modelling'; DAERA (2026c), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, particularly paras 2.14.1–2.14.7.

[314] DAERA (2025b), *Scientific Opinion*, Annex VII, pp. 4–5; DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, paras 5.3.12–5.3.20.

[315] Hatch, M. and Anderson, H. (2019), *Follow up report on the National Wildlife Management Centre TB model outputs: DAERA veterinary and NIEA interpretation of the results*, p. 4, as quoted in DAERA (2026b), Annex VIII, para. 5.3.13 and footnote 85.

[316] DAERA (2026b), Annex VIII, paras 5.3.1–5.3.3 and 7.4.4.1–7.4.4.6, including Table 22.

[317] Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, APHA National Wildlife Management Centre, pp. 15–16 and Chart Appendix B, Table B6, p. 14.

scenarios, notably starting badger prevalence and the presence or absence of a full perturbation effect, while other inputs, including trapping performance, vaccine efficacy and other epidemiological parameters, were represented by specified values or assumptions. [318] The presence of an uncertainty analysis within the model report should therefore not be interpreted as resolving the broader uncertainty around the modelled cattle outcomes.

AgriSearch considers that this could give an impression of greater comparative certainty than the scientific evidence supports. Where modelled values materially affect option ranking or downstream benefit estimates, DAERA should present ranges or alternative plausible scenarios, particularly for parameters likely to vary materially under Northern Ireland conditions, including badger density and starting prevalence, achievable capture or coverage, diagnostic performance, perturbation assumptions and the expected duration of benefit.

6.3 Transferability to Northern Ireland

DAERA appropriately recognises that evidence generated elsewhere cannot automatically be transferred to Northern Ireland. The Scientific Opinion explicitly states that the vaccination evidence from the Republic of Ireland is context-dependent because the areas concerned had already experienced years of badger removal, while Northern Ireland has not followed the same historical intervention pathway. [319]

Earlier DAERA analysis also recognised that neither English nor Irish experience can simply be read across to Northern Ireland because of ecological and practical differences. [320]

AgriSearch agrees with this caution. However, the same transferability questions should be applied to all interventions. These should include:

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[318] This is not the same as a comprehensive parameter- or structural-uncertainty analysis. Some major uncertainties were explored through separate scenarios, notably starting badger prevalence and the presence or absence of a full perturbation effect, while other inputs, including trapping performance, vaccine efficacy and other epidemiological parameters, were represented by specified values or assumptions.

[319] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, 'Badger vaccination', pp. 4–5; see also DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–32. DAERA describes the principal Irish vaccination evidence as "highly context-dependent", noting that much of the landscape had previously been subject to reactive culling for several years, and questions direct generalisation to Northern Ireland, where badger culling has not previously been policy.

[320] DAERA (2019), *Scientific Opinion on the Available Evidence on Badger Intervention*, reproduced in DAERA (2025b), Annex VII, Annex 1, section 3 'Caveats', p. 11. DAERA states that, because there is no published evidence from a long-term badger intervention in Northern Ireland, most evidence derives from English and Irish experience, but that there "cannot be a direct read across" because ecological and practical differences create uncertainty around outcomes.

- the starting prevalence of infection;
- badger population density and spatial distribution;
- landscape and boundaries;
- farming systems and cattle movement;
- the previous history of wildlife intervention;
- achievable coverage; and
- concurrent cattle controls. [321]

The Four Area Trial is understandably used as an important real-world comparator for non-selective culling. Annex VIII explicitly acknowledges that no comparable large-scale replicated research trial of vaccination or TVR has been conducted in Great Britain or on the island of Ireland. For like-for-like comparison across the three principal interventions, DAERA therefore relies on modelled cattle outcomes, while culling can additionally be benchmarked against the RBCT and Four Area Trial field results. [322] The appropriate response to this evidential asymmetry is not to discount replicated culling evidence simply because it was generated elsewhere, nor to reject TVR or vaccination because comparable replicated trials do not exist. It is to identify transparently where transferability adds uncertainty, apply that scrutiny consistently across interventions, and reflect the resulting uncertainty in the confidence attached to each conclusion.

6.4 Perturbation

Perturbation provides a particularly useful example of the need for consistent treatment of evidence and uncertainty. [323]

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[321] DAERA (2025b), *Scientific Opinion*, Annex VII, sections 'Badger Ecology', 'Transmission dynamics', 'Badger vaccination' and 'Modelling'; DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII; DAERA (2024), *CVO Review*, pp. 30–32. DAERA identifies population size and spatial distribution, cattle movements, interspecies transmission, prior wildlife management, vaccination coverage and local epidemiological conditions as factors affecting the transferability or expected performance of intervention evidence.

[322] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, paras 5.3.28–5.3.30. DAERA states that benchmarking against large replicated trials can only be undertaken for proactive non-selective culling because no large-scale replicated research trial of vaccination or TVR has been conducted in Great Britain or on the island of Ireland; it identifies the RBCT and the Republic of Ireland Four Area Trial as the two relevant large-scale replicated proactive-culling studies. Annex VIII further notes that future Northern Ireland intervention areas will not have identical cattle and badger parameters to those historic studies, while describing Irish terrain as the most appropriate comparator.

[323] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Annex 1, 'Perturbation and the Perturbation Effect'.

DAERA properly recognises the adverse peripheral cattle effect observed during the RBCT, while also noting that a comparable effect was not demonstrated in the Republic of Ireland Four Area Trial and that intervention scale and hard boundaries may have contributed to this difference. Annex VIII therefore excludes perturbation from its principal economic analysis but includes a specific sensitivity scenario in which it is assumed to occur for non-selective culling. [324]

In that sensitivity analysis, perturbation is assumed **not** to occur under TVR because increased ranging behaviour was not observed during the Northern Ireland TVR pilot. When perturbation is applied to culling alone, the ranking changes materially and restraint-based TVR becomes the highest-ranked option on illustrative NPV in the core-area analysis. [325]

There is a scientific rationale for considering perturbation less likely under TVR: substantially fewer badgers are removed and the Northern Ireland field study did not identify sustained increased ranging under the conditions studied. AgriSearch does not therefore suggest that DAERA should assume an RBCT-scale perturbation effect under TVR. [326]

The newly published 2019 APHA modelling report adds important context to this issue. The authors state that there were no data with which to parameterise perturbation specifically for the relatively low level of removal expected under TVR, and no evidence at that stage to establish whether the effect should be treated as zero or comparable to that observed in the RBCT. [327] They therefore modelled both no-perturbation and full-perturbation scenarios. [328] The report also notes evidence that removal of relatively few animals may be sufficient to induce behavioural or social perturbation, while

[324] Donnelly, C.A., Woodroffe, R., Cox, D.R., et al. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', *Nature*, 439, 843–846; Griffin, J.M., Williams, D.H., Kelly, G.E., et al. (2005a), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', *Preventive Veterinary Medicine*, 67, 237–266; DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, paras 5.3.18 and 6.1.1–6.1.4.

[325] DAERA (2026b), Annex VIII, paras 6.1.4–6.1.6 and Table 10; see also section 9.3 and Table 29. O'Hagan, M.J.H., Gordon, A.W., McCormick, C.M., et al. (2021), 'Effect of selective removal of badgers (*Meles meles*) on ranging behaviour during a "Test and Vaccinate or Remove" intervention in Northern Ireland', *Epidemiology and Infection*, 149, e125.

[326] O'Hagan et al. (2021); Allen, A., Milne, G., McCormick, C., Collins, S., O'Hagan, M., Skuce, R., Trimble, N., Harwood, R., Menzies, F. and Byrne, A.W. (2022), 'European badger (*Meles meles*) responses to low-intensity, selective culling: using mark–recapture and relatedness data to assess social perturbation', *Ecological Solutions and Evidence*, 3(3), e12165; DAERA (2025b), *Scientific Opinion*, Annex VII, TVR section.

[327] Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, APHA National Wildlife Management Centre, p. 5.

[328] Budgey and Smith (2019), Executive Summary and pp. 3–5; see also Chart Appendices A–B.

recognising considerable uncertainty over whether the resulting epidemiological effect would be comparable in Northern Ireland. [329]

The later Northern Ireland field evidence provides a reasonable basis for assigning a lower probability of perturbation to TVR than to non-selective culling. It does not, however, remove the uncertainty identified by the APHA modellers. In the current appraisal, TVR is effectively assigned the no-perturbation endpoint, whereas non-selective culling is tested under both no-perturbation and full-perturbation assumptions. [330]

However, the evidential proposition is "no broad sustained perturbation was detected under the selective removal intensity and conditions of the Northern Ireland TVR study", rather than "TVR cannot generate perturbation under any deployment scenario". This distinction becomes more relevant if TVR is deployed in areas with higher infection prevalence, greater numbers of test-positive animals and consequently higher removal rates. [331]

It would therefore strengthen the appraisal to show the sensitivity of TVR outcomes to at least a modest alternative perturbation assumption, even if DAERA considers that scenario less probable than for non-selective culling.

AgriSearch also considers that behavioural perturbation and an adverse cattle epidemiological effect should be kept distinct. Evidence of increased badger movement does not automatically demonstrate increased cattle bTB, while failure to detect increased ranging does not by itself demonstrate the absence of any epidemiological effect. [332]

6.5 Lack of controlled cattle-outcome evidence

The Scientific Opinion deals relatively openly with the principal limitation of the Northern Ireland TVR study: it was conducted in a single area and analysis did not demonstrate a cattle herd-incidence effect. As noted in Section 5.2, this limitation was

[329] Budgey and Smith (2019), pp. 3–5 and 18–19; Bielby, J., Donnelly, C.A., Pope, L.C., Burke, T. and Woodroffe, R. (2014), 'Badger responses to small-scale culling may compromise targeted control of bovine tuberculosis', Proceedings of the National Academy of Sciences, 111, 9193–9198; DAERA (2025b), Scientific Opinion, Annex VII, Annex 1, 'Perturbation and the Perturbation Effect'.
[330] Budgey and Smith (2019), p. 5; DAERA (2026b), Annex VIII, paras 6.1.3–6.1.6 and the perturbation entries in the Non-Monetary Factor/Risk analysis.
[331] O'Hagan et al. (2021); Allen et al. (2022); DAERA (2025b), *Scientific Opinion*, Annex VII, TVR section; Budgey and Smith (2019), pp. 3–5.
[332] DAERA (2025b), *Scientific Opinion*, Annex VII, Annex 1, 'Perturbation and the Perturbation Effect'; More, S.J. (2016), *Scientific peer review of the TBSPG scientific appraisal*, discussion of social perturbation and the perturbation effect; O'Hagan et al. (2021).

recognised by the TB Eradication Partnership before publication of the subsequent TVR results. [333]

The language used later in the options analysis is sometimes more positive. TVR receives the lowest weighted risk score among the "do something" options, 480, compared with 490 for non-selective culling and 550 for vaccination, partly because modelling suggests that it could deliver a disease-control impact similar to non-selective culling while removing fewer badgers and presenting lower biodiversity and ecosystem risk. [334] [335] Similarly, describing TVR as showing "promise" is reasonable and consistent with the available evidence. The key is that the qualification, cattle benefit remains to be demonstrated directly. [336]

6.6 Speed of effect

DAERA's scientific documents recognise speed of effect as a material difference between the interventions. The Scientific Opinion concludes that interventions involving a lethal component tend to provide a faster bTB response than vaccination-only and that vaccination-only may require many years of sustained high coverage. [337]

The options analysis also reflects this through its risk assessment. For the risk of failing to support progress towards bTB eradication in a timely manner, all shortlisted culling and TVR options receive a Medium rating, while vaccination-only receives a Very High rating. [338] AgriSearch considers the higher timeliness risk assigned to vaccination-only

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[333] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, TVR section and Scientific Opinion Conclusion 6; Northern Ireland TB Eradication Partnership (2019), *Advice on Bovine Tuberculosis in Northern Ireland, May 2018–June 2019*, pp. 22–24; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151.

[334] DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, section 8.3 and Tables 27–28. DAERA assigns TVR options a weighted risk score of 480, compared with 490 for non-selective culling and 550 for vaccination, explaining that TVR scores better overall because modelling suggests a disease-control impact similar to non-selective culling but with lower biodiversity/ecosystem risk from removing fewer badgers.

[335] DAERA (2026b), Annex VIII, sections 8.1–8.3 and Table 27; DAERA (2026b), Annex VIII, paras 5.3.28–5.3.29; DAERA (2025b), *Scientific Opinion*, Annex VII, TVR section and Scientific Opinion Conclusion 6.

[336] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 6; DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, TVR section; Doyle et al. (2023).

[337] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, concluding remarks and Scientific Opinion Conclusion 4 and Opinion Summary. DAERA concludes that modelling generally indicates that interventions involving a lethal component provide a faster bTB response than vaccination-only, and that vaccination-only in areas where infection is endemic is likely to require sustained high coverage over many years.

[338] DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, section 8.3, Table 28. DAERA explains that approaches containing a lethal component are assigned a Medium rating because

to be broadly consistent with the available evidence. The greater uncertainty lies in assigning the same Medium rating to proactive culling and TVR. DAERA's rationale groups interventions containing a lethal component together because modelling predicts a faster cattle response than vaccination-only. While this is a reasonable high-level distinction, the direct evidence is not equivalent. Proactive culling has controlled and operational cattle-outcome evidence demonstrating reductions over a period of several years, whereas a cattle-incidence effect from TVR has not been demonstrated directly. [339] Accordingly, similar cumulative modelled outcomes over a common time horizon should not be interpreted as demonstrating equivalent speed of effect. The common Medium timeliness rating should be understood as a broad policy-risk categorisation, rather than as evidence that the timing or reliability of cattle-level benefit is equally well established for proactive culling and TVR. This matters because Northern Ireland currently has high cattle bTB incidence and substantial recurrent disease. Annual herd incidence was 9.6% in 2025/26, while the CVO Review records a 15% recurrence rate at the six-month post-derestriction test. A difference of several years in achieving a material cattle-level reduction could therefore have significant animal-health and economic consequences. [340] Accordingly, similar cumulative modelled benefits for culling and TVR over a common time horizon should not be interpreted as evidence that the two interventions would necessarily reduce cattle disease at the same rate or with the same degree of evidential confidence. For TVR, the timing and magnitude of any cattle-level benefit remain principally model-dependent and should be tested explicitly against alternative assumptions before equivalent intervention timescales are adopted. [341]

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modelling indicates a faster cattle-herd bTB response, whereas vaccination-only is assigned a Very High rating because it is expected to act more slowly, particularly at high starting prevalence unless infection pressure has first been reduced.

[339] Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*, APHA National Wildlife Management Centre; DAERA (2026b), Annex VIII, paras 5.3.19–5.3.25 and Table 7; Brunton, L.A. et al. (2017), 'Assessing the effects of the first 2 years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle in 2013–2015', *Ecology and Evolution*, 7, 7213–7230; Downs, S.H. et al. (2019), 'Assessing effects from four years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle, 2013–2017', *Scientific Reports*, 9; Birch, C.P.D. et al. (2024), 'Difference in differences analysis evaluates the effects of the badger control policy on bovine tuberculosis in England', *Scientific Reports*, 14, 4849; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151; DAERA (2025b), Annex VII, Scientific Opinion Conclusions 5–6.

[340] DAERA (2026b), Annex VIII, paras 1.3.2 and 1.5.1–1.5.2; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 23 and 27–28; The Andersons Centre (2026), *Review of the indirect costs borne by farmers as a result of bovine TB*, Executive Summary and section 7.2.

[341] Budgey and Smith (2019); DAERA (2026b), Annex VIII, Table 7 and paras 5.3.19–5.3.25; Doyle et al. (2023); DAERA (2025b), Annex VII, Scientific Opinion Conclusion 6.

6.7 Statements about expected cattle benefit

This is perhaps where terminology matters most.

Annex VIII appropriately describes many of its cattle outcomes as modelled, potential or illustrative. [342] At points, however, the language moves beyond that caution to statements that particular options are "expected" to have benefits exceeding costs, or that TVR has the potential to deliver a disease-control impact similar to non-selective culling. [343]

Those statements may prove correct, but the degree of confidence attached to them should reflect the evidence underlying each intervention.

AgriSearch suggests a consistent terminology:

- **"demonstrated" or "observed"** where supported by field evidence measuring the outcome concerned;
- **"associated with"** where supported by observational field evidence but causal attribution is limited;
- **"modelled", "projected" or "illustrative"** for outputs from mathematical models; and
- **"plausible", "inferred" or "hypothesised"** where conclusions arise from biological principles or extrapolation rather than direct measurement. [344]

Such terminology would not favour any intervention. It would simply allow readers to understand how directly each statement is supported by evidence.

[342] DAERA (2026b), Badger Intervention – Options Analysis Paper, Annex VIII, paras 5.3.12–5.3.25 and 9.3.7–9.3.10. DAERA states that the APHA model outputs should not be taken as predictions but as a broad indication of relative performance, and repeatedly describes the resulting herd-breakdown and NPV estimates as modelled, potential or illustrative.
[343] DAERA (2026b), Annex VIII, para. 5.3.23 and para. 8.3.4. At para. 5.3.23, DAERA states that options including restraint-based TVR are "expected to have higher benefits than costs" because their modelled herd-breakdown benefit exceeds the calculated breakeven requirement. At para. 8.3.4, DAERA states that modelling suggests TVR has "the potential to deliver a similar disease-control impact to Non-selective Cull options", while removing fewer badgers and carrying lower biodiversity and ecosystem risk.
[344] See DAERA (2026b), Annex VIII, para. 5.3.13; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Modelling' and Scientific Opinion Conclusions 5–6. DAERA itself distinguishes model outputs from field evidence, describes models as context-dependent abstractions rather than field trials, identifies replicated field evidence for proactive culling, and acknowledges that the NI TVR project did not demonstrate an impact on cattle herd incidence.

6.8 A standard evidence template

To improve transparency and consistency, AgriSearch recommends that DAERA present each of the three principal intervention approaches using the same evidence template before bringing wider policy considerations into the assessment. [345]

For each intervention, this could show:

Table 3. Standard evidence template for consistent assessment of wildlife intervention options

Evidence consideration	Information to report consistently
Direct cattle-outcome evidence	Study design, outcome measured and strength of causal inference
Badger-level evidence	Infection, susceptibility, prevalence and behavioural effects
Operational evidence	Where and at what scale the intervention has actually been delivered
Modelled outcomes	Key assumptions, outputs and sensitivity
Speed of expected effect	Evidence basis and degree of confidence
Perturbation	Behavioural evidence and cattle epidemiological evidence separately
Transferability to NI	Similarities, differences and resulting uncertainty
Starting conditions	Prevalence, density, previous intervention and coverage assumptions
Key evidence gaps	What has not yet been demonstrated
Overall confidence	Clear explanation of what is observed, modelled and inferred
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[345] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, p. 1 and Opinion Summary, pp. 8–9. The Scientific Opinion states that its purpose is to inform policy development through assessment of the intervention options, while broader political, environmental, legal, economic, behavioural and social-science considerations required for the final policy decision fall outside its scope. It subsequently states that scientific viability should be assessed in parallel with ethical and welfare considerations.

[346] The proposed template is an AgriSearch analytical framework rather than a DAERA or published standard. Its categories reflect issues identified within DAERA's own evidence base, including differences in direct cattle-outcome evidence, badger-level outcomes, operational experience, modelling, likely speed of effect, perturbation, transferability and starting conditions: see DAERA (2025b), Annex VII, pp. 3–9; DAERA (2026b), Badger Intervention – Options Analysis Paper, Annex VIII, particularly sections 5–8; and

AgriSearch considers that the scientific comparison should first be set out transparently and on a consistent, like-for-like basis. Economic cost, welfare, environmental impact, operational feasibility and public acceptability can then be brought alongside it to inform the overall policy decision, without obscuring differences in the strength or directness of the underlying scientific evidence. [347] .

6.9 Presentation of evidence in the Easy Read Summary

DAERA also published an Easy Read Summary of the consultation. AgriSearch recognises that an accessible summary must necessarily simplify complex scientific and policy material and cannot reproduce all of the detail and qualification contained in the full consultation suite. However, simplification should be applied consistently across intervention options and should not materially alter the meaning of the underlying evidence. [348]

There is established guidance against which the quality of an Easy Read publication can be considered. Current UK Government guidance describes Easy Read as using clear images to support the meaning of simple, jargon-free text focused on the most important information, and recommends that it be developed in consultation with its intended audience. More detailed government guidance for producers of Easy Read information recommends that each main idea is supported by words and appropriate pictures, difficult terms are explained when first introduced, important consultation dates are highlighted prominently, documents are kept as short as practicable, and material is tested with people with learning disabilities. Government consultation principles additionally require consultations to provide sufficient accessible information to enable informed participation. [349]

DAERA (2026c), Badger Intervention Analyses – Calculation Assumptions, Annex IX, particularly paras. 2.14.1–2.14.7.

[347] DAERA (2025b), Annex VII, p. 1 and Opinion Summary, pp. 8–9; DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 3.1, pp. 22–23; DAERA (2026b), Annex VIII. The consultation explains that Annex VIII provides a preliminary comparative ranking based on estimated costs, potential benefit generation, relevant non-monetary factors and risks, to inform consultation responses and subsequent Ministerial decision-making rather than constituting a final preferred option.

[348] DAERA (2026f), Bovine Tuberculosis (bTB) Consultation on Wildlife Intervention Options – Easy Read Summary, p. 2. The Summary states that it uses simple words and short sentences and contains less detail than the full consultation document.

[349] Cabinet Office and Disability Unit (2026), Accessible communication formats, section 5.1 ‘Easy Read’; Department of Health and Office for Disability Issues (2010), Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce Easy Read information, particularly pp. 14–15, 20–22 and Annex A, pp. 27–30; Cabinet Office (2018), Consultation Principles, principles 1, 3, 6 and 7. See also HM Government (2026), Debt Management Communications Toolkit, Case Study 1, summarising DWP Easy Read Standards.

An indicative assessment of the Easy Read Summary against these principles is provided at Appendix 6. This identifies several areas of good practice, alongside areas where accessibility, consistency or preservation of the underlying evidential meaning could be improved.

AgriSearch considers that this standard is not always achieved. In particular, the Easy Read section on non-selective culling does not explain the direct field evidence that sustained proactive culling can reduce cattle bTB herd incidence, and the principal option page appears to repeat generic material concerning intervention duration and monitoring rather than describing the intervention itself. The associated "Things to think about" section refers to culling potentially reducing disease pressure more quickly than vaccination-only but gives comparatively greater prominence to removal of untested badgers, welfare, cost, delivery and public confidence. [350]

By contrast, TVR is described as removing badgers which test positive, vaccinating and releasing "healthy badgers", and helping to reduce disease levels in the badger population over time. [351] The description of test-negative badgers as "healthy" is potentially misleading. The DPP test used within TVR has an estimated whole-blood sensitivity of approximately 69%, meaning that some genuinely infected badgers will test negative and may subsequently be vaccinated and released. The Easy Read Summary also does not communicate the important qualification that the Northern Ireland TVR project was undertaken within a single intervention area, lacked replicate and untreated control areas, and did not demonstrate an impact on cattle herd incidence. [352]

This is particularly notable because the vaccination-only section demonstrates that significant scientific qualifications can be communicated in accessible language: it explains both that vaccination provides protection and that it does not treat already

[350] DAERA (2026f), *Easy Read Summary*, pp. 12–14. Page 13, headed 'Intervention Option 1: Non-selective culling', repeats the preceding page's generic statements on the proposed five-year intervention period, review using surveillance and disease trends, and DAERA monitoring. Page 14 states that culling may reduce disease pressure more quickly than vaccination-only, but otherwise highlights removal without prior testing and animal welfare, cost, delivery and public confidence. Compare DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusion 5, which states that field trials and modelling show that large-scale, sustained culling can reduce bTB in cattle and badgers.

[351] DAERA (2026f), *Easy Read Summary*, pp. 15–16. Page 15 correctly states that test-negative badgers are vaccinated and released and test-positive badgers removed; page 16 subsequently describes the released animals as "Healthy badgers" and states that TVR can help reduce disease levels in the badger population over time.

[352] Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (*Meles meles*)', *PLoS ONE*, 16, e0246141; DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, TVR section; DAERA (2025b), *Scientific Opinion*, Annex VII, TVR section and Scientific Opinion Conclusion 6. Arnold et al. estimated whole-blood DPP sensitivity at 69% (95% CrI 48–88%) and specificity at 98% (95% CrI 96–99%). Annex VIII explains that this corresponds to approximately 31 infected badgers in every 100 being missed by the test. The Northern Ireland TVR study was undertaken in one area without replicate or untreated control areas, and DAERA concludes that analysis did not demonstrate an impact on cattle herd incidence.

infected badgers, that infected animals may remain within the population, and that disease reduction may take a long time. [353]

There are also more general accessibility issues. The Easy Read Summary is 34 pages long, whereas detailed government guidance recommends that Easy Read documents should be as short as possible and indicates that more than 20 pages is generally too long. A number of the illustrations appear primarily decorative rather than helping to explain the associated concept, despite guidance that pictures should reflect and support the main point being communicated. There is also no indication within the document of whether people with learning disabilities were involved in its development or testing, as recommended by government guidance. [354]

Government guidance for Easy Read consultations also recommends adapting consultation questions for the intended audience so that people with learning disabilities can participate meaningfully. The Easy Read Summary explains how to respond through Citizen Space, email or post, but does not itself provide an Easy Read version of the consultation questions. In addition, the closing date stated within the Easy Read Summary is 25 September 2026, whereas the consultation has subsequently been extended to 9 October 2026. Accessible versions should be kept current so that users relying upon them are not given materially different information from users of the main consultation webpage. [355]

AgriSearch has not identified evidence that would justify challenging DAERA's conclusion at this stage that the proposals are unlikely to result in differential impacts

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[353] DAERA (2026f), *Easy Read Summary*, pp. 17–18. The Summary states that vaccination aims to increase protection against bTB over time, explicitly notes that vaccination does not treat badgers already infected, and states that infected badgers may remain in the population and that disease reduction may take a long time.

[354] Department of Health and Office for Disability Issues (2010), *Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce Easy Read information*, revised edition, particularly Annex A, pp. 26–30, and section 4, pp. 21–23. The guidance recommends that each main idea is supported by words and pictures, that the link between image and text is clear, that Easy Read documents are kept as short as possible and notes that more than 20 pages is generally too long; it also recommends involving people with learning disabilities in creating and testing Easy Read material. See also Cabinet Office and Disability Unit (2026), *Accessible communication formats*, section 5.1, which states that Easy Read uses clear images to support simple, jargon-free text and should be developed in consultation with its intended audience.

[355] Department of Health and Office for Disability Issues (2010), Making written information easier to understand for people with learning disabilities, particularly the case studies at pp. 14–15 and 18–19 and Annex A, p. 26. The guidance gives examples of consultation material being specifically adapted for people with learning disabilities, including a short Easy Read questionnaire and an Easy Read consultation document incorporating space to answer the consultation questions, and recommends that important dates such as consultation closing dates are highlighted at the beginning of the document. See also Government Digital Service (2018), 'Accessibility advice when creating a UK government consultation', which describes provision of Easy Read versions of the consultation overview, information and consultation questions; DAERA (2026), Bovine Tuberculosis (bTB) Consultation on Wildlife Intervention Options – Easy Read Summary, p. 29; and DAERA (2026), 'Consultation on wildlife intervention options to tackle bTB in Northern Ireland extended', News Release, 3 September 2026.

across the Section 75 equality categories. However, equality and accessibility considerations should remain under review as policy is developed and implemented. In particular, DAERA should ensure that accessible information is kept current, enables meaningful participation by people who require alternative or adapted communication formats, and is reflected in subsequent engagement on implementation. Stakeholder feedback and programme delivery should also be monitored for any unanticipated differential effects, including impacts affecting disabled people. Where such effects are identified, the equality screening should be revisited and proportionate mitigation or further assessment considered. [356]

AgriSearch therefore considers that the same evidential standard should apply to all public-facing and accessible summaries as well as to the detailed technical material. A consistent format should explain, for each intervention, what the approach involves, what outcomes have been demonstrated directly, what outcomes are modelled or inferred, the principal uncertainties and limitations, and the expected speed and practical implications of intervention. It should also make clear that wildlife intervention would be geographically targeted to defined areas selected using cattle-disease, badger, epidemiological and operational criteria, rather than applied uniformly across Northern Ireland.

6.10 Evolution of the evidence and policy position

AgriSearch notes that the current consultation builds on a substantial body of earlier Northern Ireland work. In 2016, the TB Strategic Partnership Group recommended a locally targeted, sequenced wildlife intervention in which removal would be undertaken in core areas with high levels of cattle bTB, accompanied by TVR in a surrounding buffer area to mitigate potential perturbation, and followed by consideration of vaccination in the core area. The accompanying independent scientific peer review considered the principle of removal preceding vaccination in high-risk areas to be consistent with the scientific evidence then available, while recognising uncertainty over the necessary intensity and duration of removal. [357]

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[356] DAERA (2026), *Equality & Disability Duties Screening Template*, Annex I, particularly Parts 3 and 4. The screening concludes that the policies being consulted upon are unlikely to result in differential impacts across the Section 75 categories, while inviting further equality-related evidence through the consultation and providing for monitoring and reconsideration where evidence of adverse or differential impact emerges. See also Section 6.9 and Appendix 6 of this response regarding the accessibility of the consultation material.

[357] TB Strategic Partnership Group (2016), *Bovine Tuberculosis Eradication Strategy for Northern Ireland: An Integrated Eradication Programme*, pp. 48–53, particularly Recommendation 4.3; More, S.J. (2016a), *The Bovine Tuberculosis Eradication Programme in Northern Ireland: Proposals from the Tuberculosis Strategic Partnership Group (TBSPG) – Scientific peer review: Stage 1 report*, 13 September 2016, particularly pp. 6–7 and paras. 98–121; More, S.J. (2016b), *The Bovine Tuberculosis Eradication Programme in Northern Ireland: Proposals from the TBSPG – Scientific peer review: Additional comments*,

Scientific evidence has developed materially since 2016 and AgriSearch does not suggest that policy should remain fixed as new evidence emerges. [358] However, where the relative weighting of intervention options has changed, the evidential basis for that change should be made explicit. This is particularly relevant because DAERA's 2025 Scientific Opinion concludes that the earlier departmental opinions and control options have received further support and validation from the subsequent literature, while also identifying sequenced or hybrid approaches as scientifically plausible. DAERA should therefore set out clearly which subsequent findings have altered, strengthened or weakened the principal assumptions underpinning the 2016 approach, explain how these changes have informed the current comparative assessment of non-selective culling, TVR and vaccination, and distinguish changes in the evidence from changes in weighting arising from operational, welfare, environmental, economic or wider policy considerations.

A related issue concerns how the evolving policy position in other jurisdictions is characterised. The description of England as having moved to a "vaccination-only policy" [359] may now require qualification. The 2025 season was the final year of industry-led culling in England's High Risk and Edge Areas, and England is transitioning away from widespread badger culling towards a vaccination-led, surveillance-informed approach, but the June 2026 Bovine TB Partnership recommended strategy envisages targeted vaccination, expanded wildlife surveillance and adaptive review, rather than describing a universal vaccination-only programme. It also recommends a framework through which lethal intervention could remain available in exceptional circumstances where a high evidential and legal threshold is met. [360] At the time of writing, these

9 November 2016, particularly paras. 6–17. More considered removal preceding vaccination in high-risk areas to be consistent with the scientific knowledge then available and described the proposed approach as "reasonable and prudent", while noting that the intensity and duration of removal required, and whether these would vary with starting infection prevalence, were not known.

[358] DAERA (2025a), *Annotated scientific bibliography – badger intervention – bTB – 2015 to November 2024*; DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly Scientific Opinion Conclusions 1 and 4–7. The updated review incorporated 174 peer-reviewed publications covering January 2015 to November 2024 and considered subsequent evidence relating to proactive culling, the completed Northern Ireland TVR study, vaccination and hybrid approaches.

[359] DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, section 5.4, p. 30: "After pursuing culling methods for many years, England has moved to a vaccination only policy…"

[360] Steering Group of the Bovine TB Partnership for England (2026), Bovine TB control strategy for England, particularly pp. 19–22. The recommended strategy proposes expansion of badger vaccination in targeted high-priority locations, enhanced badger surveillance and evaluation of vaccination effectiveness, together with development of a framework to inform any future use of lethal badger control. It states that lethal control should be licensed only in "very exceptional circumstances", as a last resort, where clearly justified and where the applicable legal tests are met.

remain recommendations being considered by government rather than a final adopted replacement strategy. [361]

6.11 AgriSearch assessment

AgriSearch considers that DAERA's supporting scientific documents contain a substantial and generally balanced account of the available evidence. In particular, the Scientific Opinion itself acknowledges many of the limitations identified in this review: proactive culling has the strongest direct replicated field evidence of cattle benefit; the Northern Ireland TVR study was undertaken in a single area without replicate or untreated control areas and did not demonstrate an impact on cattle herd incidence; the most relevant vaccination evidence from the Republic of Ireland is highly context-dependent; and mathematical models are context-dependent abstractions rather than field trials. [362] These qualifications are important and demonstrate that the underlying scientific review is considerably more nuanced than a simple ranking of the intervention options. DAERA's Scientific Opinion does indeed make all of those distinctions.

The principal concern identified by AgriSearch is therefore less the content of the Scientific Opinion than what can happen as evidence is translated into the subsequent options analysis. Modelled cattle outcomes that DAERA's own internal reviewers cautioned should provide only a broad indication of relative performance are subsequently used to estimate economic benefit, cattle welfare and human-welfare effects and to inform comparative risk and option rankings. [363] At the same time, important uncertainties can be treated differently between interventions: perturbation is tested as an alternative sensitivity assumption for non-selective culling but not for TVR, while culling and TVR receive the same Medium timeliness risk rating despite

[361] Department for Environment, Food & Rural Affairs (2026), 'Government welcomes expert-led recommendations for a new bovine TB eradication strategy', 10 June 2026. Defra describes the document as a package of recommendations "for government to consider" and states that Ministers will carefully consider the Steering Group's findings alongside existing evidence, stakeholder views and delivery considerations.

[362] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly pp. 3–9 and Scientific Opinion Conclusions 4–7; see also Annex 1, 'Summary points of the scientific evidence'. The Scientific Opinion records the direct field evidence for proactive culling, the lack of replicate and control areas in the Northern Ireland TVR project and absence of demonstrated cattle-incidence impact, the context-dependent nature of the Republic of Ireland vaccination evidence, and the limitations of mathematical models as context-dependent abstractions rather than field trials.

[363] DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, paras. 5.3.12–5.3.25, particularly para. 5.3.13 and footnote 85; sections 7.4.4 and 7.4.6; and sections 8.2–8.3. See also Hatch, M. and Anderson, H. (2019), *Follow up report on the National Wildlife Management Centre TB model outputs: DAERA veterinary and NIEA interpretation of the results*, p. 4, as reproduced in Annex VIII. The reviewers cautioned that the model point estimates did not show their uncertainty, that confidence intervals would probably be wide and encompass other options, and that the outputs should provide a broad indication of relative performance rather than predictions.

materially different direct evidence concerning the timing of cattle-level benefit. [364] Annex VIII itself records the very substantial uncertainty surrounding the model point estimates, including the internal reviewers' view that confidence intervals would likely be wide and encompass competing options. Yet those modelled outcomes subsequently feed into calculations such as premature cattle removals and composite risk assessments. The common Medium timeliness treatment is explicit in Table 28.

AgriSearch does not suggest that identical assumptions should be applied mechanically to every intervention. Different evidence can properly justify different assumptions; for example, the Northern Ireland TVR evidence provides a reasonable basis for considering perturbation less likely under the removal intensity studied than under broad non-selective culling. AgriSearch does not seek to infer intent from the differences identified. The requirement is instead that, where assumptions or levels of confidence differ between options, the evidential basis for those differences should be explicit and, where they materially affect conclusions or rankings, appropriately tested against alternative plausible assumptions. [365]

The same principle should extend to public-facing material. AgriSearch recognises that an Easy Read Summary must simplify complex evidence, but simplification should not materially change the evidential meaning or result in different options receiving materially different levels of qualification. The assessment in Section 6.9 and Appendix 6 identifies several areas of good accessibility practice, but also areas where the underlying evidential distinctions are not communicated consistently. AgriSearch considers that accessible summaries should preserve, in appropriately simple language, the distinction between outcomes that have been demonstrated directly, those that are modelled or inferred, and the principal uncertainties attaching to each intervention. [366]

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[364] DAERA (2026b), Annex VIII, paras. 6.1.3–6.1.6 and Table 28; Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*. Annex VIII tests a perturbation sensitivity for non-selective culling while retaining the no-perturbation assumption for TVR on the basis of the Northern Ireland field evidence; Table 28 assigns both proactive culling and TVR a Medium timeliness risk rating, with vaccination-only rated Very High.

[365] O'Hagan, M.J.H. et al. (2021b), 'Effect of selective removal of badgers (*Meles meles*) on ranging behaviour during a "Test and Vaccinate or Remove" intervention in Northern Ireland', *Epidemiology and Infection*, 149, e125; Allen, A. et al. (2022), 'European badger (*Meles meles*) responses to low-intensity, selective culling: using mark–recapture and relatedness data to assess social perturbation', *Ecological Solutions and Evidence*, 3, e12165; Budgey and Smith (2019), p. 5; DAERA (2026b), Annex VIII, paras. 6.1.3–6.1.6.

[366] Cabinet Office and Disability Unit (2026), *Accessible communication formats*, section 5.1 'Easy Read'; Department of Health and Office for Disability Issues (2010), *Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce Easy Read information*; Cabinet Office (2018), *Consultation Principles*, particularly principles 1, 3, 6 and 7; DAERA (2026), *Bovine Tuberculosis (bTB) Consultation on Wildlife Intervention Options – Easy Read Summary*, particularly pp. 13–18; see also Appendix 6 of this review.

The need for transparency is reinforced by the substantial history of Northern Ireland-specific scientific and policy appraisal preceding the current consultation. Earlier work recognised the importance of locally targeted intervention, sequencing, reducing infection pressure before vaccination in higher-risk settings, uncertainty over intervention duration, limitations in the evidence available for TVR, monitoring and adjustment as evidence develops. Several of these propositions were subjected to independent scientific peer review. [367] Significantly, DAERA's updated 2025 Scientific Opinion concludes that the opinions, conclusions and control options identified in its earlier 2019 opinion have received "further support and validation" from subsequent evidence, while also describing hybrid strategies as conceptually strong. Annex VIII nevertheless does not take the CVO's adaptive hybrid approach forward into the current comparative analysis because it is considered novel, complex and in need of further exploratory work. [368] This does not in itself indicate inconsistency; it does, however, reinforce the importance of distinguishing transparently between changes arising from the scientific evidence and those arising from operational feasibility, welfare, environmental, economic or wider policy considerations. DAERA's updated opinion is unusually explicit that its previous conclusions remain supported, including the long-term role for vaccination and the scientific plausibility of sequencing or hybrid approaches. Annex VIII, separately, explains that the adaptive hybrid was omitted because its design would be complex and require significant further work.

Applying a common evidential template and consistently distinguishing demonstrated, observational, modelled and inferred outcomes would provide a clearer basis for comparing the options. The same distinctions should then be retained as scientific evidence is combined with economic, welfare, environmental, operational and public-acceptability considerations and carried into public-facing summaries. This would not determine which intervention should ultimately be preferred; rather, it would make clear both the strength of the evidence supporting each conclusion and where the final policy judgement necessarily depends upon wider considerations and uncertainty.

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[367] TB Strategic Partnership Group (2016), Bovine Tuberculosis Eradication Strategy for Northern Ireland: An Integrated Eradication Programme, pp. 48–53, particularly Recommendation 4.3; More, S.J. (2016a), The Bovine Tuberculosis Eradication Programme in Northern Ireland: Proposals from the Tuberculosis Strategic Partnership Group (TBSPG) – Scientific peer review: Final report, 13 September 2016, particularly pp. 6–7 and paras. 98–121; More, S.J. (2016b), The Bovine Tuberculosis Eradication Programme in Northern Ireland: Proposals from the TBSPG – Scientific peer review: Additional comments, 9 November 2016, particularly paras. 6–17. See also Northern Ireland TB Eradication Partnership (2019), Advice on Bovine Tuberculosis in Northern Ireland, May 2018–June 2019, and DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, particularly pp. 62–65.

[368] DAERA (2025b), Annex VII, Scientific Opinion Conclusions 1, 4, 7 and 9 and Opinion Summary; DAERA (2026b), Annex VIII, paras. 4.2.11–4.2.12. DAERA's updated Scientific Opinion states that the conclusions and control options identified in the 2019 opinion have received further support and validation and describes hybrid strategies as conceptually strong, while Annex VIII explains that the CVO adaptive hybrid was not included in the current analysis because it would be novel, complex and require significant further exploratory work.

7. Intervention-area selection and targeting

The effectiveness of wildlife intervention will depend not only on the intervention selected, but also on where it is deployed and the epidemiological circumstances within that area. As discussed in Sections 3 and 5, Northern Ireland should not be assumed to have a uniform distribution of cattle disease, badger density, badger infection prevalence or cattle-badger transmission. [369]

DAERA's consultation already recognises this principle. It proposes that intervention areas may be selected where there is evidence that badgers are contributing to ongoing cattle bTB problems, taking account of long-term high cattle bTB levels, higher-than-average badger social-group density, evidence of infection in local badgers, local veterinary and epidemiological information, and natural or physical boundaries capable of limiting badger movement. Each intervention area would be at least 100 km^2, with its precise size and configuration dependent on local conditions. [370]

The importance of local conditions has been recognised in Northern Ireland for some time. An AFBI review commissioned by DARD in 2011 concluded that variation in badger density, ecology and behaviour could affect badger–cattle contact and transmission risk, and recommended improved Northern Ireland-specific ecological and epidemiological evidence to inform the design of locally appropriate interventions. [371] Subsequent ecological and genomic evidence has strengthened the case for considering such spatial variation. [372]

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[369] DAERA (2025b), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII, particularly 'Badger Ecology', 'Transmission dynamics' and 'Modelling', pp. 1–5, and Scientific Opinion Conclusion 9. DAERA notes that robust population information is required for intervention design, that habitat and previous badger management should inform population modelling, that the relative contribution of different host species varies between bTB hotspots, and that cattle movements, testing frequency and interspecies transmission rates may contribute to differences between hotspots. See also Allen, A.R., Skuce, R.A. and McDowell, S.W.J. (2011), Bovine TB: a review of badger-to-cattle transmission, AFBI, pp. 4 and 16–18.

[370] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, sections 4.1–4.2, pp. 26–27; see also section 1.2, p. 12. DAERA proposes that wildlife intervention should be targeted in areas where badgers are contributing to ongoing cattle bTB problems, taking account of long-term high cattle bTB levels, above-average badger social-group density, evidence of local badger infection, local veterinary and epidemiological information and natural or physical boundaries limiting badger movement. Each intervention area would be at least 100 km^2, with size and configuration determined by local conditions.

[371] Allen, A.R., Skuce, R.A. and McDowell, S.W.J. (2011), *Bovine TB: a review of badger-to-cattle transmission*, Bacteriology Branch, Veterinary Sciences Division, Agri-Food and Biosciences Institute, 31 March 2011, particularly Executive Summary, pp. 3–5, and sections 4.1–4.2, pp. 14–18. The review was prepared in response to a DARD Animal Health and Welfare Branch commission. It concluded that regional variation in badger density, ecology and population dynamics could affect movement, contact and potentially transmission, and recommended improved Northern Ireland evidence on badger ecology, population and social structure alongside epidemiological analysis.

[372] Akhmetova, A. et al. (2023), 'Genomic epidemiology of *Mycobacterium bovis* infection in sympatric badger and cattle populations in Northern Ireland', *Microbial Genomics*, 9, 001023; Byrne, A.W. et al.

AgriSearch supports this area-based and evidence-led approach. However, given the heterogeneity identified within the scientific evidence, AgriSearch considers that the proposed characterisation exercise should be developed into a more explicit and transparent framework which integrates cattle epidemiology, contemporary wildlife evidence, molecular epidemiology, landscape and operational information before intervention begins.

7.1 Cattle disease patterns and recurrent breakdowns

Long-term or recurrent cattle bTB is an appropriate starting point when identifying potential intervention areas, but the pattern of cattle disease needs to be understood rather than simply mapped. [373]

Northern Ireland evidence demonstrates that prolonged and recurrent herd breakdowns can arise through several mechanisms, including residual infection within herds, cattle movements, wildlife exposure, contiguous spread and limitations in diagnostic sensitivity. [374] The CVO Review identifies chronic breakdowns as particularly important but also notes that recurrent breakdowns in one Northern Ireland study were strongly associated with carry-over of infection from previous breakdowns, with badger-associated source attribution not showing a statistically significant association in that particular analysis. [375]

(2024), 'Badger Ecology, Bovine Tuberculosis, and Population Management: Lessons from the Island of Ireland', *Transboundary and Emerging Diseases*, 2024, 8875146; Allen, A. et al. (2024), 'Whole-Genome sequencing in routine *Mycobacterium bovis* epidemiology – scoping the potential', *Microbial Genomics*, 10, 001185; O'Shaughnessy, J. et al. (2026), 'The genomic diversity and spatial patterns of *Mycobacterium bovis* in Ireland revealed by whole genome sequencing', *Irish Veterinary Journal*, 79, 6.

[373] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly pp. 22–27 and 49–50; Doyle, L.P. et al. (2014), 'Bovine tuberculosis in Northern Ireland: Risk factors associated with time from post-outbreak test to subsequent herd breakdown', *Preventive Veterinary Medicine*, 116, 47–55; Doyle, L.P. et al. (2016), 'Bovine tuberculosis in Northern Ireland: Risk factors associated with duration and recurrence of chronic herd breakdowns', *Preventive Veterinary Medicine*, 131, 1–7.

[374] DAERA (2024), *CVO Review*, pp. 22–28, particularly the sections 'Residual Infection & Cattle Movements' and 'Chronic bTB Herds'; Doyle et al. (2016); Doyle, L.P. et al. (2017), 'Bovine tuberculosis in Northern Ireland: quantification of the population disease-level effect from cattle leaving herds detected as a source of infection', *Epidemiology and Infection*, 145, 3505–3515; Doyle, L.P. et al. (2020), 'Northern Ireland farm-level management factors for prolonged bovine tuberculosis herd breakdowns', *Epidemiology and Infection*, 148, e234; Doyle, L.P. et al. (2022), 'Northern Ireland farm-level management factors for recurrent bovine tuberculosis herd breakdowns', *Epidemiology and Infection*, 150, e176.

[375] Doyle, L.P. et al. (2022), 'Northern Ireland farm-level management factors for recurrent bovine tuberculosis herd breakdowns', *Epidemiology and Infection*, 150, e176; DAERA (2024), *CVO Review*, pp. 26–27. DAERA summarises the study as finding recurrent breakdowns to be strongly associated with carry-over of infection from a previous breakdown, with other attributed sources such as badgers showing no statistically significant association; it further describes inability of control measures to remove infection effectively as the principal driver identified for recurrent breakdowns.

This is an important qualification. A concentration of recurrent breakdowns should not automatically be interpreted as evidence that wildlife is the principal local driver. Instead, it should trigger more detailed epidemiological investigation.

AgriSearch considers that area characterisation should therefore include, as appropriate:

- frequency, duration and recurrence of herd breakdowns;
- numbers of reactors and severity of breakdowns;
- patterns of neighbouring or epidemiologically linked herd infection;
- previous testing and derestriction history;
- herd type and size; and
- whether the pattern suggests repeated external introduction, residual within-herd infection or another common source. [376]

This would help ensure that wildlife intervention is targeted towards areas in which there is a reasonable evidential basis for expecting wildlife intervention to contribute materially to disease reduction.

7.2 Cattle movements and risk of disease introduction

Cattle movements should form part of this assessment. The CVO Review notes that one Northern Ireland analysis attributed approximately 6.4% of herd breakdowns directly to movement of infected cattle and that cattle movements may also contribute to repeated introduction of infection into chronically affected herds. [377] This is particularly important for an area-based intervention. The epidemiological gains from reducing infection in the local badger population could be undermined if M. bovis is repeatedly reintroduced through cattle movements and subsequently amplified through cattle-to-

[376] DAERA (2024), *CVO Review*, particularly pp. 13–15, 22–28, 39–40, 43–44 and 49–51; Doyle et al. (2014, 2016, 2020, 2022). The CVO Review identifies breakdown recurrence, duration and severity as useful programme measures; notes that future herd risk is associated with breakdown size/severity, herd type and previous history; and recommends fuller use of molecular epidemiology to resolve spatial and temporal transmission pathways.

[377] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 22–27; Doyle, L.P., Courcier, E.A., Gordon, A.W., O'Hagan, M.J.H., Stegeman, J.A. and Menzies, F.D. (2017), 'Bovine tuberculosis in Northern Ireland: quantification of the population disease-level effect from cattle leaving herds detected as a source of infection', *Epidemiology and Infection*, 145(16), 3505–3515. The CVO Review reports that 6.4% of Northern Ireland herd breakdowns were directly attributable to movement of infected animals and notes that, although cattle movement was not identified as the dominant source of initial breakdowns, it can provide a mechanism for repeated introduction of infection into some chronically infected herds.

cattle transmission or transmitted back into wildlife. [378] DAERA's own regionalisation analysis identifies inward cattle movements, trade flows, geographical boundaries and land fragmentation as factors requiring consideration when selecting geographical areas for bTB control, alongside the need to address all infection sources within the region. [379]

AgriSearch therefore considers that cattle movement history and trade patterns should form part of the wildlife intervention-area characterisation exercise, particularly where movements could provide an alternative explanation for the persistence or geographical spread of infection. [380]

This is not an argument against wildlife intervention. It is an argument for ensuring that intervention is accompanied by cattle measures capable of protecting the epidemiological gains made within the area.

7.3 Evidence of wildlife linkage: WGS, strain information and epidemiology

Whole-genome sequencing (WGS) provides an increasingly important means of adding resolution to conventional epidemiological investigation. The CVO Review describes WGS as providing information on spatial and temporal transmission pathways and enabling more refined disease tracing than previous molecular typing approaches. It

[378] DAERA (2024), *CVO Review*, pp. 22–23 and 72–74; Akhmetova, A. et al. (2023), 'Genomic epidemiology of *Mycobacterium bovis* infection in sympatric badger and cattle populations in Northern Ireland', *Microbial Genomics*, 9, 001023; DAERA (2025a), *Annotated scientific bibliography*, section on transmission dynamics. The CVO Review identifies residual infection and substantial cattle movements as mechanisms by which infection can be recycled through the Northern Ireland cattle population, while its regionalisation analysis identifies prevention of inward infection and control of all cattle, wildlife and environmental sources as prerequisites for a successful area-based approach. Genomic analysis from the Northern Ireland TVR area found predominantly cattle-associated transmission, with occasional interspecies transmission.

[379] DAERA (2024), *CVO Review*, section 'Regionalisation', pp. 70–74, particularly pp. 72–74. The Review identifies management of inward infection through cattle movements, movements between fragmented holdings and wildlife as a principal challenge; lists inward cattle movements, trade flows, geographical boundaries and land fragmentation among the criteria for selecting a region; and states that all infection sources within the area must be addressed, including cattle-to-cattle, wildlife-to-cattle and environmental transmission.

[380] DAERA (2024), *CVO Review*, pp. 22–23, 35–36 and 72–74; Brown, E., Marshall, A.E., Mitchell, H.J. and Byrne, A.W. (2019), 'Cattle movements in Northern Ireland form a robust network: implications for disease management', *Preventive Veterinary Medicine*, 170, 104740. The CVO Review identifies cattle movements and location as epidemiological variables suitable for risk prediction, proposes further analysis of livestock trade networks through the ELITE CLINIC project, and includes inward movements and trade flows among criteria for regional selection.

also notes its potential to identify how *M. bovis* lineages are disseminated across the landscape, including through cattle movement. [381]

This is particularly relevant to wildlife intervention because WGS studies have demonstrated that the relative importance of cattle and badgers can differ markedly between bTB hotspots. DAERA's annotated scientific bibliography concludes that transmission dynamics are context-dependent and that the contribution of different host species varies between locations. [382]

The Northern Ireland TVR area provides a useful example. WGS analysis there suggested that transmission was dominated by cattle-associated spread, with only sporadic inferred interspecies transmission and no directly inferred badger-to-badger transmission events. Other studies in Britain and Ireland have produced different transmission patterns. [383]

AgriSearch therefore considers that WGS and existing strain information should be used, wherever sufficiently informative data are available, to help answer questions such as:

- is the same or closely related *M. bovis* lineage recurring locally over time?
- are neighbouring cattle herds epidemiologically linked?
- is there evidence consistent with movement of infection into the area through cattle?
- are cattle and local badgers sharing closely related strains?

[381] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, p. 51; Allen, A. et al. (2024), 'Whole-Genome sequencing in routine *Mycobacterium bovis* epidemiology – scoping the potential', *Microbial Genomics*, 10, 001185. The CVO Review describes WGS as providing spatial and temporal information on transmission pathways, allowing finer disease tracing than established VNTR typing and helping determine how lineages are disseminated across the landscape, including likely dissemination through cattle movement.

[382] DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, pp. 16–17, 'Whole-genome sequencing (WGS)' and Conclusion; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Transmission dynamics', pp. 2–3; Crispell, J. et al. (2019), 'Combining genomics and epidemiology to analyse bi-directional transmission of *Mycobacterium bovis* in a multi-host system', *eLife*, 8, e45833; Rossi, G. et al. (2022), 'Phylodynamic analysis of an emergent *Mycobacterium bovis* outbreak in an area with no previously known wildlife infections', *Journal of Applied Ecology*, 59, 210–222; Akhmetova, A. et al. (2023), 'Genomic epidemiology of *Mycobacterium bovis* infection in sympatric badger and cattle populations in Northern Ireland', *Microbial Genomics*, 9, 001023.

[383] Akhmetova et al. (2023); DAERA (2024), *CVO Review*, pp. 49–51; DAERA (2025a), *Annotated scientific bibliography*, p. 17. The CVO Review reports that 35 of 37 inferred direct transmission events in the TVR-area analysis were cattle-associated, with two inferred interspecies events and no directly inferred badger-to-badger events. Compare Crispell et al. (2019), which inferred a substantially greater badger-to-cattle contribution in its English study system, and Rossi et al. (2022), which reconstructed cattle introduction followed by spillover to badgers and subsequent circulation between hosts in Cumbria.

- does the available evidence suggest that wildlife is likely to be contributing to persistence within the proposed intervention area? [384]

WGS will not necessarily provide an unambiguous direction of transmission in every case, particularly where sampling is incomplete or uneven and genetically similar isolates circulate over time. It should therefore be interpreted alongside, rather than as a replacement for, conventional epidemiological investigation, cattle movement and testing histories, spatial information and local veterinary knowledge. [385] Recent English evidence also supports a more explicitly surveillance-led approach to intervention-area selection and review. Powell et al. (2025) demonstrated marked geographical variation in M. bovis infection among found-dead badgers along England's expanding endemic edge, with WGS identifying geographically localised correspondence between *M. bovis* clades detected in badgers and cattle. [386] APHA's Low Risk Area hotspot approach combines cattle epidemiology, found-dead wildlife surveillance, culture and WGS, badger ecology and natural boundaries to define and refine areas for intervention, with subsequent surveillance and evidence review informing whether measures are continued, modified or ended. [387] Such evidence cannot by itself establish direction of transmission or intervention efficacy, but supports the use of multiple current epidemiological indicators rather than reliance on cattle incidence or estimated badger density alone when characterising proposed intervention areas and determining where and how wildlife intervention may be justified.

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[384] DAERA (2024), *CVO Review*, p. 51; Allen et al. (2024); O'Shaughnessy, J. et al. (2026), 'The genomic diversity and spatial patterns of *Mycobacterium bovis* in Ireland revealed by whole genome sequencing', *Irish Veterinary Journal*, 79, 6; Harvey, N. et al. (2026), 'Integrating whole-genome sequencing and epidemiology to characterise *Mycobacterium bovis* transmission in Ireland: a proof of concept', *Irish Veterinary Journal*, 79, 3.

[385] Biek, R., O'Hare, A., Wright, D., Mallon, T., McCormick, C., Orton, R.J., McDowell, S., Trewby, H., Skuce, R.A. and Kao, R.R. (2012), 'Whole genome sequencing reveals local transmission patterns of Mycobacterium bovis in sympatric cattle and badger populations', PLoS Pathogens, 8(11), e1003008.; Allen et al. (2024); Harvey et al. (2026). WGS inference is affected by incomplete and potentially unbalanced host sampling, the slow evolutionary rate of *M. bovis* and the interval between infection and sampling; genomic data are therefore most informative when interpreted alongside movement, spatial, testing and other epidemiological information.

[386] Powell, S.M., Dessi, N., Bennett, M., Wang, B., Robertson, A., Waller, E., Smith, G.C. and Delahay, R.J. (2025), 'Tuberculosis in found dead badgers at the edge of the expanding bovine tuberculosis epidemic', *Scientific Reports*, 15, 10547. https://doi.org/10.1038/s41598-025-86930-y.

[387] Department for Environment, Food & Rural Affairs and Animal and Plant Health Agency (2026), 'April 2026: TB hotspots in the Low Risk Area of England', updated 19 May 2026, particularly 'Surveillance for disease in wildlife (stage 3)', 'Licensed badger disease control (stage 4)' and 'Closure of hotspots (stage 5)'. APHA defines hotspots through cattle epidemiology and enhanced wildlife surveillance; culture-positive wildlife isolates undergo WGS to assess links with local cattle breakdowns; intervention areas incorporate infected wildlife, associated and contiguous cattle breakdowns, badger territorial ecology and natural barriers; and subsequent surveillance and evidence review inform continuation, modification or closure of hotspot measures.

7.4 Badger infection prevalence and population density

The wildlife side of the characterisation exercise should similarly extend beyond simply determining whether badgers are present.

As discussed in Sections 3.3 and 3.4, both badger infection prevalence and population density are likely to vary substantially between areas, and each has implications for intervention design. DAERA already proposes to consider higher-than-average social-group density and evidence of infection in local badgers when selecting intervention areas. [388]

AgriSearch supports this but considers that, as far as practicable, intervention planning should use contemporary and geographically resolved evidence rather than relying primarily on national averages. [389]

Relevant information could include:

- local or regional badger density and social-group distribution;
- evidence of *M. bovis* infection in badgers from RTA surveillance or other appropriately validated surveillance;
- available strain or WGS information linking cattle and badger infection;
- expected trapping probability and achievable coverage; and
- surrounding badger populations which could contribute to recolonisation or immigration. [390]

As discussed in Section 3.3, RTA surveillance can contribute useful evidence on broad spatial patterns of badger infection, but should not alone be treated as a precise measure of prevalence within a proposed intervention area. [391]

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[388] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, sections 4.1–4.2, pp. 26–27; DAERA (2026c), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, particularly paras. 2.7.1–2.8.2 and 2.14.1–2.14.4; Byrne, A.W. et al. (2024), 'Badger Ecology, Bovine Tuberculosis, and Population Management: Lessons from the Island of Ireland', *Transboundary and Emerging Diseases*, 2024, 8875146.
[389] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, sections 4.1–4.2, pp. 26–27; DAERA (2026c), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, particularly paras. 2.7.1–2.8.2 and 2.14.1–2.14.4; Byrne, A.W. et al. (2024), 'Badger Ecology, Bovine Tuberculosis, and Population Management: Lessons from the Island of Ireland', *Transboundary and Emerging Diseases*, 2024, 8875146.
[390] DAERA (2025b), *Scientific Opinion*, Annex VII, sections 'Badger Ecology', 'Transmission dynamics' and 'Modelling'; DAERA (2026c), Annex IX, paras. 2.7–2.14; DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, discussion of population estimation, coverage, boundaries and reintroduction of infection; Menzies, F.D. et al. (2021), 'Test and vaccinate or remove: methodology and preliminary results from a badger intervention research project', *Veterinary Record*, 189, e248.
[391] Courcier, E.A., Menzies, F.D., Strain, S.A.J., Skuce, R.A., Robinson, P.A., Patterson, I.A.P., McBride, K.R., McCormick, C.M., Walton, E., McDowell, S.W.J. and Abernethy, D.A. (2018), 'Monitoring *Mycobacterium bovis* in Eurasian badgers (*Meles meles*) killed by vehicles in Northern Ireland between 1998 and 2011',

Recent all-island whole-genome sequencing evidence also reinforces the spatial heterogeneity of bTB transmission. Analysis of 5,875 M. bovis isolates from cattle and badgers found strong geographical structuring and substantial genetic similarity between cattle and badger isolates, while also identifying situations in which cattle movements provided a more plausible explanation for non-local infection. This supports combining genomic evidence with cattle movement history, local wildlife infection information and veterinary epidemiological assessment when characterising proposed intervention areas, rather than assuming a uniform wildlife contribution to cattle infection. [392]

Recent Republic of Ireland evidence also supports giving weight to current wildlife distribution and landscape context. A large Republic of Ireland-wide matched case-control analysis found higher active badger-sett density to be associated with increased relative cattle bTB breakdown risk. However, the authors emphasise that active-sett density is a proxy for badger presence rather than a direct estimate of badger abundance, and that wildlife-related risk may vary with local ecological and landscape conditions. This reinforces the case for contemporary, area-specific ecological characterisation rather than reliance on a single national density assumption. [393]

Interim observations from the current Queen's University Belfast work provide further support for this approach. Although fieldwork and analysis remain ongoing, the results available to date indicate substantial local variation in badger density and demonstrate the value of contemporary direct survey methods in characterising badger presence and abundance within potential intervention areas. QUB also reports that badger densities were significantly higher in locations where high badger activity had been reported than in randomly selected locations of similar habitat. This provides preliminary empirical support for local reports of badger activity being used to help identify areas warranting more detailed population assessment, while not treating such reports as a substitute for systematic survey. The findings should not yet be interpreted as providing a revised Northern Ireland-wide population estimate. [394] The importance of

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Veterinary Record, 182, 259–265; TB Strategic Partnership Group (2016), *Bovine Tuberculosis Eradication Strategy for Northern Ireland*, p. 52 and Recommendation 4.4.

[392] O'Shaughnessy, J., Harvey, N., Byrne, B. et al. (2026), 'The genomic diversity and spatial patterns of Mycobacterium bovis in Ireland revealed by whole genome sequencing', Irish Veterinary Journal, 79, 6, https://doi.org/10.1186/s13620-025-00324-0; Harvey, N., McGrath, G., O'Shaughnessy, J. et al. (2026), 'Integrating whole-genome sequencing and epidemiology to characterise Mycobacterium bovis transmission in Ireland: a proof of concept', Irish Veterinary Journal, 79, 3, https://doi.org/10.1186/s13620-025-00321-3.

[393] Khouri, R.M., Murphy, K.J., Morera-Pujol, V., McGrath, G., Burkitt, T., Quinn, D., Byrne, A.W. et al. (2026), 'The effect of wildlife host hotspots on bovine tuberculosis (bTB) risk dynamics in a disturbed landscape', Landscape Ecology, 41, 51, https://doi.org/10.1007/s10980-026-02319-w.

[394] Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, written communication to AgriSearch, 4 September 2026, reproduced at Appendix 4; see also Dick, J., *Badger populations in N. Ireland: a re-assessment with thermal technology*, QUB project proposal. Fieldwork and analysis remain ongoing and

this information extends beyond deciding whether intervention is justified. It may also influence **which intervention is most appropriate**. For example, an area with relatively high badger infection prevalence presents a different starting position for vaccination-only from an area in which infection prevalence is already low. [395]

7.5 Landscape, boundaries and intervention scale

Landscape should be treated as an epidemiological consideration rather than simply an administrative means of drawing boundaries.

DAERA proposes that intervention areas will be at least 100 km^2 and that rivers, major roads and other natural or physical boundaries should be used where possible to reduce badger movement across intervention-area boundaries. This is consistent with the scientific evidence reviewed in Annex VI, which emphasises the importance of ecology, habitat, population density and natural routes and barriers to movement when designing regional multi-species control. [396]

AgriSearch supports this principle. The 100 km^2 figure should therefore be regarded as a minimum scale and a convenient analytical reference rather than as an established epidemiological optimum. The appropriate size and shape of an intervention area should be determined by local disease geography, badger territories and density, suitable boundaries, cattle movements and the practicality of securing effective intervention coverage. [397]

There is also an upper constraint on the scale of intervention at any one time. DAERA states that, in order to remain consistent with the protection afforded to badgers under the Bern Convention, the total area subject to wildlife intervention would not at any one

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the interim findings should not be interpreted as providing a final Northern Ireland-wide population estimate.

[395] DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger vaccination' and Opinion Summary; DAERA (2026), Consultation, Chapter 8, pp. 62–63; Aznar, I. et al. (2018), 'Trial design to estimate the effect of vaccination on tuberculosis incidence in badgers', *Preventive Veterinary Medicine*, 154, 82–92; DAERA (2026), *Strategic Environmental Assessment*, section 2.7.2.6.

[396] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, section 4.2, pp. 26–27; DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, particularly pp. 5–10 and 22–23; O'Hagan, M.J.H., McCormick, C.M., Collins, S.F., McBride, K.R. and Menzies, F.D. (2021), 'Are major roads effective barriers for badger (*Meles meles*) movements?', *Research in Veterinary Science*, 138, 49–52, https://doi.org/10.1016/j.rvsc.2021.06.003; Tratalos, J., Madden, J., McGrath, G. and More, S. (2024), 'Computing metrics to inform selection of candidate areas for a regionalized approach to bovine tuberculosis eradication in Ireland', *Veterinaria Italiana*, 60(4 Special Issue), https://doi.org/10.12834/VetIt.3486.23927.2.

[397] **[2]** DAERA (2026c), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, paras. 2.7.1–2.7.2; TB Strategic Partnership Group (2016), *Bovine Tuberculosis Eradication Strategy for Northern Ireland*, Annex B, pp. 8–9; Tratalos et al. (2024).

time exceed 30% of Northern Ireland's agricultural land. [398] This further strengthens the case for rigorous prioritisation of intervention areas. Where only a proportion of the land area can be subject to intervention at any one time, resources should be concentrated where the epidemiological evidence indicates the greatest likelihood of wildlife involvement and where effective intervention coverage can realistically be achieved.

The emerging Queen's University Belfast population work also provides relevant contemporary evidence. Interim findings indicate that badgers were detected across all land-class types surveyed, including mountain habitats previously thought unsuitable, and in several areas where the 2007–08 survey had recorded no badger presence. These findings remain preliminary and do not establish that particular landscape features are ineffective barriers to badger movement. They do, however, reinforce the need to establish contemporary local badger presence and density rather than infer either absence or low density solely from historic survey results, broad land classification or apparent habitat suitability when defining intervention areas and boundaries. [399]

The importance of treating landscape as a dynamic epidemiological consideration may increase over the timescale of a bTB eradication strategy. The recently published report of the Northern Ireland Land Use Working Group does not itself prescribe a future pattern of land use and is advisory rather than Government policy. However, it brings together existing policy targets and wider pressures which could imply significant longer-term changes in woodland, peatland restoration, habitat creation and other land uses as Northern Ireland seeks to reconcile food production, climate, biodiversity and other objectives. Such changes are not considered in the report specifically in relation to bTB, but given the evidence that habitat, resource availability and landscape structure can influence badger density and movement, they could alter badger habitat suitability, distribution and movement and consequently the pattern of cattle–badger interaction. This further supports treating landscape and habitat as dynamic epidemiological considerations when intervention areas and boundaries are designed, rather than as fixed background characteristics. [400]

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[398] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 3, 'Bern Convention', p.24, and Chapter 4.2, 'Selection and Scale of Intervention Area', pp.26–27. DAERA states that the total intervention area would not at any one time exceed 30% of the total agricultural land area in Northern Ireland in order not to conflict with the protection afforded to protected species under the Bern Convention.

[399] Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, written communication to AgriSearch, 4 September 2026, reproduced at Appendix 4; see also Dick, J., *Badger populations in N. Ireland: a re-assessment with thermal technology*, QUB project proposal. Fieldwork and analysis remain ongoing and the interim findings should not be interpreted as providing a final Northern Ireland-wide population estimate. See also Byrne, A.W., O'Keeffe, J., Buesching, C.D. and Newman, C. (2019), 'Push and pull factors driving movement in a social mammal: context dependent behavioral plasticity at the landscape scale', *Current Zoology*, 65(5), 517–525.

[400] Northern Ireland Land Use Working Group (2026), *Land of Plenty? Report of the Northern Ireland Land Use Working Group*, particularly Executive Summary, pp. 4–5, and Annex B, pp. 43–54; DAERA (2025a),

There is some Northern Ireland-specific modelling support for 100 km^2 as an adequate management scale for TVR. Smith, Budgey and Delahay (2013) found no apparent substantial benefit within their model from increasing the managed area from approximately 100 km^2 to 200 km^2. This is relevant evidence and should be recognised. However, it was a model-specific finding concerning TVR, based on the parameters and assumptions available at that time, and does not establish 100 km^2 as a universal epidemiological optimum for every form of wildlife intervention or every Northern Ireland landscape. [401] Subsequent TBSPG work similarly envisaged intervention areas being determined with regard to local cattle disease, badger activity and infection, practical scale and natural boundaries. AgriSearch therefore considers that 100 km^2 may provide a reasonable starting scale for analysis or delivery, but actual intervention boundaries should also take account of local transmission patterns, natural barriers, contemporary evidence on badger presence and population density, land access and operational practicality. [402]

7.6 Local veterinary epidemiology and operational practicality

Quantitative data should be complemented by local veterinary and epidemiological knowledge. DAERA already includes this explicitly within its proposed area-selection criteria. [403]

Local veterinary teams may hold information that is difficult to capture fully within national datasets, including the history and circumstances of recurrent breakdowns, adjoining herd relationships, livestock movements, farm fragmentation, known badger activity and the practical context in which disease has persisted. [404] Local reports of

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Annex VI, 'Badger ecology', pp. 5–11; Byrne et al. (2019); Byrne et al. (2024), *Badger Ecology, Bovine Tuberculosis, and Population Management: Lessons from the Island of Ireland*, *Transboundary and Emerging Diseases*, 2024, 8875146.

[401] Smith, G.C., Budgey, R. and Delahay, R.J. (2013), A simulation model to support a study of Test and Vaccinate or Remove (TVR) in Northern Ireland, National Wildlife Management Centre, Animal Health and Veterinary Laboratories Agency, particularly pp. 15–17; DAERA (2026c), Annex IX, para. 2.7.1

[402] TB Strategic Partnership Group (2016), Bovine Tuberculosis Eradication Strategy for Northern Ireland, Annex B, pp. 8–9; DAERA (2026), Consultation, Chapter 4, section 4.2, pp. 26–27; DAERA (2026c), Annex IX, para. 2.7.2; O'Hagan et al. (2021a), 'Are major roads effective barriers for badger (Meles meles) movements?', Research in Veterinary Science, 138, 49–52.

[403] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, sections 4.1–4.2, pp. 26–27; DAERA (2026c), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, para. 2.7.2; DAERA (2026), *Strategic Environmental Assessment*, Annex IV, section 2.6.1. DAERA identifies local veterinary and epidemiological assessment as one of the factors to inform the selection and configuration of wildlife intervention areas, alongside cattle disease, badger density, physical boundaries and land access.

[404] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly pp. 22–28 and 65–66; Doyle, L.P. et al. (2020), 'Northern Ireland farm-level management factors for prolonged bovine tuberculosis herd breakdowns', *Epidemiology and Infection*, 148, e234; Doyle, L.P. et al. (2022), 'Northern Ireland farm-level management factors for recurrent bovine tuberculosis herd breakdowns', *Epidemiology and Infection*, 150, e176; Milne, G. et al. (2021), *Quantifying Land*

unusually high badger activity may also help identify areas warranting more detailed investigation. As discussed in Section 7.4, the interim QUB findings provide preliminary empirical support for using such reports to help prioritise systematic population assessment. They should nevertheless be confirmed through appropriate survey and interpreted alongside the wider epidemiological evidence rather than treated as a substitute for measured population density.

Operational feasibility should also be assessed before an area is finally selected. Previous DAERA area-selection criteria included topography, logistics and local knowledge, while the current options analysis acknowledges that land access is required for all wildlife interventions. Repeated trapping approaches in particular may also be constrained by terrain, access conditions and the practical burden of trap deployment and daily checking. [405]

An epidemiologically attractive intervention area in which sufficient land access, intervention coverage, workforce capacity or continuity of delivery cannot be achieved may perform poorly in practice. The characterisation exercise should therefore assess epidemiological suitability and operational deliverability together, while ensuring that ease of delivery does not become the primary determinant of where intervention occurs. [406]

7.7 Matching the intervention to the area

The consultation currently provides for the possibility that the Minister may select more than one intervention option and that DAERA could subsequently adopt an adaptable approach according to the disease picture in a particular area. [407]

Fragmentation Metrics for Cattle Enterprises in Northern Ireland. The CVO Review also records that DAERA officials already use the Badger App during bTB breakdown visits to collect local epidemiological information on sett locations and proposes wider reporting to improve knowledge of the distribution of badger activity.

[405] DAERA (2026), *Strategic Environmental Assessment*, Annex IV, section 2.5.1.1; DAERA (2026c), Annex IX, paras. 2.7.2 and 2.8–2.11; DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, section 8.1 and Table 27; DAERA (2026), Consultation, Chapters 6–8; Menzies, F.D. et al. (2021), 'Test and vaccinate or remove: Methodology and preliminary results from a badger intervention research project', *Veterinary Record*, 189, e248.**

[406] DAERA (2026b), Annex VIII, section 3.5 'Constraints and Dependencies' and section 8.1, Table 27; DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, p. 23; Smith, G.C. et al. (2022), regional wildlife-intervention framework discussed in DAERA (2025a), recommending that intervention planning should 'Confirm, Clarify, Resource and Exit'. DAERA's bibliography concludes that, irrespective of intervention method, thorough preparation, sound methodology and sufficient resources are essential. Annex VIII likewise identifies practical feasibility, labour availability and capability, resource availability and widespread land access as delivery constraints or risks.**

[407] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 5.1, p. 29; DAERA (2026), *Strategic*

AgriSearch considers that this is potentially important.

If the evidence shows that starting prevalence, population density and transmission dynamics vary substantially between areas, there is no necessary scientific reason to assume that the same intervention must be optimal in every location.

For example:

- an area with high badger infection pressure and strong evidence of wildlife involvement may warrant an intervention capable of reducing existing infection comparatively rapidly;
- an area with lower infection prevalence may present a stronger case for vaccination;
- where the respective contributions of cattle and wildlife are uncertain, further characterisation or an intervention capable of generating additional surveillance information may be appropriate;
- intervention may subsequently change as infection prevalence and disease risk decline. [408]

These examples should not be interpreted as predetermined prescriptions. Rather, they illustrate why the choice of intervention should follow diagnosis of the local epidemiological problem, not precede it.

This approach is consistent with recent peer-reviewed wildlife-intervention framework reviewed by DAERA. Smith et al. (2022) proposed that local wildlife intervention should begin by confirming the role of wildlife, clarifying the objective, ensuring adequate resources and identifying an exit strategy, followed by surveillance, definition of the infected area, intervention, measurement and adaptation. [409]

Environmental Assessment, Annex IV, sections 2.7.2 and 2.7.2.2. DAERA states that the Minister may select one or more intervention options and that, if more than one is selected, the Department may develop an adaptable approach to deployment based on the disease picture in the area.

[408] DAERA (2025b), *Scientific Opinion*, Annex VII, Scientific Opinion Conclusions 4, 7 and 9 and Opinion Summary; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 64–65. DAERA concludes that vaccination-only is likely to act more slowly where infection prevalence is high, describes hybrid/adaptive approaches as scientifically plausible, and states that there is no one-size-fits-all solution. The CVO Review proposes an illustrative adaptive approach in which first-year TVR could inform subsequent use of TVR or proactive culling in sub-areas with relatively high densities of test-positive badgers and vaccination in lower-prevalence sub-areas, with subsequent annual review.

[409] Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Vaclavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192, https://doi.org/10.1002/2688-8319.12192; see also DAERA (2025a), *Annotated scientific bibliography*, 'Future focus'. Smith et al. identify the initial considerations as 'Confirm, Clarify, Resource and Exit', followed by surveillance, definition and buffering of the infected area, intervention, monitoring and adaptive management.

Recent Northern Ireland evidence further supports attention to local land use and the wildlife–cattle interface when characterising an intervention area. Holmes et al. (2025), using GPS data from 35 bTB-test-negative badgers in the Northern Ireland TVR study area together with cattle grazing records across 446 fields on 18 farms, found substantial variation in badger use of cattle-grazed land. Individual badgers spanned a median of three farms; 71% were recorded repeatedly in the same fields as cattle, while 29% were never recorded co-occurring with cattle. [410] Badger field use was more strongly associated with dairy farms, fodder and rough grazing, and fields containing a badger sett. The study did not measure M. bovis transmission directly and was undertaken within one study area over one grazing season, so these patterns should not be converted into quantitative estimates of infection risk. They do, however, reinforce that opportunities for indirect badger–cattle contact can vary materially between farms and fields, and that land use, sett location and grazing management may be relevant both to local epidemiological characterisation and to targeted farm biosecurity.

Recent Northern Ireland evidence also supports retaining a wider wildlife perspective when characterising local bTB epidemiology. Allen et al. (2025) examined 522 deer sampled across Northern Ireland between 2019 and 2023, of which 13 were culture-positive for M. bovis, equivalent to 2.5% of the sampled animals. Whole-genome sequencing and phylodynamic analysis of deer and cattle isolates were consistent with infected cattle being the main detected driver of transmission, with deer playing a smaller role, although the analysis also indicated that deer were not simply a dead-end host and that some transmission back to cattle may occur. The sampling was associated with deer population-management activity and the findings do not establish deer as a maintenance reservoir across Northern Ireland or provide a basis for deer intervention. They do, however, support continued surveillance and the use of molecular and local epidemiological evidence to establish whether other wildlife hosts are contributing materially to transmission within particular areas. [411]

Recent all-island genomic work further strengthens the case for combining molecular and conventional epidemiological evidence when characterising an intervention area. O'Shaughnessy et al. (2026), analysing 5,875 M. bovis isolates from cattle and badgers across the island of Ireland, identified strong geographical structuring of strains alongside close genetic similarity between cattle and badger isolates, while also

[410] Holmes, E.L., O'Hagan, M.J.H., Menzies, F.D., Byrne, A.W., McBride, K.R., McCormick, C.M., Scantlebury, D.M. and Reid, N. (2025). Landscape as a shared space for badgers and cattle: insights into indirect contact and bovine tuberculosis transmission risk. Ecology and Evolution, 15(4), e71114. https://doi.org/10.1002/ece3.71114

[411] Allen, A., Porter, S., McCleery, D., Ranasinghe, P.D., Devaney, R., Ardis, T., Lyons, M., Whiteside, D., Corrigan, C., McCormick, C., Presho, E., Holmes, C., McCarthy, J., Decena, D., Doyle, M., Montgomery, J., Redpath, S., Thompson, S., Wright, L., Jones, K., Ferguson, I., Johnston, P., Ford, T., O'Brien, D., Salvador, L. and Skuce, R. (2025). Assessing the potential role of deer in the dissemination of Mycobacterium bovis infection to cattle in Northern Ireland. Infection, Genetics and Evolution, 128, 105721. https://doi.org/10.1016/j.meegid.2025.105721

identifying circumstances in which infection patterns were more consistent with inward cattle movements than local transmission. [412] Harvey et al. (2026) subsequently demonstrated, as a proof of concept, how WGS can be combined with cattle movement, spatial, wildlife and land-use information to distinguish probable local, within-herd and movement-associated transmission pathways. [413] The latter analysis was based on a single case study and should not be generalised quantitatively, but together the studies demonstrate the additional value obtained when WGS is interpreted alongside rather than separately from conventional epidemiological information. For intervention-area selection, this could help distinguish persistent local transmission potentially involving wildlife from infection patterns substantially influenced by cattle movements or other epidemiological links.

International experience also illustrates the importance of establishing whether wildlife infection represents an established maintenance reservoir or a more recent and geographically contained spillover event. In north-western Minnesota, M. bovis was detected in cattle and free-ranging white-tailed deer from 2005, but subsequent whole-genome sequencing showed little genetic divergence and was consistent with a relatively recent introduction. Intensive and geographically targeted cattle and wildlife measures were followed by no further detection of infected cattle or deer after 2009. The species, epidemiology and intervention methods differ substantially from Northern Ireland and this experience does not provide an efficacy estimate for badger intervention. It does, however, reinforce that the apparent stage and epidemiological role of wildlife infection should form part of the diagnosis used to select and scale an intervention. [414]

Continental European experience also illustrates how wildlife intervention can be linked explicitly to locally assessed risk. Spain's national PATUBES framework classifies areas using information including cattle TB prevalence, infection in recognised wildlife reservoirs, epidemiological and molecular evidence, wildlife density and opportunities for contact with livestock. [415] Wildlife surveillance is used to reassess risk over time,

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[412] O'Shaughnessy, J., Harvey, N., Byrne, B. et al. (2026). The genomic diversity and spatial patterns of Mycobacterium bovis in Ireland revealed by whole genome sequencing. Irish Veterinary Journal, 79, 6. https://doi.org/10.1186/s13620-025-00324-0.

[413] Harvey, N., McGrath, G., O'Shaughnessy, J. et al. (2026). Integrating whole-genome sequencing and epidemiology to characterise Mycobacterium bovis transmission in Ireland: a proof of concept. Irish Veterinary Journal, 79, 3. https://doi.org/10.1186/s13620-025-00321-3.

[414] Carstensen, M. and DonCarlos, M.W. (2011), 'Preventing the establishment of a wildlife disease reservoir: a case study of bovine tuberculosis in wild deer in Minnesota, USA', Veterinary Medicine International, 2011, 413240, https://doi.org/10.4061/2011/413240; Glaser, L., Carstensen, M., Shaw, S., Robbe-Austerman, S., Wunschmann, A., Grear, D., Stuber, T. and Thomsen, B. (2016), 'Descriptive epidemiology and whole genome sequencing analysis for an outbreak of bovine tuberculosis in beef cattle and white-tailed deer in northwestern Minnesota', PLoS ONE, 11(1), e0145735, https://doi.org/10.1371/journal.pone.0145735.

[415]Gobierno de España [Government of Spain] (2020), Real Decreto 138/2020, de 28 de enero, por el que se establece la normativa básica en materia de actuaciones sanitarias en especies cinegéticas que

with progressively stronger measures including biosecurity, restrictions on practices which promote wildlife aggregation and increased population control in higher-risk circumstances. [416] The Spanish reservoir system is dominated by wild boar and deer rather than badgers and therefore does not provide direct evidence for the efficacy of any particular Northern Ireland badger intervention. [417] It does, however, provide a relevant operational example of a transparent, risk-based framework in which the intensity of wildlife management follows the local epidemiological assessment rather than being applied uniformly across the country.

AgriSearch assessment

AgriSearch supports DAERA's proposal to undertake a characterisation exercise before wildlife intervention areas are established. The criteria already identified in the consultation: cattle disease burden, badger density, local badger infection, veterinary

actúan como reservorio de la tuberculosis (complejo Mycobacterium tuberculosis) [Royal Decree 138/2020 of 28 January, establishing the basic rules on animal-health measures for game species that act as reservoirs of tuberculosis (Mycobacterium tuberculosis complex)], Boletín Oficial del Estado [Official State Gazette], no. 38, BOE-A-2020-2109, particularly Article 4 and Annex II. The framework classifies veterinary districts or units by risk using cattle-herd prevalence, confirmed infection in wildlife reservoir species, microbiological/molecular evidence comparing strains, and, in specified circumstances, wildlife density and the extent of wildlife–cattle contact.

[416] Gobierno de España [Government of Spain] (2020), Real Decreto 138/2020, de 28 de enero, por el que se establece la normativa básica en materia de actuaciones sanitarias en especies cinegéticas que actúan como reservorio de la tuberculosis (complejo Mycobacterium tuberculosis) [Royal Decree 138/2020 of 28 January, establishing the basic rules on animal-health measures for game species that act as reservoirs of tuberculosis (Mycobacterium tuberculosis complex)], Boletín Oficial del Estado [Official State Gazette], no. 38, BOE-A-2020-2109, Articles 3, 9 and 10 and Annex VI. Article 3 requires annual surveillance of tuberculosis in wildlife reservoir species and periodic reassessment of the risk status of provinces and veterinary districts or units. Articles 9 and 10 apply progressively stronger measures in moderate-risk and special-risk areas, including enhanced livestock–wildlife biosecurity, wildlife population-management measures and, in specified cattle herds, biosecurity audits. Annex VI sets minimum requirements for those audits, including consideration of herd and wildlife tuberculosis history, farm mapping, wildlife presence and abundance, identification of risk points and the specification and follow-up of corrective measures.

[417] Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente (MAPAMA) [Ministry of Agriculture and Fisheries, Food and Environment] (2017), *PATUBES: Plan de Actuación sobre Tuberculosis en Especies Silvestres* [PATUBES: Action Plan on Tuberculosis in Wildlife Species], Madrid: MAPAMA; Gobierno de España [Government of Spain] (2020), *Real Decreto 138/2020, de 28 de enero, por el que se establece la normativa básica en materia de actuaciones sanitarias en especies cinegéticas que actúan como reservorio de la tuberculosis (complejo Mycobacterium tuberculosis)* [Royal Decree 138/2020 of 28 January, establishing the basic rules on animal-health measures for game species that act as reservoirs of tuberculosis (*Mycobacterium tuberculosis* complex)], *Boletín Oficial del Estado* [Official State Gazette], no. 38, BOE-A-2020-2109, Article 1. Article 1 establishes the national framework for animal-health measures addressing tuberculosis in game species that may act as wildlife reservoirs, providing the statutory basis for the risk-based approach developed through PATUBES.

and epidemiological information and suitable physical boundaries; provide a reasonable foundation. [418]

AgriSearch considers, however, that this framework could be strengthened by making more explicit use of recurrent and prolonged breakdown history, cattle movement information, WGS and strain evidence, contemporary and geographically resolved badger population and infection data, landscape and land-use characteristics, the local wildlife–cattle interface, and operational feasibility. The framework should also make clear how these different evidence streams will be combined and how uncertainty or conflicting indicators will be treated. [419] In particular, area selection should seek to establish a reasonable evidential basis for concluding that wildlife is contributing materially to the persistence or spread of infection within the area rather than assuming that all cattle bTB hotspots have the same underlying epidemiology. Northern Ireland's own evidence demonstrates that chronic or recurrent disease can have multiple causes and that the relative contribution of cattle and badgers can vary between locations. [420]

AgriSearch therefore recommends that DAERA publish a **t**ransparent intervention-area characterisation framework setting out:

1. the criteria used to identify candidate areas;
2. the evidence required to demonstrate likely wildlife involvement;
3. how cattle movements, recurrent disease and WGS information will be considered;

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[418] Department of Agriculture, Environment and Rural Affairs (DAERA) (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 1.2, p. 12 and Chapter 4, particularly sections 4.1–4.2, p. 26. The consultation proposes targeted intervention in areas of at least 100 km^2, taking account of long-term high cattle bTB levels, higher-than-average badger social-group density, evidence of local badger infection, local veterinary and epidemiological information and natural boundaries where available.

[419] DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, particularly pp. 5–11 and 16–17; Holmes, E.L., O'Hagan, M.J.H., Menzies, F.D., Byrne, A.W., McBride, K.R., McCormick, C.M., Scantlebury, D.M. and Reid, N. (2025), 'Landscape as a shared space for badgers and cattle: insights into indirect contact and bovine tuberculosis transmission risk', *Ecology and Evolution*, 15(4), e71114, https://doi.org/10.1002/ece3.71114; O'Shaughnessy, J., Harvey, N., Byrne, B. *et al.* (2026), 'The genomic diversity and spatial patterns of *Mycobacterium bovis* in Ireland revealed by whole genome sequencing', *Irish Veterinary Journal*, 79, 6, https://doi.org/10.1186/s13620-025-00324-0; Harvey, N., McGrath, G., O'Shaughnessy, J. *et al.* (2026), 'Integrating whole-genome sequencing and epidemiology to characterise *Mycobacterium bovis* transmission in Ireland: a proof of concept', *Irish Veterinary Journal*, 79, 3, https://doi.org/10.1186/s13620-025-00321-3.

[420] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly pp. 26–29 and 49–50; Doyle, L.P., Courcier, E.A., Gordon, A.W., O'Hagan, M.J.H., Johnston, P., McAleese, E., Buchanan, J.R., Stegeman, J.A. and Menzies, F.D. (2022), 'Northern Ireland farm-level management factors for recurrent bovine tuberculosis herd breakdowns', *Epidemiology and Infection*, 150, e176, https://doi.org/10.1017/S0950268822001479; Akhmetova, A. *et al.* (2023), 'Genomic epidemiology of *Mycobacterium bovis* infection in sympatric badger and cattle populations in Northern Ireland', *Microbial Genomics*, 9, 001023, https://doi.org/10.1099/mgen.0.001023.

4. how local badger population and infection information will be established;
5. how boundaries, scale, land access and operational coverage will be assessed;
6. how the resulting evidence will influence the choice**,** sequencing or subsequent adaptation of intervention; and
7. the baseline measures against which subsequent progress will be evaluated. [421]

The central question should therefore move beyond simply:

"Which wildlife intervention should Northern Ireland adopt?"

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and include:

"Given the cattle epidemiology, wildlife infection pressure, badger population, transmission evidence and practical circumstances in this area, which intervention - or sequence of interventions - provides the most appropriate response?"

[421] Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Vaclavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192, https://doi.org/10.1002/2688-8319.12192; see also DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, p. 23. Smith et al. propose the initial considerations 'Confirm, Clarify, Resource and Exit', followed by surveillance, definition of the infected area, intervention, measurement and adaptation.

8. Economic assessment

AgriSearch commissioned The Andersons Centre to undertake an independent review of the economic assumptions and analysis underpinning DAERA's consultation. [422] The purpose of the review was not to advocate for any particular wildlife intervention, but to assess whether the methods and assumptions used to compare the options are clearly stated, justified, robust, transparent, internally consistent and relevant to Northern Ireland conditions.

The Andersons review recognises that estimating the future costs and benefits of wildlife intervention is inherently difficult and necessarily involves assumptions and simplifications. It considers DAERA's broad methodological approach to be logical and the options to have been treated consistently in important respects, but found that independent scrutiny of several cost assumptions was severely constrained by the level of detail available within the published consultation material. [423]

Andersons therefore requested additional underlying information from DAERA on 18 August. DAERA supplied substantial additional data on 11 September 2026, after the Stage 1 analysis had been substantially completed. [424] That material has not been fully incorporated into the substantive Stage 1 analysis discussed below. Preliminary examination indicates that it provides considerably greater detail on several of the underlying calculations, although important assumptions remain to be tested and detailed DAFM information relating to the stopped-restraint options has not been released. [425]

AgriSearch considers this distinction important. The additional material may make it possible to reconstruct more of DAERA's underlying calculations, but reproducibility of the arithmetic is not in itself the same as robustness of the appraisal. Even where individual calculations are internally correct, the resulting economic conclusions

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[422] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, prepared for AgriSearch, September 2026, section 1.1.

[423] The Andersons Centre (2026), Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB, Executive Summary and sections 3.1–3.3. Andersons describes DAERA's component-based costing methodology as logical and says the options appear to have been treated consistently, while highlighting the lack of detail available to independently assess the calculations.

[424] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, Executive Summary and sections 1.1 and 2.2; Department of Agriculture, Environment and Rural Affairs (DAERA) (2026h), *Environmental Information Regulations 2004 response*, reference DAERA/26-659, 11 September 2026. Andersons requested additional background information from DAERA on 18 August 2026. DAERA supplied substantial additional material on 11 September, after the Stage 1 analysis had been substantially completed.

[425] Department of Agriculture, Environment and Rural Affairs (DAERA) (2026i), Public Interest Test – EIR, reference DAERA/26-659, 11 September 2026. DAERA did not release the detailed DAFM cost information underpinning the stopped-restraint options, relying on Regulations 12(5)(a) and 12(5)(e) of the Environmental Information Regulations 2004.

remain conditional on the assumptions that underpin them — including badger population density, capture and delivery requirements, intervention effectiveness, the timing and duration of benefits and the value attributed to avoided herd breakdowns. The central issue is therefore not simply whether the calculations can be reproduced, but whether the assumptions on which they depend are sufficiently evidenced, consistently applied and appropriately sensitivity-tested.

The Stage 1 findings should therefore be read as an assessment of the transparency and robustness of the economic evidence made available through the published consultation, rather than as a final audit of all subsequently supplied underlying workings.

8.1 Transparency and reproducibility of the appraisal

DAERA provides headline intervention costs in Annex VIII and identifies the broad data sources and cost categories in Annex IX. Andersons considers the general approach of building intervention costs from individual cost components to be logical and notes that, at a high level, the options appear to have been treated consistently. [426] However, it also observes that the restraint-trapping and controlled-shooting options appear to rely more heavily on aggregate external cost data, making it difficult to determine whether individual cost components and assumptions have been harmonised consistently across the different source datasets.

The principal difficulty for consultees is that the detailed workings were not published as part of the consultation. The consultation identifies categories such as labour, trapping, treatment, transport, equipment, monitoring and disposal, but does not generally provide sufficient information on the underlying quantities, hours, wage rates or individual unit costs to reproduce the headline totals. [427] In the published consultation, DAERA explained that full details had not been provided in order to avoid compromising any potential future procurement exercise.

DAERA subsequently released substantial additional information directly to Andersons on 11 September in response to an Environmental Information Regulations request. [428] That release materially improves the level of detail available for the cage-trapping and

[426] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, sections 3.2–3.3. Andersons describes the component-based methodology as logical and considers the options to have been treated consistently at a high level, while noting uncertainty over whether assumptions derived from different datasets have been harmonised.
[427] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, sections 2.2, 4.1–4.3; DAERA (2026), Annex IX, para. 1.1.2 and sections 2.14–2.20. DAERA identifies the broad inputs and methodology but does not publish the detailed workings necessary to reproduce many of the headline intervention costs.
[428] DAERA (2026h), Environmental Information Regulations 2004 response, ref. DAERA/26-659, 11 September 2026.

controlled-shooting options. However, it was received after Stage 1 analysis had been substantially completed and has not been subjected to a full independent reconstruction and assessment by Andersons. In addition, DAERA has not released the detailed DAFM information underpinning the stopped-restraint options on commercial-confidentiality and international-relations grounds. [429]

The material released comprises PDF and CSV files. While these provide extensive additional inputs and calculated outputs, the CSV files do not preserve the formulae and links between worksheets within the underlying spreadsheet model.

Publicly available Republic of Ireland programme data also provide a useful external benchmark. The Irish Comptroller and Auditor General reports that DAFM estimated that, in 2024, it cost approximately €468 to vaccinate a captured badger and €660 to cull a badger, and notes that costs are also incurred when previously vaccinated badgers are recaptured. [430] These figures are not directly transferable to Northern Ireland, nor are they necessarily calculated on the same accounting basis as DAERA's five-year intervention cost estimates. Programme structure, operating arrangements, capture effort and delivery conditions also differ. Nevertheless, given that DAERA's restraint-based cost estimates rely materially on high-level DAFM information which is not reproduced in the consultation papers, the published Irish figures reinforce the case for sufficient disclosure of the source unit costs and conversion assumptions to allow meaningful external comparison and sense-checking. [431]

Andersons accepts the procurement consideration but concludes that the absence of greater detail makes it difficult, and in some cases impossible, independently to judge whether the resulting cost estimates are robust. [432] DAERA does undertake a number of sensitivity analyses, but the headline consultation presents each option as a single monetary estimate, generally to the nearest £1,000. Andersons considers that this may convey a greater degree of certainty and accuracy than the underlying evidence warrants. Where the underlying evidence is necessarily incomplete or uncertain, that uncertainty should be made explicit in the headline presentation and reflected, where

[429] DAERA (2026i), *Public Interest Test – EIR*, ref. DAERA/26-659, 11 September 2026
[430] Comptroller and Auditor General (2025), *Report on the Accounts of the Public Services 2024*, Chapter 14, "Bovine TB eradication programme", para. 14.16 and Figure 14.2, p. 224. The report gives DAFM estimates of approximately €468 to vaccinate a captured badger and €660 to cull a badger, and notes that costs are incurred where previously vaccinated badgers are recaptured.
[431] DAERA (2026), Annex IX, paras. 2.16.1–2.16.6 and 2.19.1–2.19.3. DAERA states that it obtained high-level information from DAFM to estimate a euro cost per badger trapped using stopped restraints, converted this to sterling, and added separate assumptions for restraint equipment and, where applicable, TVR treatment costs. See also The Andersons Centre (2026), section 3.6.
[432] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, Executive Summary and sections 2.2, 3.7.2 and 4.2–4.3. Andersons concludes that the lack of detail severely constrains independent scrutiny and that presentation of five-year costs to the nearest £1,000 risks giving a misleading impression of certainty.

practicable, through ranges or scenario analysis rather than being obscured by precise single-point estimates.

AgriSearch considers that DAERA should publish sufficient information to allow the principal economic assumptions to be understood, sense-tested and reproduced, even if commercially sensitive elements need to be presented as ranges or at an appropriately aggregated level.

8.2 Underlying cost assumptions and delivery model

The intervention cost estimates are derived from three principal evidence sources. Cage-trapping options rely heavily on DAERA's Northern Ireland TVR pilot undertaken at Banbridge between 2014 and 2018; restraint-trapping estimates are largely derived from information supplied by DAFM in the Republic of Ireland; and the controlled-shooting option uses Defra information from England. [433]

These sources have different strengths and limitations. The Banbridge data have the advantage of being generated under Northern Ireland conditions and provide DAERA with direct operational experience of cage trapping. Andersons considers these data to be relatively robust, but questions whether costs derived from a research pilot undertaken between 2014 and 2018 can be assumed, after adjustment, to represent efficient large-scale operational delivery. It also notes that it is unclear what adjustments, if any, have been made to reflect the move from a trial setting to wider deployment. [434]

The Republic of Ireland restraint-trapping evidence appears to have been supplied at a relatively high level, including aggregate measures such as cost per badger trapped. The published Defra information used for controlled shooting provides somewhat greater detail, but Andersons nevertheless considers it to remain relatively high-level and notes that it was not possible from the published consultation material to determine how the aggregate English costs have been translated into the Northern Ireland appraisal. [435]

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[433] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, sections 2.3 and 3.6; DAERA (2026), Annex IX, paras. 1.1.3–1.1.4. DAERA bases the cage-trapping options principally on its 2014–2018 Banbridge TVR pilot, restraint-based options on high-level Republic of Ireland information and controlled shooting on Defra's 2019 Value for Money Analysis.

[434] The Andersons Centre (2026), Executive Summary and sections 3.6 and 4.2.3. Andersons considers the Banbridge evidence relatively robust but identifies concerns over its age, whether trial costs are directly applicable to general roll-out, and the absence of information on adjustments made for wider operational deployment.

[435] The Andersons Centre (2026), sections 3.3, 3.6 and 4.2.2. Andersons notes that the DAFM evidence appears to be based on high-level cost-per-badger information, while the Defra source provides more detail but remains relatively high-level; it is unclear whether labour rates and other cost assumptions from different jurisdictions and time periods have been harmonised.

This creates uncertainty over whether the resulting estimates are genuinely comparable on a like-for-like basis. In particular, it is not clear whether equivalent cost components, labour rates, overheads and other assumptions have been harmonised where evidence has been drawn from Northern Ireland, the Republic of Ireland and England, in some cases from different time periods. Presenting the resulting figures within a common appraisal framework does not, in itself, demonstrate that the underlying cost estimates have been placed on a fully equivalent basis.

There are also differences in the programmes from which the external benchmarks have been derived. The current Republic of Ireland programme is primarily reactive to local epidemiological risk rather than a directly equivalent proactive area-based intervention, which may result in different cost structures. [436]

A further distinction concerns the delivery model. Andersons notes that most of DAERA's private-sector costings appear to assume delivery by a commercial contractor, whereas the controlled-shooting estimate is derived from the English farmer-led company model. [437] DAERA itself acknowledges that farmer-led, not-for-profit companies could in principle deliver cage- or restraint-based vaccination, TVR or culling and that, if such arrangements proved feasible in Northern Ireland, their costs could be lower than the estimates currently presented. However, these alternatives have not been costed because sufficiently detailed delivery data are not available. [438]

AgriSearch therefore considers that future economic appraisal should distinguish clearly between the cost of the intervention method itself and the cost implications of the delivery model. Where more than one delivery model is realistically available, alternative commercial-contractor and farmer-led scenarios should be examined where sufficient evidence exists, rather than assuming that the currently costed model necessarily represents the most efficient form of delivery.

AgriSearch considers that the choice of delivery model should not be determined by headline cost alone. Private-sector or farmer-led delivery may provide an effective and cost-efficient means of implementation, but whichever model is selected should be

[436] The Andersons Centre (2026), section 3.6. Andersons notes that the current Republic of Ireland system is based on reactive intervention around bTB hotspots rather than proactive area culling, which may produce different cost structures.
[437] The Andersons Centre (2026), section 4.2.2. Andersons observes that most private-sector options appear to have been costed on the basis of commercial-contractor delivery, whereas Option 5 uses evidence from the English farmer-led cull model.
[438] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, sections 5.8.1–5.8.2; Annex VIII, discussion of delivery models. DAERA states that farmer-led not-for-profit companies could in principle deploy cage and restraint approaches for vaccination, TVR and culling, but that these alternatives have not been costed because sufficiently detailed delivery-model data are unavailable; it also acknowledges that costs could be lower than those currently estimated if such models were feasible.

required to demonstrate the capacity to deliver the intervention consistently, safely and to the required standard over its full geographical extent and intended duration.

At a minimum, delivery arrangements should provide for appropriately trained and demonstrably competent personnel; documented operating protocols and quality-assurance procedures; continuity of staffing and operational capacity over the full intervention period; complete and auditable records of effort, capture, vaccination, removal and relevant welfare or non-target incidents; timely reporting of operational and epidemiological data; and oversight, audit and performance monitoring that are organisationally separate from the delivery body itself. The cost of meeting these requirements—including supervision, quality assurance, data management, equipment, access arrangements, contingency capacity and regulatory compliance—should be reflected explicitly in the appraisal rather than assumed to be absorbed within a headline delivery cost. [439]

The question of who delivers the intervention should remain distinct from the question of who funds it. A conclusion that private-sector delivery is operationally preferable or less costly would not, by itself, establish that farmers or industry should finance the programme. Funding is considered separately in Section 8.8.

8.3 Labour, trapping, treatment and equipment

Andersons identifies labour as likely to be the largest single component of intervention cost and therefore one of the assumptions with greatest potential to influence the relative cost of the options. [440]

For the cage-trapping options, labour costs can in principle be built up from the hours required for each activity multiplied by the relevant labour cost. Activities include sett survey, trapping and associated preparation, travel, handling and treatment, training, monitoring and project management. However, neither the time assigned to individual tasks nor the detailed mix of staff grades was published as part of the consultation material available to Andersons for the Stage 1 review. Andersons therefore concludes

[439] DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, sections 5.8.1–5.8.2. DAERA proposes that commercial providers or farmer-led not-for-profit companies would operate under Departmental authorisation, monitoring and oversight, with requirements relating to competence, protocols, quality assurance and performance monitoring. See also Tetra Tech (2026), Strategic Environmental Assessment, Annex IV, section 2.7.2.8. The additional criteria identified by AgriSearch reflect the need to ensure that apparent differences in delivery cost are not achieved by omitting capacity, continuity, record-keeping, assurance or compliance requirements from the comparison.

[440] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, Executive Summary and sections 3.2 and 4.2. Andersons identifies labour as likely to be the largest component of intervention costs and therefore particularly important to the robustness of the appraisal.

that it is not possible to apply a meaningful external "sense check" to the labour requirement or to assess whether the allocation of staff and operational effort is efficient. [441]

There are also questions around the cost difference between public- and private-sector delivery. DAERA calculates public-sector labour using average salary by staff grade together with National Insurance and pension costs, and applies an average 30% economic-cost adjustment for central services and accommodation. [442] Private cage-trapping labour rates are adjusted using the Annual Survey of Hours and Earnings, which Andersons considers the most appropriate available source, but the percentage adjustment and detailed staff mix were not disclosed in the published consultation material. For restraint trapping and controlled shooting, labour is incorporated within more aggregated external cost figures. This makes it difficult to establish whether the volume and value of labour embedded within those estimates are directly comparable with the more disaggregated assumptions used for the cage-trapping options. [443]

Similar limitations apply to equipment and treatment costs. Andersons considers DAERA's list of relevant equipment and other cost categories to be comprehensive, including treatment equipment and consumables, trapping equipment, transport, communications and carcase disposal. [444] However, detailed quantities and unit costs were generally unavailable within the published consultation material considered in the Stage 1 review. The review was therefore unable independently to assess whether the individual quantities and costs underlying these categories are proportionate. The absence of criticism of an individual input should not therefore be interpreted as independent validation of that input.

The Andersons economic review also identifies a specific assumption affecting Option 5. DAERA assumes that 30% of badgers removed under the predominantly controlled-shooting option would be taken by cage trapping, based on experience from the initial English cull areas in 2013. [445] Andersons notes that the proportion requiring cage

[441] The Andersons Centre (2026), sections 4.2 and 4.2.3. Andersons notes that activity-level labour hours are not published and concludes that this prevents meaningful external sense-checking of the effort assumed for cage-trapping operations.
[442] DAERA (2026), Annex IX, paras. 2.4.1–2.4.3. Public-sector labour costs are based on average salary, National Insurance and employer pension costs by grade, with an average 30% economic-cost adjustment applied for central services and accommodation.
[443] The Andersons Centre (2026), sections 4.2.1–4.2.3. Andersons considers ASHE an appropriate source for private-sector wage rates but notes that the adjustment applied is not disclosed and that labour within restraint and controlled-shooting options is embedded within aggregate external cost data.
[444] The Andersons Centre (2026), section 4.3; DAERA (2026), Annex IX, Table 5. Andersons considers the range of equipment and related cost categories comprehensive but notes that detailed quantities and unit costs are not published.
[445] DAERA (2026), Annex IX, section 2.20; The Andersons Centre (2026), section 4.4.1. DAERA's Option 5 costing assumes that approximately 30% of badgers would be removed through supplementary cage trapping, based on experience from the initial English cull areas in 2013. Andersons notes that the cage-

trapping in most more recent English areas has been substantially lower. As cage trapping is more expensive per badger than controlled shooting, use of a lower cage-trapping proportion would reduce the estimated cost of Option 5. AgriSearch considers that this assumption should be transparently justified and specifically sensitivity-tested using more recent operational experience.

AgriSearch considers that greater transparency around both labour volume and labour value, together with sensitivity testing of operational assumptions that materially affect costs, would substantially strengthen confidence in the appraisal. Where detailed commercial information cannot be published, DAERA should provide sufficient activity-level assumptions, staff requirements and plausible ranges to allow the relative costs of the different interventions to be independently sense-checked.

8.4 Badger population, intervention scale and scalability

The number of badgers present is a direct driver of intervention cost. More badgers require greater trapping, vaccination, testing or removal effort to achieve the level of population coverage required by the chosen intervention.

DAERA's appraisal assumes 423 badgers per indicative 100 km^2 intervention area, equivalent to an average density of 4.23 badgers per km^2. [446] Andersons highlights the uncertainty surrounding this population assumption and notes that contemporary badger densities may differ materially from those historically assumed. If densities are higher, greater intervention effort would be required and costs would increase. Importantly, the final Andersons review also notes that the cost implications of higher badger densities are likely to differ between intervention methods because their capture, treatment and removal requirements differ. DAERA has not examined badger-density variation in its sensitivity analysis. [447]

The interim Queen's University Belfast findings make this uncertainty more tangible. Across 50 randomly selected 1 km^2 areas surveyed during winter and spring before cubs were born, observed badger density ranged from zero to 12 badgers per km^2, with a mean of three badgers per km^2 in those areas where badgers were detected. In four known badger hotspots, densities ranged from 12 to 18 badgers per km^2, with a mean of

trapped proportion in more recent English areas has generally been lower and that a lower assumption would reduce the estimated cost of Option 5.

[446] DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, section 2.14, particularly para. 2.14.2. DAERA's intervention cost calculations assume 423 badgers per 100 km^2, equivalent to 4.23 badgers per km^2.

[447] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, Executive Summary and section 4.1. Andersons notes that intervention costs depend on the number of badgers present, that contemporary densities may be higher than traditionally assumed, and that the cost implications of higher density are likely to differ between intervention methods; badger-density variation is not included in DAERA's sensitivity analysis.

14.25 badgers per km^2. [448] These interim findings do not demonstrate that DAERA's 4.23 badgers per km^2 assumption is systematically too high or too low, nor do they provide a revised Northern Ireland-wide population estimate. They do, however, demonstrate substantial local variation around any single central assumption. This is particularly relevant because DAERA proposes to target intervention towards areas with higher-than-average badger social-group density. [449]

Andersons does not, however, consider DAERA's use of a 100 km^2 unit of analysis to be a major flaw. Some common notional area is required to compare options, and DAERA expressly describes 100 km^2 as a convenient analytical unit rather than the intended size of every future intervention area. Andersons notes that actual intervention areas are likely to be larger and considers the use of a standard area reasonable for comparative purposes. [450]

The more important issue is the extent to which costs derived for a standard 100 km^2 area can be extrapolated to operational deployment. DAERA itself acknowledges that expressing costs per standard 100 km^2 area takes no account of scale effects and that the scale of operation may alter cost-effectiveness. [451] Larger or multiple intervention areas could generate efficiencies through learning, procurement and shared infrastructure, but could also create constraints around trained labour, management capacity, equipment, land access and logistics. Andersons similarly notes that scaling from a trial or limited operation to multi-area deployment could produce either economies of scale or additional resourcing and management pressures. [452]

AgriSearch considers that DAERA should therefore sensitivity-test the principal intervention costs across a realistic range of local badger-density assumptions, including credible higher-density scenarios, and across realistic scales of operational deployment. This should assess not only total intervention cost but also the

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[448] Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, written communication to AgriSearch, 4 September 2026, reproduced at Appendix 4. Fieldwork and analysis remain ongoing and the findings should not be interpreted as providing a final Northern Ireland-wide population estimate.
[449] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, sections 4.1–4.2. DAERA identifies higher-than-average badger social-group density as one of the factors to be considered when selecting intervention areas.
[450] The Andersons Centre (2026), section 3.4; DAERA (2026), Annex IX, section 2.7. DAERA describes 100 km^2 as a convenient unit allowing like-for-like comparison. Andersons concludes that use of a notional 100 km^2 unit is not a major issue for the comparative analysis, although actual intervention areas are likely to be larger.
[451] DAERA (2026), Annex IX, footnote 12 to section 2.7. DAERA acknowledges that expressing costs per standard 100 km^2 area takes no account of scale effects and that the scale of operation may alter cost-effectiveness.
[452] The Andersons Centre (2026), sections 3.4 and 3.7.2. Andersons notes that scaling from trial-level activity to larger or multiple intervention areas could produce economies of scale and learning effects, but could also create additional resourcing and management pressures.

implications for staffing, trapping effort, equipment requirements and the proportion of the local population that can realistically be captured, vaccinated, tested or removed. The use of a standardised 100 km^2 analytical unit is reasonable for comparison, but reliance on a single assumed badger population and simple linear extrapolation of those costs risks obscuring potentially important differences in operational feasibility, achievable coverage and cost between intervention areas.

8.5 Timing of costs and benefits

DAERA costs each intervention over a five-year intervention period and values the resulting avoided-breakdown benefits over a nine-year period from the commencement of intervention. [453]

Andersons questions the rationale for the five-year intervention period. It notes that more recent English controlled-shooting programmes have generally used an initial intensive four-year culling period, although supplementary culling has subsequently taken place in some areas. It also notes that the Northern Ireland parameterised model used by DAERA assumed an initial four-year cull, TVR or vaccination intervention followed by three years of vaccination, rather than the five-year initial intervention now being costed. [454]

Andersons also identifies an internal difficulty in the rationale for the nine-year benefit period. DAERA explains that the Northern Ireland model sought to consider effects for five years following the initial intervention. However, the nine-year period used in the economic appraisal is derived from the model's four-year initial intervention plus five further years, while the intervention currently being costed lasts five years. On that basis, Andersons suggests that, if a five-year intervention period is retained, a 10-year benefit period would be more internally consistent. [455] DAERA does, however, test alternative seven- and eleven-year benefit periods in its sensitivity analysis, and those

[453] DAERA (2026), *Badger Intervention Options Analysis*, Annex VIII, para. 5.3.4 and Table 5; *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, para. 2.9.1. DAERA costs each shortlisted intervention over five years and uses a nine-year benefit period from commencement for the main economic analysis.

[454] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, section 3.5. Andersons notes that recent English controlled-shooting programmes used initial intensive four-year periods and that the NI parameterised model used by DAERA was based on a different intervention structure from the five-year intervention currently being costed.

[455] The Andersons Centre (2026), section 3.5; DAERA (2026), Annex VIII, para. 5.3.4 and Table 5. Andersons questions the derivation of a nine-year benefit period from a four-year modelled initial intervention plus five years of follow-up when the economic appraisal itself assumes a five-year initial intervention, and suggests a 5:10 cost-to-benefit period.

scenarios demonstrate that the assumed duration of benefit can affect the economic outcome and, in some cases, the relative performance of options. [456]

Andersons considers that a five-year intervention period may be longer than necessary for some approaches, particularly culling by controlled shooting, where a four-year initial intensive period may be sufficient based on more recent English experience. AgriSearch considers this best regarded as an intervention-specific scenario to be tested rather than as a conclusion that all interventions should necessarily cease after four years. As discussed in the scientific assessment, appropriate duration and any subsequent transition or maintenance phase may differ between intervention methods and should ultimately reflect epidemiological evidence.

More generally, timing matters economically because a disease benefit realised earlier has a greater present value than the same benefit realised later. Culling, TVR and vaccination may differ in the speed with which disease effects emerge and in the duration for which those effects persist. Andersons expressly raises the question of whether different interventions may have different profiles of costs and benefits, while recognising that the underlying assumptions are primarily scientific rather than economic. [457] A common timeframe assists like-for-like comparison, but should not prevent intervention-specific timing scenarios being examined where there is sufficient evidence to support them.

DAERA discounts future economic costs and benefits using a real discount rate of 3.5%, reflecting the standard social time-preference approach used for public-sector appraisal. [458] Andersons does not identify the discount rate itself as a material concern. AgriSearch therefore does not draw a separate conclusion on the choice of discount rate. The more important issue identified by the independent review is whether the intervention duration, benefit period and timing of disease effects used before discounting accurately reflect the likely characteristics of each intervention.

[456] DAERA (2026), Annex VIII, section 6 and particularly sections 6.7–6.8. DAERA sensitivity-tests seven-, nine- and eleven-year benefit periods. The results show that changing benefit duration can alter illustrative NPVs and, in some scenarios, the relative ranking of options.
[457] The Andersons Centre (2026), section 3.5. Andersons notes that interventions may differ in the appropriate duration and timing of costs and benefits, for example, whether shooting could require fewer years than trapping or vaccination could produce longer-lasting effects, while recognising that these are principally scientific questions.
[458] DAERA (2026), Annex IX, paras. 2.6.2–2.6.3 and section 4.1. DAERA conducts the economic analysis in real terms and applies a 3.5% real discount rate reflecting social time preference to future costs and benefits.

8.6 Valuing avoided herd breakdowns

The economic benefit attributed to wildlife intervention is principally the value of cattle herd breakdowns avoided. This includes costs borne both by government and by affected farm businesses. [459]

DAERA does not claim to know precisely how many breakdowns each wildlife intervention will prevent. Instead, it first calculates a breakeven number of breakdowns: given the cost of an intervention and the estimated economic value of avoiding a breakdown, how many breakdowns would need to be prevented for the benefits to offset the intervention cost? DAERA then considers whether outputs from epidemiological modelling, and for culling relevant field evidence, suggest that this threshold could plausibly be achieved. [460]

The value attributed to an avoided herd breakdown is therefore a crucial assumption. DAERA estimates total breakdown-related costs of approximately £88.5 million and applies an estimate of 3,216 unique herd breakdowns, producing an average economic cost of approximately £27,500 per breakdown. [461] Andersons considers the methodology used to derive an average cost per breakdown to be reasonable, but notes that the resulting figure depends directly on whether the underlying estimate of total breakdown costs is complete.

Andersons considers DAERA's estimates of Government expenditure to be relatively robust, reflecting the Department's direct access to programme and compensation information. DAERA estimates total public expenditure on bTB at approximately £77.8 million in 2026/27, of which £66.1 million is attributed to breakdown-related costs. [462]

There is substantially greater uncertainty, and a material difference between estimates, over the costs borne by farmers. DAERA estimates total farmer costs at approximately £33.0 million, of which around £22.4 million is attributed to breakdowns. [463] The

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[459] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, paras. 1.2.1.2–1.2.1.3. DAERA defines the economic benefit of intervention as the value of herd breakdowns avoided, incorporating costs borne by government/taxpayers and farmers

[460] DAERA (2026), Annex IX, paras. 1.2.1.3–1.2.1.4; Badger Intervention Options Analysis, Annex VIII, section 5.3. DAERA first calculates the number of avoided breakdowns required for breakeven and then benchmarks these thresholds against the NI parameterised model and, for culling, the Four Areas Trial.

[461] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, Figure 2 and section 5.5. DAERA's estimated £88.5m of annual breakdown-related costs divided by 3,216 unique breakdowns produces an average cost of approximately £27,500 per breakdown. Andersons considers the methodology reasonable while questioning the underlying total breakdown-cost estimate.

[462] The Andersons Centre (2026), section 5.3. Andersons considers DAERA's government-cost calculations relatively robust and reports estimated 2026/27 public costs of £77.8m, of which £66.1m are breakdown-related.

[463] DAERA (2026), Annex IX, sections 3.6–3.7 and Table 12. DAERA estimates total farmer costs of £33.0m, comprising approximately £20.2m in programme-compliance costs and £12.8m in other costs, with £22.4m classified as breakdown-related.

Andersons Centre's separate March 2026 study estimated total indirect farmer costs of approximately £96.1 million. For the purposes of the current economic review, Andersons estimates that approximately £46.8 million of this could be associated with farms experiencing breakdowns, while explicitly acknowledging that the March study was designed to estimate total costs rather than divide them between breakdown and non-breakdown activity and that the £46.8 million figure is therefore likely to contain some non-breakdown costs. [464]

DAERA itself acknowledges that the March 2026 Andersons study was published after its economic calculations had been undertaken and that its own farmer-cost estimates are significantly lower. [465] Andersons identifies several reasons why the DAERA estimate may understate current farmer costs. The farmer compliance calculations draw partly on the 2009 Northern Ireland Better Regulation Survey, while several other cost assumptions originate in historic Defra studies and have subsequently been uprated using general inflation measures. Andersons questions whether this approach adequately reflects contemporary agricultural costs, Northern Ireland farm structures and the economic value of farmers' management time. [466]

The economic implication is important. If the true cost of a breakdown is higher than DAERA assumes, the value of preventing each breakdown is correspondingly greater. This would reduce the number of breakdowns that an intervention would need to prevent to reach breakeven and would increase the estimated economic benefit of interventions that successfully reduce cattle breakdowns. It does not, however, remove the separate uncertainty over how many breakdowns each intervention will actually prevent.

A further consideration is that the £27,500 figure is an average across Northern Ireland, whereas wildlife intervention is expected to be targeted towards areas with persistent or

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[464] The Andersons Centre (2026), *Economic Review*, sections 5.4–5.5 and Figure 2; The Andersons Centre (2026), *Review of the Indirect Costs Borne by Farmers as a Result of Bovine TB*, March 2026. The earlier study estimated aggregate indirect farmer costs at £96.1m annually. In the subsequent economic review Andersons apportions approximately £46.8m to farms experiencing breakdowns but cautions that this includes some routine non-breakdown activity and is therefore a slight overestimate of strictly breakdown-specific costs.

[465] DAERA (2026), Annex IX, footnote 61 to section 3.6. DAERA notes that the March 2026 Andersons study was published after its calculations had been undertaken and acknowledges that its own farmer-cost estimates are significantly lower.

[466] The Andersons Centre (2026), Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB, sections 5.4–5.5; DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, sections 2.3 and 3.4–3.6. DAERA's farmer-compliance estimate uses time inputs from the 2009 Better Regulation Survey, updated using contemporary ASHE wage rates, while its estimates of other farmer costs draw on Defra methodology and earlier cost sources uprated to 2026/27 prices. Andersons questions whether reliance on these historic inputs fully reflects contemporary Northern Ireland farm costs and the value of farmers' management time. See also The Andersons Centre (2026), Review of the Indirect Costs Borne by Farmers as a Result of Bovine TB, March 2026, section 3.2 and Figures 3-4–3-5.

recurrent cattle bTB and other evidence of local wildlife involvement. Breakdowns in such areas may be more severe, prolonged or recurrent than the Northern Ireland-wide case mix and may therefore impose higher costs. [467] If so, applying the national average would understate the economic value of breakdowns avoided in well-targeted intervention areas. The magnitude of any such effect cannot presently be quantified and should not be assumed in advance, particularly because recurrent breakdowns may also reflect residual or cattle-mediated infection within the herd. DAERA should therefore consider sensitivity testing higher breakdown-cost scenarios representative of prolonged or recurrent breakdowns in candidate intervention areas.

AgriSearch considers that DAERA should update and sensitivity-test the value attributed to avoided breakdowns using the best available contemporary Northern Ireland evidence. The March 2026 Andersons study provides an important current benchmark and should now be incorporated into that assessment, subject to appropriate adjustment to distinguish breakdown-specific from wider programme costs. Rather than relying on a single £27,500 value, DAERA should test a plausible range of breakdown costs derived from contemporary evidence and show how this affects breakeven thresholds and the resulting cost-benefit conclusions.

8.7 Uncertainty and sensitivity analysis

DAERA does undertake a substantial sensitivity analysis, including alternative assumptions around perturbation, policing costs, intervention cost increases, duration of benefits and benefits arising outside the immediate intervention area. [468] Andersons recognises that uncertainty is therefore addressed within the appraisal, but identifies several areas where sensitivity testing could be extended or made more symmetrical. [469]

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[467] DAERA (2026a), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, sections 4.1–4.2, pp. 26–27. DAERA proposes that intervention areas may be selected where badgers are contributing to ongoing cattle bTB problems, taking account of long-term high levels of cattle bTB, badger density and infection, and local veterinary and epidemiological information. See also DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly pp. 25–27 and 48–50, which identifies prolonged and recurrent breakdowns as contributing disproportionately high numbers of reactors and a significant financial burden, while also recognising that chronicity may arise from residual infection, cattle movements or purchases, wildlife and other epidemiological factors; Doyle et al. (2016) and Doyle et al. (2022); See also The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, section 5.5.

[468] DAERA (2026), *Badger Intervention Options Analysis*, Annex VIII, section 6. DAERA's sensitivity analysis examines perturbation, policing costs, changes in private-sector intervention costs, alternative seven- and eleven-year benefit periods and measurement of benefits across the wider "arena" as well as the core intervention area.

[469] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, section 3.7. Andersons recognises that DAERA addresses uncertainty principally through sensitivity analysis but identifies additional uncertainties and asymmetries which could be explored.

The importance of testing assumptions concerning timing and disease response has previously been demonstrated in Northern Ireland bTB appraisal. The 2016 PACEC cost-benefit analysis of the wider TBSPG eradication package tested alternative discount rates and different rates of decline in disease incidence. Its results showed that the lowest-cost option could change under materially different assumptions, including where disease incidence declined substantially more slowly than projected. [470] That analysis addressed a different policy comparison and a much longer appraisal period from the present wildlife assessment and should not be read across directly. Nor does it imply that the 3.5% discount rate used in the present appraisal is inappropriate. Its relevance is methodological: economic conclusions about disease-control programmes can be sensitive to assumptions about the speed and timing with which disease benefits are realised.

The Andersons review also examines sensitivity to the assumed epidemiological benefit itself. DAERA's economic appraisal uses modelled estimates of approximately 7.5 herd breakdowns avoided per year for non-selective culling, 7.3 for TVR and 2.3 for vaccination. [471] Andersons applies an illustrative ±15% change in assumed effectiveness across all intervention types and, for TVR only, also illustrates a wider ±30% range. The latter is not presented as a confidence interval or prediction of actual variability, but as a means of illustrating the greater evidential uncertainty where the cattle-level effect of TVR remains modelled rather than directly demonstrated. [472]

The exercise demonstrates that the economic conclusions remain conditional on the assumed epidemiological benefits being realised. Under the ±15% scenarios, the ordering of the leading economic options is unchanged, although Option 7 moves from a negative to a positive net present value under the higher-effectiveness scenario and Option 3 becomes negative under the lower-effectiveness scenario. Notably, Option 8 remains positive even under Andersons' illustrative 30% lower-effectiveness TVR scenario, although this should not be interpreted as validating the underlying effectiveness assumption itself. [473] AgriSearch considers the broader principle

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[470] PACEC (2016), *TBSPG Cost Benefit Analysis against Baseline of Draft Strategic Recommendations*, sections 6.5–6.6. PACEC tested alternative disease-reduction scenarios and discount rates. A 25% slower decline in disease incidence did not alter the preferred economic option, whereas a 50% slower decline did; the lowest-cost option also differed between the 3.5% and 8% discount-rate analyses.
[471] DAERA (2026), Annex VIII, para. 5.3.22; The Andersons Centre (2026), section 5.6. The NI parameterised model provides illustrative annual avoided-breakdown estimates of approximately 7.5 for non-selective culling, 7.3 for TVR and 2.3 for vaccination.
[472] The Andersons Centre (2026), section 5.6 and Figure 3. Andersons applies an illustrative ±15% effectiveness range to all intervention types and an additional ±30% range to TVR. It stresses that the latter does not predict actual variability but illustrates the greater uncertainty associated with a cattle-level effect that remains modelled rather than directly demonstrated.
[473] The Andersons Centre (2026), Figure 3 and section 5.6. Under the illustrative sensitivity analysis, Option 7 moves to a positive NPV with 15% greater effectiveness, Option 3 becomes negative at 15% lower effectiveness, and Option 8 retains a positive illustrative NPV of approximately £0.208m even at 30% lower TVR effectiveness.

important: uncertainty in the magnitude and timing of disease reduction should carry through explicitly into the economic appraisal rather than disappearing once a single modelled estimate of breakdowns avoided is assigned.

One concern is asymmetry in the treatment of cost uncertainty. DAERA applies cost increases of 15% and 30% to private-sector options but does not subject the public-sector cage-trapping options derived from the Banbridge pilot to equivalent cost sensitivity. Andersons considers the 15% and 30% private-sector scenarios reasonable, but questions whether costs derived from a research project undertaken around a decade previously should be treated as sufficiently certain to avoid comparable testing, particularly when wider deployment could generate either economies of scale or additional resourcing and management pressures. [474]

Similarly, DAERA's sensitivity analysis does not test materially different badger-population assumptions, despite the direct relationship between population size, intervention effort and cost. Andersons also notes that higher badger densities may affect intervention methods differently because their capture, treatment and removal requirements differ. [475]

Some private-sector option costs are also based on evidence transferred from different jurisdictions, delivery systems and time periods. Andersons therefore suggests that, while the 15% and 30% cost uplifts are reasonable, a more extreme uplift could also be considered as a "worst-case" scenario given the uncertainty surrounding some of the underlying external benchmarks. [476]

AgriSearch considers that uncertainty should be communicated not only through sensitivity analysis in supporting annexes but also in the way headline figures are presented. Indicative ranges would often convey the underlying evidence more accurately than single figures expressed to the nearest £1,000. Sensitivity analysis should concentrate particularly on assumptions capable of materially changing the economic conclusions, including epidemiological effectiveness, badger density, public-sector delivery costs, intervention scale and the value attributed to avoided herd breakdowns.

[474] The Andersons Centre (2026), section 3.7.2. Andersons notes that DAERA applies 15% and 30% cost increases to private-sector options but not to public-sector options based on the Banbridge pilot; it regards the private-sector ranges as reasonable but questions the absence of equivalent sensitivity around the older public-sector cost evidence.
[475] The Andersons Centre (2026), Executive Summary and section 4.1. Andersons identifies badger population density as a material cost driver which is not included in DAERA's sensitivity analysis and notes that its effects are likely to differ between intervention methods
[476] The Andersons Centre (2026), section 3.7.2. Andersons notes that private-sector baseline costs draw on evidence from different jurisdictions and suggests that a more extreme cost uplift could be considered as a worst-case scenario.

8.8 Who pays and the distribution of costs

DAERA's economic annexes largely defer decisions on how a future wildlife intervention would ultimately be financed. Annex VIII states that decisions on programme management and funding will be considered at a later stage. The main consultation document, however, goes further. It states that, because of constraints on public expenditure, it is proposed that industry would fund the delivery costs of privately delivered wildlife intervention, with Government meeting oversight, regulation, monitoring and compliance costs. Question 9 then asks whether respondents agree with this approach. [477]

Andersons identifies a tension between advancing this proposed funding split and the absence of a developed economic analysis of alternative funding arrangements. It notes that different models operate elsewhere: farmer-led companies have funded much of the English culling programme, while the Republic of Ireland programme is delivered by a private-sector contractor but partly financed through a statutory animal-disease levy. Andersons also notes that England's developing vaccination programme is Government-funded. [478] These examples illustrate that who delivers an intervention and who finances it are separate questions.

AgriSearch considers this distinction important. A private-sector delivery model may be more cost-effective without necessarily implying that farmers or industry should bear the full cost. Equally, the use of the term "private sector" should not obscure different possible funding arrangements, including direct contributions by participating landowners, wider industry funding or levy-based approaches.

Earlier Northern Ireland strategy work also provides relevant context. The 2016 TBSPG Finance work explicitly sought to rebalance the cost of bTB between the public and private sectors and promote shared responsibility for eradication. At the same time, it recognised that affected farms already incur substantial uncompensated costs beyond the value of animals removed. [479] Importantly, the consultation evidence considered by TBSPG recorded the industry view that no justification for changing the existing funding

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[477] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 5.8 and p. 43, Questions 8–9. DAERA states that, owing to constraints on public expenditure, it proposes that industry should fund private-sector wildlife-intervention delivery costs while Government funds oversight, regulation, monitoring and compliance.

[478] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, section 4.4.2. Andersons notes that the economic annexes defer funding decisions despite Question 9 and contrasts the farmer-funded English cull, the DAFM-contracted Republic of Ireland programme partly financed through an animal-disease levy, and the Government-funded emerging English badger-vaccination programme.

[479] TB Strategic Partnership Group (2016), *Bovine Tuberculosis Eradication Strategy for Northern Ireland*, Chapter 6, Finance; TBSPG, *Background Thinking Paper – Finance*, pp. 2–4. The Finance work sought to rebalance costs between the public and private sectors while recognising the substantial additional costs incurred by farm businesses beyond compensation for removed animals.

arrangements could be countenanced until a robust programme was in place with a reasonable possibility of eradicating bTB. [480] The TBSPG subsequently recommended that implementation of finance measures should be linked to progress on other key recommendations and kept under review as the disease picture evolved. [481]

The current Blueprint takes a similarly staged approach, committing in the short term to "consider and evaluate options for financial sustainability for both farm businesses and government", before consultation and implementation of any agreed finance reforms. [482] AgriSearch considers that the funding of wildlife intervention should be approached on the same evidence-led basis.

On the evidence currently available, AgriSearch does not consider there to be a sufficient basis to endorse the specific funding proposition in Question 9 that the private sector should meet the operational costs of wildlife intervention while Government funds only oversight, regulation and monitoring. This should not be interpreted as opposition in principle to an appropriate industry contribution within a future eradication programme. Rather, the scale, mechanism and conditions of any contribution should be determined only following a separate and transparent assessment of public and private benefits, existing costs borne by farmers, affordability, distributional impacts and the expected effectiveness of the programme.

For the avoidance of doubt, nothing in this consultation response should be interpreted as AgriSearch agreeing to a new or additional levy for wildlife intervention or endorsing any particular Government–industry funding split. Any future proposal involving AgriSearch's levy income would require separate consideration through AgriSearch's own governance arrangements and would need to be consistent with its charitable purposes. Any future proposal for an industry contribution should therefore be supported by a separate and transparent assessment of:

- the overall public and private benefits arising from successful intervention;
- the existing economic burden of bTB already borne by farmers;
- affordability and the distribution of costs between different farm sectors and businesses;

[480] TBSPG (2016), *Background Thinking Paper – Finance*, pp. 5–6. In the consultation evidence considered by TBSPG, industry argued that no justification for changing the prevailing funding arrangements could be accepted until there was a robust programme in place with a reasonable possibility of eradicating bTB.
[481] TBSPG (2016), *Background Thinking Paper – Finance*, p. 9. TBSPG stated that implementation of finance recommendations should be linked to progress on other key recommendations and kept under review in light of the changing disease picture.
[482] TB Partnership Steering Group (2025), *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Finance action. The Blueprint provides first for consideration and evaluation of options for financial sustainability for both farm businesses and Government, followed by consultation and implementation of any agreed reforms.

- the extent to which the intervention delivers wider animal-health, wildlife-health, trade and public benefits;
- the relationship between any contribution and the expected effectiveness of the intervention; and
- the respective financial responsibilities of Government and industry within the wider eradication programme.

The current appraisal does not, in AgriSearch's view, provide a sufficient economic basis to determine the appropriate funding split. In particular, evidence that private-sector delivery may be cheaper should not, by itself, be treated as evidence that full private-sector funding is economically justified.

AgriSearch recognises the substantial potential benefit to rural communities from achieving sustained reductions in bTB and has not identified evidence that would justify challenging the overall conclusions of DAERA's Rural Needs Impact Assessment at this stage. However, the practical and economic effects of implementation may not necessarily be distributed uniformly across farms or geographical areas. Wildlife intervention is intended to be geographically targeted, and the selection and sequencing of intervention areas will therefore determine which farms and rural communities experience intervention first, while delivery may also require extensive land access, cooperation with farmers and landowners and differing levels of practical involvement. [483]

These considerations should be monitored as the programme develops. In particular, DAERA should consider the distribution of additional costs, farmer and landowner time, access requirements and other practical burdens associated with delivery; the effect of any future industry contribution or funding mechanism on different types of farm business; and whether regional prioritisation results in materially different short- or medium-term impacts between rural areas. This does not imply that such differences will necessarily be adverse or inequitable, but it would be prudent to monitor them rather than assume that a nationally applicable policy will have identical effects in every locality. Where material differential rural impacts emerge, the Rural Needs Impact Assessment should be revisited and appropriate mitigation considered. [484]

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[483] DAERA (2026), *Rural Needs Impact Assessment*, Annex II, sections 2–5; DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, particularly sections 4.1–4.2; DAERA (2026b), *Badger Intervention – Options Analysis Paper*, Annex VIII, section 8.1 and Table 27. DAERA identifies intervention-area selection, widespread land access, labour and operational capacity as relevant implementation considerations. See also Section 7 of this response.

[484] DAERA (2026), *Rural Needs Impact Assessment*, Annex II. The assessment recognises significant financial, labour and social impacts of bTB on farm businesses and rural communities and identifies rural businesses, employment, poverty/deprivation and rural development among the relevant policy areas. See also The Andersons Centre (2026), *Review of the Indirect Costs Borne by Farmers as a Result of Bovine TB*, particularly its assessment of farm-level financial, labour and wider rural-economic impacts.

AgriSearch therefore considers that DAERA has not yet demonstrated that the funding split proposed in Question 9 is the appropriate model. Any future industry contribution should be subject to separate and transparent appraisal. For the avoidance of doubt, this response should not be interpreted as AgriSearch endorsing a new or additional levy or any particular Government–industry funding split. Any proposal involving AgriSearch's levy income would require separate consideration and approval through AgriSearch's own governance arrangements.

8.9 Economic ranking and the overall option ranking

An important distinction identified by Andersons is the difference between the economic ranking of the options and DAERA's overall composite ranking. [485]

Under DAERA's principal economic analysis, which assumes no perturbation effect for non-selective culling, the highest-ranked intervention is Option 5, non-selective culling using predominantly controlled shooting, principally because of its relatively low implementation cost. This is followed by Option 4, non-selective culling using restraints; Option 8, TVR using restraints; and Option 3, private-sector cage-trap culling. However, DAERA's separate perturbation sensitivity scenario changes the economic ranking materially. When perturbation is applied to the non-selective culling options, but not to TVR, Option 8 becomes the highest-ranked option on illustrative net present value, ahead of Options 5 and 4. The economic ranking is therefore contingent on the epidemiological scenario being applied rather than representing a fixed ordering of the interventions. [486]

This does not mean that Andersons recommends either Option 5 or Option 8. Its review does not endorse a particular intervention, and the economic ranking is only one element of DAERA's wider assessment.

DAERA separately assesses the options against non-monetary considerations and operational risks. At the final ranking stage, each option's economic rank, non-monetary rank and risk rank are added together and divided by three, giving the three categories equal weight in the composite result. [487] Under both DAERA's no-perturbation and

[485] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, sections 5.6–5.7. Andersons distinguishes between the ranking generated by the economic appraisal and the overall ranking produced after combining economic, non-monetary and risk assessments.
[486] The Andersons Centre (2026), section 5.6; DAERA (2026), Badger Intervention Options Analysis, Annex VIII, sections 6.1, 6.8 and 9.3. Under DAERA's principal no-perturbation economic analysis, Option 5 ranks first, followed by Options 4, 8 and 3. When perturbation is assumed for the non-selective culling options, Option 8 ranks first on illustrative NPV, ahead of Options 5 and 4.
[487] DAERA (2026), *Badger Intervention Options Analysis*, Annex VIII, section 9.3 and Table 29. DAERA calculates the final average rank by adding each option's economic, non-monetary and risk ranks and dividing by three.

perturbation scenarios, Option 8, TVR using restraints, is the highest-ranked overall option, although the precise average scores differ. [488]

Andersons questions whether equal weighting of the three final ranking categories is necessarily the only appropriate approach. In particular, it notes that a quantitative economic appraisal is being combined on an equal basis with scored but more qualitative assessments of non-monetary factors and risk. Andersons treats this as a public-policy question rather than a matter capable of being resolved by economic analysis alone. [489]

Andersons illustrates the significance of the weighting choice. If the economic criterion is given twice the weight of each of the other two categories, Option 8 remains highest-ranked, with a weighted score of 2.5, but the gap to Option 5 narrows to 3.3. If economics is given 3.5 times the weight of the other categories, Options 5 and 8 have the same overall score of 2.6. [490] This demonstrates that the composite ranking is not invariant: it depends materially on the value judgements embedded in the weighting scheme.

AgriSearch considers that economic considerations should carry substantial weight in the final appraisal. Bovine tuberculosis already imposes very significant costs on farmers and the public purse, while any wildlife intervention would require material expenditure over a number of years and could potentially involve a future industry contribution. Cost-effectiveness and the economic value of disease reduction are therefore not peripheral considerations.

A separate weighting issue arises within the non-monetary assessment itself. Five criteria are scored equally, but three of them, specifically cattle killed prematurely, GHG-related inefficiency and human welfare, are all derived from the same underlying modelled number of herd breakdowns avoided. These represent genuinely different consequences of disease and are therefore legitimate policy considerations, but they are not analytically independent. Giving each criterion equal weight means that the same underlying APHA model output influences three of the five non-monetary criteria and therefore 60% of the non-monetary score. [491] DAERA should make this dependence

[488] DAERA (2026), Annex VIII, paras. 9.3.21–9.3.24 and Table 29. Without a perturbation effect for non-selective culling, Option 8 has an average rank of 2.3 and ranks first; when perturbation is assumed, Option 8 remains first with an average rank of 1.7.
[489] The Andersons Centre (2026), section 5.7. Andersons notes that the three ranking categories are given equal weight and questions whether some criteria, such as economic benefit, might reasonably receive greater weight than more qualitative perceived risks, while recognising that this is ultimately a public-policy judgement.
[490] The Andersons Centre (2026), section 5.7. Andersons' illustrative reweighting gives Option 8 a score of 2.5 and Option 5 a score of 3.3 where economics receives twice the weight of the other categories; at 3.5 times the economic weight, Options 5 and 8 both score 2.6.
[491] DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII, section 7.3 and paras. 7.4.4–7.4.6, Tables 22–25. DAERA states that the five non-monetary criteria are treated as equally weighted (para. 7.1.1). The cattle-welfare assessment derives the estimated number of cattle killed prematurely

explicit and test whether alternative groupings or weightings materially affect the resulting assessment.

AgriSearch does not seek to prescribe a single numerical weighting, because the final balance between economic, welfare, environmental, operational and other considerations is ultimately a matter for Government. However, it is not self-evident that each of these broad categories should receive equal weight. DAERA should explain the rationale for the weighting adopted and test alternative plausible approaches, including scenarios in which economic performance receives greater weight. The resulting trade-offs and any change in the preferred option should be shown transparently.

AgriSearch considers this an important point of transparency. Government is entirely entitled to consider animal welfare, environmental impacts, operational risk, public acceptability and other non-monetary factors alongside economics. However, the resulting overall ranking should be presented clearly as a multi-criteria policy judgement, rather than as the outcome of the economic appraisal itself.

DAERA should therefore explain the rationale for the relative weighting attached to the economic, non-monetary and risk components and show whether the overall ranking remains stable under reasonable alternative weighting assumptions. The separate economic ranking should also remain visible alongside the composite result so that stakeholders can see clearly how the inclusion and weighting of wider policy considerations changes the ordering of the options.

AgriSearch assessment

The independent Andersons review provides useful reassurance in some areas. It considers DAERA's broad cost-building methodology logical, finds that the options appear to have been treated consistently at a high level, regards the use of a common 100 km^2 comparison unit as reasonable for analytical purposes and considers the Department's estimates of its own bTB programme costs to be relatively robust. [492]

from APHA-modelled herd breakdowns; the GHG criterion is linked to the resulting number of cattle killed prematurely; and the human-welfare assessment derives the number of farm household members affected from the modelled number of herd breakdowns. Table 25 then gives each of these criteria equal weight within the overall non-monetary score; See also The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, section 5.7, which similarly notes that three of the five non-monetary criteria derive from the same underlying APHA-modelled number of herd breakdowns avoided and that the APHA model therefore influences 60% of the non-monetary score.

[492] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, sections 3.2–3.4 and 5.3. Andersons describes the component-based costing approach as logical, considers the options to have been treated consistently at a high level,

The principal limitation of the Stage 1 review was the amount of supporting information available through the published consultation to test the intervention cost estimates independently. This particularly affected labour requirements and rates, the translation of data from the Banbridge TVR pilot to wider operational delivery, restraint-trapping and controlled-shooting costs derived from external programmes, and the extent to which cost components and assumptions drawn from different jurisdictions and delivery models had been harmonised between options. [493]

The additional information supplied by DAERA on 11 September substantially improves transparency around several of these matters, particularly the cage-trapping and controlled-shooting calculations. [494] Preliminary examination indicates that the published headline costs for those options can be reconstructed from the data supplied. However, this does not in itself establish that all of the underlying assumptions are robust, and the detailed DAFM information underpinning the stopped-restraint options remains unavailable for independent scrutiny. [495] A fuller independent reconstruction of the newly released material could provide additional assurance, but has not been undertaken within the Stage 1 exercise and remains available if subsequently considered necessary.

Importantly, Andersons does not conclude that these uncertainties remove the economic case for wildlife intervention. Under DAERA's baseline modelling, Options 3, 4, 5 and 8 produce a positive net present value, and Andersons ultimately concludes that investment in wildlife intervention "seems worthwhile" when indicative intervention expenditure is considered alongside the substantial annual economic cost of bTB. [496] This is not an endorsement of any particular intervention option, and Andersons also emphasises that the economic benefits remain conditional on the assumed reductions in cattle herd breakdowns actually being realised.

AgriSearch considers seven findings particularly relevant to the eventual policy decision:

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regards the 100 km^2 analytical unit as reasonable for comparison and considers DAERA's estimates of Government bTB costs relatively robust.

[493] The Andersons Centre (2026), Executive Summary and sections 2.2, 3.3, 3.6 and 4.1–4.3. Andersons repeatedly identifies the lack of detailed workings, uncertainty over labour inputs and difficulties in comparing cost evidence derived from DAERA, DAFM and Defra sources.

[494] DAERA (2026h), Environmental Information Regulations 2004 response, ref. DAERA/26-659, 11 September 2026.

[495] DAERA (2026i), *Public Interest Test – EIR*, ref. DAERA/26-659, 11 September 2026.

[496] The Andersons Centre (2026), sections 5.6–5.8 and Executive Summary. Under DAERA's baseline modelling, Options 3, 4, 5 and 8 produce positive NPVs. Andersons concludes that, although wildlife intervention cannot alone eradicate bTB, "an investment in wildlife intervention seems worthwhile" when indicative intervention expenditure is compared with the annual economic cost of breakdowns. The report also states that neither AgriSearch nor Andersons has a preference for any particular wildlife intervention.

1. **The precision with which intervention costs are presented exceeds the degree of certainty apparent in some of the underlying evidence.** Headline single-point estimates expressed to the nearest £1,000 risk conveying greater accuracy than can reasonably be supported.
2. **Badger population density and operational scale are potentially important cost drivers.** Contemporary evidence demonstrates substantial local variation in badger density, while DAERA's present sensitivity analysis does not test alternative population assumptions. Higher density may also affect intervention methods differently because their capture, treatment and removal requirements differ. [497]
3. **DAERA's valuation of the economic burden of cattle breakdowns appears likely to understate the costs borne by farmers.** If the value of an avoided breakdown is higher than DAERA currently assumes, successful disease intervention becomes correspondingly more economically valuable and the number of breakdowns required to reach breakeven falls. [498]
4. **The economic benefits attributed to wildlife intervention remain conditional on assumed epidemiological effects.** This is particularly important for TVR, where the cattle-level effect used in the appraisal remains modelled rather than directly demonstrated. Andersons' additional effectiveness sensitivity analysis illustrates this uncertainty, while also showing that Option 8 remains economically positive under its illustrative 30% lower-effectiveness scenario. [499]
5. **The duration and timing of costs and benefits require further testing.** Andersons questions the consistency between the five-year intervention period and nine-year benefit period and suggests that different intervention methods may warrant different timing assumptions. AgriSearch considers these intervention-specific scenarios that should be informed by the scientific evidence rather than imposed uniformly.

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[497] The Andersons Centre (2026), Executive Summary and sections 4.1 and 3.7.2. Andersons identifies badger population as a direct driver of intervention cost, notes that higher densities may affect intervention methods differently and observes that badger-density variation is not included in DAERA's sensitivity analysis. See also Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, reproduced at Appendix 4.

[498] The Andersons Centre (2026), sections 5.3–5.5 and Figure 2. Andersons considers DAERA's Government-cost estimates relatively robust but identifies a substantial discrepancy between DAERA's estimate of farmer breakdown costs (£22.4m) and the corresponding approximate breakdown-related component derived from Andersons' March 2026 study (£46.8m), while recognising that the latter includes some non-breakdown activity.

[499] The Andersons Centre (2026), section 5.6 and Figure 3. Andersons stresses that DAERA's economic results remain conditional on modelled cattle benefits being realised. Its illustrative effectiveness sensitivity applies ±15% across intervention types and ±30% to TVR; Option 8 retains a positive illustrative NPV at 30% lower assumed TVR effectiveness.

6. **The choice of delivery model should be distinguished from the question of who pays.** Evidence that private-sector delivery may reduce operating costs does not in itself establish that farmers or industry should bear the full cost of intervention. Any proposed industry contribution requires a separate assessment of public and private benefits, existing farmer costs, affordability and expected programme effectiveness.
7. **The economic ranking is scenario-dependent,** while the composite ranking is also weighting-dependent. Under DAERA's principal no-perturbation economic scenario, Option 5 ranks highest on illustrative NPV, whereas under the sensitivity scenario applying perturbation to non-selective culling alone, Option 8 ranks highest. Option 8 also ranks highest in DAERA's composite assessment under both the no-perturbation and perturbation scenarios. Andersons demonstrates that the relative position of Options 5 and 8 changes materially when alternative weighting is applied, confirming that the composite ranking represents a multi-criteria policy judgement rather than an economic conclusion alone. [500]

AgriSearch therefore recommends that, before a final intervention, delivery model and funding approach are selected, DAERA should publish sufficient additional information to allow the principal economic calculations to be independently understood and sense-tested; update and sensitivity-test key assumptions around badger population density, operational scale, labour, intervention duration, the value of avoided breakdowns and modelled intervention effectiveness; and present headline cost estimates in a manner that more accurately reflects the underlying uncertainty.

The appraisal should also distinguish clearly between the **intervention method**, the **delivery model** and the **funding model**, retain the separate economic ranking alongside any composite assessment, and explain the rationale for the weighting applied to wider policy considerations. In particular, uncertainty in the expected cattle-level benefit of each intervention should be carried explicitly through into the economic appraisal rather than being lost when modelled epidemiological outputs are converted into monetary benefits.

The principal remaining uncertainty is therefore not simply whether the detailed arithmetic can be reconstructed, but whether the scientific, operational and economic

[500] The Andersons Centre (2026), sections 5.6–5.7; DAERA (2026), Badger Intervention Options Analysis, Annex VIII, sections 6.1, 6.8 and 9.3 and Table 29. Under DAERA's no-perturbation economic analysis, Option 5 ranks first and Option 8 third; when perturbation is applied to the non-selective culling options, Option 8 ranks first. In the composite assessment, Option 8 ranks first under both scenarios. Andersons' illustrative reweighting leaves Option 8 first where economics receives twice the weight of each other category but produces equal overall scores for Options 5 and 8 when economics receives 3.5 times the weight.

assumptions driving those calculations are sufficiently robust and remain valid under plausible alternative scenarios.

9. Bringing the scientific and economic evidence together

The scientific and economic assessments considered in the preceding sections are complementary, but they answer different questions. The scientific evidence concerns whether an intervention is likely to reduce infection in badgers and, ultimately, cattle; the economic assessment considers the resources required to deliver that intervention and whether the resulting disease reduction is likely to justify those costs. [501]

DAERA's own analytical framework illustrates this interdependence. The economic appraisal first estimates the cost of each intervention, then defines its benefit in terms of the value of cattle herd breakdowns avoided over time, before considering whether the number of breakdowns required for the intervention to break even appears achievable. This is a logical structure, but it also means that the economic conclusions are necessarily conditional on the scientific assumptions used to estimate the number and duration of herd breakdowns avoided. Where those inputs are modelled or otherwise uncertain, that uncertainty carries directly into the resulting estimates of economic benefit. [502]

The resulting scientific and economic evidence therefore cannot sensibly be interpreted in isolation. A relatively inexpensive intervention does not represent good value if it delivers insufficient disease reduction, while an epidemiologically effective intervention may not represent a practical or proportionate option if its costs are excessive or it cannot be delivered at the required scale. Equally, where the expected cattle benefit is

[501] Department of Agriculture, Environment and Rural Affairs (DAERA) (2025), DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis, Annex VII to the 2026 consultation, p. 1; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, section 5.1, pp. 39–40; DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, section 1.2, pp. 4–6. The Scientific Opinion defines scientific viability in terms of whether an intervention can be implemented and is likely to reduce bTB in badgers and cattle, while expressly excluding economic considerations. The economic analysis separately estimates intervention costs and treats the economic benefit of intervention as the value of cattle herd breakdowns avoided.

[502] DAERA (2026), Badger Intervention Analyses – Calculation Assumptions, Annex IX, section 1.2, pp. 4–6; DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, sections 5.1 and 5.3, pp. 39–40 and 47–57. DAERA estimates intervention costs separately and defines economic benefit as the value of herd breakdowns avoided over the period in which intervention benefits are assumed to persist. Because the number of breakdowns avoided specifically as a result of wildlife intervention is uncertain, the appraisal first calculates the number required for breakeven and then compares this with available field evidence and outputs from a Northern Ireland-parameterised model. DAERA notes that the model outputs should not be treated as predictions but as broad indications of relative performance.

based principally on modelling rather than observed field outcomes, that scientific uncertainty necessarily carries through into the economic appraisal. [503]

DAERA itself recognises that all three principal approaches are scientifically viable but have different characteristics. Its Scientific Opinion concludes that interventions containing a lethal component are generally expected to provide a faster response than vaccination-only, that proactive culling has demonstrated cattle benefits in field trials, that TVR shows promise but did not demonstrate a cattle herd-incidence effect in the Northern Ireland trial, and that vaccination reduces susceptibility to infection but its population-level effect is context-dependent and requires sustained high coverage. [504] .

9.1 Comparative assessment

The following table draws together the principal scientific and economic considerations identified in this response. It is intended as a summary of the nature and strength of the available evidence, rather than as a numerical ranking of the interventions.

[503] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, particularly paras 5.3.12–5.3.25, pp. 51–57. DAERA uses outputs from the Northern Ireland-parameterised APHA model to sense-check whether the number of herd breakdowns required for economic breakeven appears achievable and to derive illustrative benefits. The internal review of that modelling cautioned that its outputs should not be treated as predictions, but as providing a broad indication of the relative performance of interventions, with substantial uncertainty around the point estimates. See also Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*, APHA; Hatch, M. and Anderson, H. (2019), *Follow up report on the National Wildlife Management Centre TB model outputs: DAERA veterinary and NIEA interpretation of the results*.

[504] DAERA (2025), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly pp. 3–9. The Scientific Opinion concludes that all three principal approaches, TVR, proactive culling and vaccination, are scientifically viable. It states that modelling generally indicates a faster bTB response from interventions containing a lethal component than from vaccination-only; that field trials and modelling demonstrate reductions in cattle and badger bTB from large-scale sustained proactive culling; that the Northern Ireland TVR trial reduced *M. bovis* prevalence in badgers but did not demonstrate an impact on cattle herd incidence; and that BCG vaccination reduces susceptibility to infection but vaccination-only is likely to require sustained high coverage over many years, particularly where infection is endemic in badgers.

Table 4. Comparative assessment of non-selective culling, TVR and vaccination-only

Consideration	Non-selective culling	TVR	Vaccination-only
Direct cattle-outcome evidence	**Strongest of the three approaches.** Replicated field trials in England and the Republic of Ireland demonstrated reductions in cattle herd incidence, supported by later observational English evidence. [505]	NI field trial generated valuable badger and operational evidence but **did not demonstrate a causal reduction in cattle herd incidence**. Cattle benefit is therefore supported principally by modelling and biological rationale. [506]	Direct cattle-outcome evidence exists from the Republic of Ireland non-inferiority trial, but principally demonstrates vaccination following previous targeted culling. Less direct evidence exists for vaccination-only as the initial intervention in a previously untreated population. [507]

[505] Griffin, J.M., Williams, D.H., Kelly, G.E., Clegg, T.A., O'Boyle, I., Collins, J.D. and More, S.J. (2005a), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', *Preventive Veterinary Medicine*, 67, 237–266; Donnelly, C.A. et al. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', *Nature*, 439, 843–846; Downs, S.H. et al. (2019), 'Assessing effects from four years of industry-led badger culling in England on the incidence of bovine tuberculosis in cattle, 2013–2017', *Scientific Reports*, 9; Birch, C.P.D. et al. (2024), 'Difference in differences analysis evaluates the effects of the badger control policy on bovine tuberculosis in England', *Scientific Reports*, 14, 4849. The RBCT and Four Area Trial provide the principal direct cattle-outcome evidence; the later English studies provide observational evidence under operational conditions and should not be regarded as equivalent in causal strength to the controlled field evidence.

[506] Menzies, F.D. et al. (2021), 'Test and vaccinate or remove: Methodology and preliminary results from a badger intervention research project', *Veterinary Record*, 189; Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (Meles meles)', *PLoS ONE*, 16(1), e0246141; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151; DAERA (2025), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, pp. 3, 7–9. The NI study demonstrated operational feasibility and a substantial decline in estimated badger infection prevalence, but was conducted in one intervention area without replicated untreated controls and did not demonstrate a causal reduction in cattle herd incidence.

[507] Martin, L.E.R. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (Meles meles) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland? A practical non-inferiority wildlife intervention study in the Republic of Ireland (2011–2017)', *Preventive Veterinary Medicine*; DAERA (2025), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, pp. 4, 7–8. The Irish non-inferiority study provides important direct cattle-outcome evidence for vaccination, but the study areas had previously been subject to

Consideration	Non-selective culling	TVR	Vaccination-only
Speed of expected effect	Expected to reduce existing infection pressure comparatively rapidly, although measurable cattle benefits still emerge over several years.	Selective removal provides a mechanism for reducing existing infection while vaccinating test-negative badgers. Potentially faster than vaccination-only, but the speed of cattle benefit has not been directly demonstrated and remains model-dependent.	Generally expected to act more slowly because already infected badgers remain within the population. Sustained high coverage over many years may be required where infection is endemic. [508]
Principal scientific uncertainty	Magnitude of effect under NI conditions; perturbation; appropriate scale, boundaries, coverage and duration; transferability from GB/RoI.	Magnitude and timing of cattle-level benefit; scalability beyond one research area; interaction between capture rate, diagnostic performance, prevalence and repeated intervention.	Magnitude and timing of cattle benefit under NI starting conditions; required coverage; performance in areas with substantial existing prevalence and without preceding removal.

targeted/reactive badger culling. It therefore provides stronger evidence for vaccination following a reduction in infection pressure than for vaccination-only as the initial intervention in an untreated population.

[508] DAERA (2025), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, pp. 6–8; DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, pp. 62–63. DAERA concludes that interventions containing a lethal component generally produce a faster bTB response than vaccination-only. Vaccination does not remove existing infection and, where infection is endemic, vaccination-only is expected to require sustained high coverage over many years.

Consideration	Non-selective culling	TVR	Vaccination-only
Sensitivity to starting prevalence	Relevant to the amount of infection removed and expected benefit, although removal acts directly on infected and uninfected animals alike.	**High.** Prevalence affects the number of infected animals requiring detection and removal and interacts with imperfect diagnostic sensitivity.	**High.** Vaccination does not remove existing infection; higher starting prevalence is therefore likely to extend the time required to reduce infection pressure.
Sensitivity to population size/density	Important for establishing the denominator against which population reduction and coverage are measured.	**High.** Directly affects the number of badgers requiring capture, testing and treatment and therefore operational cost.	**High.** Determines the absolute trapping and vaccination effort required to achieve and sustain target coverage. [509]

[509] DAERA (2025), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, pp. 1–2, 4 and 7–9; Byrne, A.W. et al. (2012), 'Population Estimation and Trappability of the European Badger (*Meles meles*): Implications for Tuberculosis Management', *PLoS ONE*, 7(12), e50807. Intervention performance depends on the underlying badger population, infection prevalence and achievable capture or vaccination coverage. These factors are particularly important for TVR, where infected animals must be both captured and correctly identified, and for vaccination-only, where existing infected animals remain in the population.

Consideration	Non-selective culling	TVR	Vaccination-only
Operational evidence	Extensive operational experience in England and the Republic of Ireland, although no directly equivalent contemporary large-scale NI programme.	**Strong NI-specific research experience.** The Banbridge project demonstrated practical trap-side testing, selective removal and vaccination. Comprehensive operational deployment at scale remains untested. [510]	Extensive vaccination experience in the Republic of Ireland and other programmes; comparatively limited operational experience under NI conditions. [511]
Perturbation	Adverse cattle effect demonstrated around RBCT intervention areas during culling; not consistently demonstrated in Irish experience. Scale, boundaries and coverage are important. [512]	NI trial found no broad sustained increase in badger ranging under the selective-removal intensity studied. This does not establish absence of risk under all prevalence or removal scenarios. [513]	No equivalent removal-related perturbation mechanism because badgers are not removed.

[510] Menzies et al. (2021), op. cit.; DAERA (2025), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, pp. 3 and 9. The five-year NI TVR project provides substantial locally relevant evidence on trapping, trap-side testing, vaccination, selective removal and repeated field operation, but DAERA notes that TVR has not yet been comprehensively deployed on a 100 km^2 basis outside a research setting.

[511] Ryan et al. (2023), as reviewed in DAERA (2025), *Annotated Scientific Bibliography*, pp. 25–28. Routine badger BCG vaccination has been expanded across more than 20,000 km^2 in the Republic of Ireland, providing evidence of large-scale operational deliverability, although evaluation of vaccination coverage and cattle-disease outcomes remains ongoing.

[512] Donnelly et al. (2006), op. cit.; Jenkins, H.E., Woodroffe, R. and Donnelly, C.A. (2010), 'The duration of the effects of repeated widespread badger culling on cattle tuberculosis following the cessation of culling', *PLoS ONE*, 5(2), e9090; DAERA (2025), *Scientific Opinion*, pp. 3 and 7. The RBCT demonstrated an adverse peripheral cattle effect during proactive culling, whereas comparable perturbation effects have not been consistently demonstrated in the Republic of Ireland. DAERA consequently identifies intervention scale, spatial design, boundaries and population reduction as important considerations.

[513] O'Hagan, M.J.H. et al. (2021b), 'Effect of selective removal of badgers (*Meles meles*) on ranging behaviour during a "Test and Vaccinate or Remove" intervention in Northern Ireland', *Epidemiology and Infection*, 149, e125; Allen, A. et al. (2022), 'European badger (*Meles meles*) responses to low-intensity, selective culling: using mark–recapture and relatedness data to assess social perturbation', *Ecological Solutions and Evidence*, 3(3), e12165. No broad sustained increase in ranging

Consideration	Non-selective culling	TVR	Vaccination-only
Economic evidence	Generally the lowest-cost intervention type in DAERA's appraisal. Under the principal no-perturbation economic scenario, controlled shooting is the highest-ranked option on illustrative NPV. When perturbation is applied to non-selective culling, the economic ranking changes and restraint-based TVR ranks first.	Generally more expensive because of trapping, testing, handling and treatment. Restraint-based private-sector TVR performs comparatively well economically: it ranks first on illustrative NPV under DAERA's perturbation sensitivity scenario and first in the composite assessment under both the no-perturbation and perturbation scenarios.	Implementation can cost less than TVR using the same trapping system, but the slower modelled disease benefit means vaccination options rank less well in DAERA's economic analysis. [514]
Key evidence gaps	Contemporary NI population and prevalence data; NI-specific perturbation risk; optimum duration, scale and transition point; achievable coverage.	Direct controlled evidence of cattle benefit; performance under different starting prevalences and densities; large-scale delivery; implications of imperfect test sensitivity and repeated capture.	Direct cattle outcomes when used as the initial intervention under NI conditions; speed of benefit at higher prevalence; required long-term coverage; durability and scalability of delivery.

or major social disruption was detected under the relatively low selective-removal intensity studied; these findings do not establish the absence of risk under materially different removal rates or epidemiological conditions.

[514] DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, sections 5.3, 6.1, 6.8 and 9.3. Under DAERA's no-perturbation economic analysis, controlled shooting (Option 5) ranks first, restraint-based non-selective culling (Option 4) second and restraint-based TVR (Option 8) third. When perturbation is applied to the non-selective culling options, Option 8 ranks first on illustrative NPV. Vaccination options rank less well economically under both scenarios. In the composite assessment, Option 8 ranks first under both the no-perturbation and perturbation scenarios.

DAERA's own modelling illustrates why the distinction between observed and modelled evidence remains important. The model projects reductions in cattle herd breakdowns from all three approaches and, under specified assumptions, predicts TVR outcomes close to those of non-selective culling. However, DAERA's scientific review itself cautions that models are highly context-dependent abstractions rather than field trials. [515]

The same point applies economically. DAERA's economic appraisal relies on expected or modelled herd breakdowns avoided to establish whether intervention costs can be justified. The independent Andersons review considers the broad structure of the economic appraisal logical, but identifies significant limitations in the transparency of the underlying cost calculations and uncertainty around a number of important assumptions. It also highlights that the economically highest-ranked intervention is not the same as the highest-ranked option after economic, non-monetary and risk considerations are combined. [516]

Accordingly, the economic comparison should be regarded as conditional on the scientific assumptions underpinning expected disease reduction. Where there is greater uncertainty about the magnitude or timing of cattle benefit, that uncertainty should carry through explicitly into the economic assessment rather than being lost once a single modelled value is assigned. [517]

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[515] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, section 5.3, particularly Table 7; DAERA (2025), *Scientific Opinion*, pp. 4–5. In the NI-parameterised model, under the specified no-perturbation scenario, non-selective culling and TVR produced very similar projected reductions in herd breakdowns, while vaccination produced a smaller reduction. DAERA's Scientific Opinion cautions that such models are highly context-dependent, abstract representations rather than field trials.

[516] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, Executive Summary and sections 3 and 5. The review considers DAERA's component-based costing methodology logical and finds that applying common areas and timescales facilitates comparison, but concludes that independent scrutiny is significantly constrained by the lack of detailed underlying calculations. It also identifies uncertainty in the modelled breakdown benefits, particularly for TVR where direct cattle-outcome evidence is limited, and notes that controlled shooting ranks first economically whereas restraint-based TVR ranks first once economic, non-monetary and risk criteria are combined.

[517] DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX; DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, section 5.3; The Andersons Centre (2026), op. cit., Executive Summary. DAERA's economic appraisal values intervention benefit principally through the number of herd breakdowns expected to be avoided. The resulting economic estimates therefore inherit uncertainty in the modelled magnitude and duration of cattle-disease benefit. Andersons specifically identifies uncertainty around these modelled effectiveness estimates and notes that it is not made explicit in the economic analysis, particularly for TVR.

9.2 Distinguishing disease-control effectiveness, wider evidence and policy judgements

Evidence on disease-control effectiveness is only one part of the assessment required to determine wildlife policy. Evidence is also relevant to animal welfare, environmental and ecological effects, economic consequences, operational deliverability and social impacts or public acceptability, while ethical and legal considerations must also form part of the eventual decision. DAERA's Scientific Opinion focuses principally on the scientific viability of the intervention options and expressly distinguishes that assessment from the broader considerations required for a final policy decision. [518]

AgriSearch has not undertaken an independent ecological or legal review of the Habitats Regulations Assessment and has not identified evidence within the scope of this response that would justify challenging its conclusions.

AgriSearch considers that these different dimensions should first be assessed transparently against the evidence relevant to each of them, before being brought together through an explicit overall policy judgement. Evidence about welfare or environmental effects should not be treated as though it alters evidence about disease-control effectiveness, and equally evidence of epidemiological effectiveness does not determine the appropriate weight to be given to welfare, environmental, economic or other consequences.

For example, the fact that non-selective culling presents greater welfare or public-acceptability challenges does not reduce the strength of the field evidence demonstrating a cattle disease effect. Equally, the welfare advantages of removing fewer badgers under TVR do not strengthen the direct cattle-outcome evidence for that intervention. Similarly, the non-lethal nature of vaccination does not itself establish that vaccination will achieve sufficiently rapid disease reduction under high-prevalence conditions. [519]

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[518] Department of Agriculture, Environment and Rural Affairs (DAERA) (2025), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII to the 2026 consultation, pp. 1 and 8–9. The Scientific Opinion defines scientific viability as the capability of an intervention to be implemented and to be likely to reduce bTB in badgers and cattle in the Northern Ireland context, while stating that the broader political, environmental, legal, economic, behavioural and social-science considerations required for a final policy decision fall outside that assessment. It nevertheless recognises welfare and ethical considerations as important parallel factors in policy development.

[519] DAERA (2025), *Scientific Opinion*, particularly pp. 3–4 and 7–9. DAERA concludes that large-scale sustained proactive culling can reduce bTB in cattle and badgers, while separately identifying animal-welfare, public-acceptability and ecological concerns; that the Northern Ireland TVR trial reduced badger infection prevalence but did not demonstrate an impact on cattle herd incidence; and that badger BCG vaccination reduces susceptibility to infection but is slower to act and may require sustained high coverage over many years where infection is endemic, particularly if not preceded by a reduction in infection pressure.

The same principle operates in the opposite direction. Stronger direct evidence of epidemiological efficacy does not automatically make an intervention the appropriate policy choice if legitimate welfare, environmental, economic or operational considerations outweigh that advantage.

A related distinction should be maintained between the choice of disease-control strategy and the choice of deployment or capture method used to implement it. Evidence supporting the epidemiological effectiveness or scientific rationale of an intervention does not, by itself, determine which delivery method is most appropriate. Controlled shooting, cage trapping and stopped restraints should each be assessed on their own operational merits and against consistent requirements for operator competence, animal welfare, public safety, non-target risk, achievable population coverage, reliable recording, quality assurance and appropriate oversight. The most suitable method, or combination of methods, may therefore vary according to the intervention selected and local operational circumstances. [520]

AgriSearch therefore considers that the decision-making process should proceed in a transparent sequence:

evidence on disease-control effectiveness and uncertainty → economic consequences conditional on that effectiveness → evidence on welfare, environmental, operational and societal effects → explicit consideration of weights and trade-offs → transparent overall policy judgement

This is particularly important because DAERA's final ranking combines economic, non-monetary and risk assessments. The options analysis shows that, under the principal no-perturbation economic scenario, controlled shooting and restraint-based non-selective culling rank ahead of restraint-based TVR. When perturbation is applied to non-selective culling, however, restraint-based TVR becomes the highest-ranked option on illustrative NPV. TVR also ranks highest in the composite assessment under both scenarios once the economic, non-monetary and risk rankings are combined. [521] This is a legitimate multi-criteria policy approach, but the resulting preference should be

[520] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 5 and Chapters 6–8. DAERA distinguishes between the intervention strategy and the associated deployment or capture methods and allows for one or more methods to be selected or used in combination. The consultation also identifies training, competency, welfare, monitoring and operational requirements relevant to individual methods. See Sections 5.1–5.3 and 8.2 of this response.

[521] DAERA (2026), Badger Intervention – Options Analysis Paper, Annex VIII, paras. 6.1.3–6.1.6 and Table 10, pp. 61–63; paras. 9.3.9–9.3.15 and 9.3.21–9.3.24, and Table 29, pp. 130–135. Under the principal no-perturbation economic analysis, Option 5 (non-selective culling using predominant controlled shooting) ranks first by illustrative NPV, Option 4 (non-selective culling using restraints) second and Option 8 (TVR using restraints) third. When perturbation is assumed for the non-selective culling options, while no perturbation is assumed for TVR, Option 8 ranks first by illustrative NPV, ahead of Options 5 and 4. In DAERA's composite assessment combining economic, non-monetary and risk rankings, Option 8 ranks first under both the no-perturbation and perturbation scenarios.

clearly identified as such rather than interpreted as a finding that one intervention has the strongest scientific or economic evidence across every dimension.

AgriSearch considers that economic performance should carry substantial weight in this overall judgement, given the very significant costs of bTB and of any future intervention. However, the fact that some economic outcomes can be expressed numerically or monetised does not, by itself, determine the weight they should receive relative to welfare, environmental or other material effects; the weighting and resulting trade-offs should be explained transparently.

AgriSearch considers that ethical appraisal should address the consequences of continuing disease as well as the impacts of intervention. The financial pressures, uncertainty and psychological distress experienced by farming families, together with premature cattle removals, are material considerations in their own right. DAERA's inclusion of human and cattle welfare within its options analysis is therefore welcome. However, the comparison should consider not only the eventual benefits projected for each intervention, but also the time required to achieve them, the confidence that can be attached to those projections and the distribution of continuing burdens while disease remains uncontrolled. [522]

This is particularly important where welfare scores depend on modelled cattle outcomes. DAERA assigns the same human-welfare score to non-selective culling and TVR because their projected reductions in herd breakdowns are similar. Those scores should not be interpreted as demonstrating an equivalent likelihood of achieving the anticipated benefit. DAERA should show how its welfare conclusions would change if cattle benefits were delayed, smaller than projected or not achieved, with the evidential basis and uncertainty treated consistently across the options. [523]

Where an approach with less direct evidence of cattle benefit, or a longer expected time to meaningful disease reduction, is preferred over an available alternative, DAERA should explain why the anticipated advantages justify accepting the associated risk of prolonged herd breakdowns, further cattle removals, continuing distress and additional costs. This does not predetermine the policy choice, but it requires the consequences for those bearing the risk to be made explicit. Uncertainty should not prevent

[522] The Andersons Centre (2026a), *Review of the indirect costs borne by farmers, as a result of bovine TB (bTB) – Final Report*, March 2026, section 4.5, pp. 25–29, and section 5.6, pp. 50–54; DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII, sections 7.4.4 and 7.4.6. See also Section 3.1 of this response.

[523] DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII, paragraphs 7.4.6.7–7.4.6.9 and Tables 24–25, pp. 105–109. The human-welfare estimates are derived from APHA-modelled herd breakdowns and an assumed average number of household members. Non-selective culling and TVR each receive a human-welfare score of 4 out of 4, while vaccination-only receives 1 out of 4. See Sections 5.1–5.3 and 6.1 of this response for the distinction between observed and modelled cattle outcomes.

proportionate action, but neither should it be transferred to farming families without clear justification, monitoring and predefined opportunities to change course.

The stewardship of limited public resources is also an ethical consideration. Appraisal should consider the combined costs of intervention and continuing disease over an appropriate period, rather than intervention expenditure alone. Where a more costly approach is preferred for welfare, environmental or other reasons, the expected gains and additional resource commitment should be explained transparently, including the implications for other public priorities. The relevant question is not simply which intervention is cheapest, but whether the chosen approach offers a proportionate and sufficiently well-supported use of resources to achieve sustained disease reduction.

AgriSearch assessment

Taken together, AgriSearch does not consider that the evidence supports a single universal ranking of the three interventions, irrespective of epidemiological context or the criterion being considered. [524] There are, however, meaningful differences in the type and strength of evidence and in the likely speed of effect. Non-selective culling has the strongest direct field evidence of reducing cattle bTB; TVR has particularly valuable Northern Ireland-specific operational and badger-level evidence but lacks equivalent direct cattle-outcome evidence; and vaccination has a well-established biological basis and an important long-term role, but the magnitude and speed of its effect as an initial stand-alone intervention are more dependent on starting infection pressure and the achievement of sustained high coverage. [525] The economic evidence does not remove these scientific distinctions; rather, it translates assumptions about efficacy and delivery into economic consequences. Intervention costs vary materially with capture method, delivery model, population size and density, achievable capture or treatment coverage and scale of deployment. Estimated benefits depend in turn on the value assigned to a cattle herd breakdown avoided, the duration of benefit and, critically, the number and timing of breakdowns actually avoided as a consequence of intervention. [526] AgriSearch therefore considers that the most robust approach is not to

[524] **Department of Agriculture, Environment and Rural Affairs (DAERA) (2025),** *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII to the 2026 consultation, pp. 8–9. DAERA concludes that there is "no one-size-fits-all solution", that effective control will require coordinated cattle and wildlife action tailored to local areas and conditions, and that TVR, proactive culling and vaccination are all scientifically viable options.
[525] **DAERA (2025),** *Scientific Opinion*, particularly pp. 3–8. The Opinion concludes that field trials and modelling show that large-scale sustained proactive culling can reduce bTB in cattle and badgers; that the Northern Ireland TVR project produced valuable operational evidence and reduced badger infection prevalence but did not demonstrate an impact on cattle herd incidence; and that BCG vaccination reduces susceptibility to infection but is slower to act and, where badger infection is endemic, is likely to require sustained high coverage over many years, particularly where it has not been preceded by a reduction in infection pressure.
[526] **DAERA (2026),** *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, particularly sections 1.2, 2.5, 2.7 and 2.10; **DAERA (2026),** *Badger Intervention – Options Analysis Paper*, Annex VIII,

seek a single abstract ranking divorced from context, but to determine which intervention, or sequence of interventions, offers the most appropriate balance of evidential confidence, expected speed of effect, cost, operational deliverability and uncertainty for the epidemiological circumstances of the area concerned. Wider welfare, environmental and societal considerations can then be incorporated transparently into the final policy decision, with subsequent surveillance and review informing whether the intervention should be continued, adapted or transitioned. [527]

section 5.3 and Table 8. DAERA notes that most intervention costs are variable with scale, uses a standard 100 km^2 area as a convenient like-for-like unit of analysis, and acknowledges that scale effects are not captured. Its economic benefit calculation depends on the value of a herd breakdown avoided, the assumed duration of benefit and the number of breakdowns avoided as a result of intervention; the latter is uncertain and is informed principally by modelling, with field-trial benchmarking additionally available for non-selective culling.

[527] **DAERA (2025),** *Scientific Opinion*, pp. 8–9; **DAERA (2026),** *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 5, particularly section 5.1. DAERA's Scientific Opinion identifies targeted and adaptive combinations of intervention as conceptually possible and emphasises tailoring control to local circumstances. The consultation similarly envisages the possibility of selecting one or more intervention and capture methods and developing an adaptable approach based on the disease picture in the area.

10. A proposed evidence-led framework for wildlife intervention

The evidence reviewed in this response suggests that wildlife intervention in Northern Ireland should not be regarded as a single decision taken at the outset and then applied unchanged for a predetermined period. Disease prevalence, badger density, cattle epidemiology and the relative contribution of different transmission pathways vary between areas and may change as intervention progresses. [528]

DAERA's own scientific evidence points in a similar direction. The annotated bibliography cites Smith et al. (2022), who recommend four considerations before localised wildlife intervention begins: **Confirm, Clarify, Resource and Exit** - confirm that wildlife is likely to constitute a maintenance host, clarify the objective, ensure sufficient resources are available and identify the conditions required for exit. The subsequent process proposed includes surveillance, definition of the infected area, selection and implementation of control, measurement and adaptation where required. [529]

DAERA also proposes that intervention areas should be kept under continuing review, with future approaches informed by surveillance data, disease trends and emerging scientific evidence. The CVO Review goes further by suggesting that information generated during intervention could be used to alter the approach between sub-areas and over time. [530]

AgriSearch considers that these principles could be brought together within a simple evidence-led framework:

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[528] DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 64–65; DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, Chapter 4, pp. 26–27. The CVO Review notes heterogeneity in badger density and DPP test-positive badger density within an intervention area and proposes that information generated during intervention could support an adaptive management approach varying between sub-areas. The consultation similarly proposes that intervention areas should be selected and configured according to local epidemiological and ecological conditions.

[529] DAERA (2025), *Annotated scientific bibliography – badger intervention – bTB – 2015 to November 2024*, p. 23; Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Vaclavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192. https://doi.org/10.1002/2688-8319.12192.

[530] DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, section 4.3, p. 27; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 64–65. The consultation proposes close continuous review during intervention and states that subsequent approaches should be informed by surveillance data, disease trends and emerging scientific evidence. The CVO Review envisages an adaptive approach in which intervention could differ between sub-areas according to the observed density of DPP test-positive badgers and be modified through annual review.

Diagnose → Select → Intervene → Monitor → Adapt→ Transition/Exit [531]

The purpose of such a framework would not be to predetermine which wildlife intervention should be used. Rather, it would ensure that the intervention is selected on the basis of the epidemiological problem being addressed, that its objectives and success criteria are clear from the outset, and that there is a defined process for changing course and ultimately transitioning or exiting from intensive intervention where the evidence warrants it.

This adaptive approach would also build on earlier Northern Ireland policy advice rather than represent an entirely new direction. The TBSPG envisaged wildlife intervention as a combination of tools which could vary according to local circumstances and be reviewed as epidemiological and scientific evidence developed. It specifically proposed that the subsequent TB Eradication Partnership should have a role in monitoring and reviewing wildlife intervention, enabling refinement of the programme, monitoring of disease impacts in cattle and badgers, consideration of issues as they emerged and incorporation of emerging findings. Its supporting scientific appraisal similarly envisaged further intervention being considered on the basis of evaluation and available scientific evidence, with intervention criteria reviewed regularly as new epidemiological evidence emerged. The 2024 CVO Review and current consultation continue this adaptive principle. AgriSearch considers that these earlier principles remain sound and should now be translated into explicit, predefined decision criteria. [532] The staged logic also has precedent in the wider international wildlife-bTB literature. O'Brien et al. (2011) described management of bTB in free-ranging wildlife as progressing through overlapping stages of discovery, epidemiological characterisation, initial control, simulation and forecasting, focused control and verification of eradication, with surveillance remaining important throughout. Although developed as a general conceptual framework rather than specifically for badgers or Northern Ireland, it provides independent support for treating wildlife intervention as an adaptive process extending from initial characterisation of the epidemiological problem, through

[531] TBSPG (2016), *Bovine Tuberculosis Eradication Strategy for Northern Ireland*, pp. 48–49; DAERA (2026), *Badger Intervention Options Analysis Paper*, Annex VIII, p. 14. Both documents contemplate movement between intervention approaches over time, including transition from removal-based intervention towards vaccination.

[532] TB Strategic Partnership Group (TBSPG) (2016), *Bovine Tuberculosis Eradication Strategy for Northern Ireland*, Wildlife chapter, particularly pp. 48–53. The TBSPG recommended a multiplicity of wildlife-intervention tools capable of being applied according to local circumstances and proposed that the subsequent TB Eradication Partnership (TBEP) should monitor and review wildlife intervention in order to refine the eradication programme, monitor disease impacts in cattle and badgers, consider issues as they emerged and incorporate emerging findings. See also **TBSPG (2016),** *Annex B: Wildlife & Vaccination – Scientific Appraisal*, particularly sections 1.2 and 1.5, which states that further intervention should be considered by the TBEP on the basis of evaluation and available scientific evidence, that area-selection criteria should be reviewed regularly and that decisions should be informed as new epidemiological evidence emerges.

intervention and monitoring, to verification that the required disease outcome has been achieved. [533]

10.1 Diagnose - establish the local epidemiological starting position

Before intervention begins, DAERA should establish as clearly as practicable what epidemiological problem the intervention is intended to address within the proposed area.

As discussed in Section 7, a high cattle bTB incidence alone does not establish the scale or nature of the local wildlife contribution. Recurrent and prolonged breakdowns can arise from residual infection, cattle-to-cattle transmission, cattle movements, neighbouring herds, wildlife exposure or combinations of these factors. [534] The diagnostic stage should therefore bring together the available evidence on cattle breakdown patterns and recurrence, movement history, WGS and other strain information, badger infection prevalence, contemporary badger population density and spatial distribution, landscape and land-use characteristics, farm fragmentation and likely cattle–wildlife contact, together with local veterinary epidemiology. The strengths, limitations and degree of uncertainty associated with each evidence stream should be made explicit rather than treating any single indicator as determinative. [535] It should also establish a clear pre-intervention baseline and evaluation protocol against which subsequent change can be assessed. This is particularly important because, without reliable pre-intervention information, it may be difficult several years later to determine

[533] O'Brien, D.J., Schmitt, S.M., Rudolph, B.A. and Nugent, G. (2011), 'Recent advances in the management of bovine tuberculosis in free-ranging wildlife', Veterinary Microbiology, 151(1–2), 23–33. https://doi.org/10.1016/j.vetmic.2011.02.022. The authors describe wildlife-disease management as progressing through overlapping stages from discovery and epidemiological characterisation through control and forecasting to focused control and verification of eradication, with surveillance remaining important throughout.

[534] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly pp. 22–26 and 49–50; Doyle, L.P. et al. (2016), 'Bovine tuberculosis in Northern Ireland: risk factors associated with duration and recurrence of chronic herd breakdowns', *Preventive Veterinary Medicine*, 131, 1–7; Doyle, L.P. et al. (2022), 'Northern Ireland farm-level management factors for recurrent bovine tuberculosis herd breakdowns', *Epidemiology and Infection*, 150, e176; Akhmetova, A. et al. (2023), 'Genomic epidemiology of *Mycobacterium bovis* infection in sympatric badger and cattle populations in Northern Ireland', *Microbial Genomics*, 9, 001023. The CVO Review identifies residual infection, within-herd spread, cattle movements, contiguous exposure and wildlife among relevant pathways and notes that genomic analysis of the NI TVR area inferred predominantly cattle-associated transmission.

[535] **DAERA (2024),** *Chief Veterinary Officer Review*, pp. 25, 35–36 and 49–50; **DAERA (2025),** *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, particularly pp. 5–11 and 14–17; **TBSPG (2016),** *Annex B: Wildlife & Vaccination – Scientific Appraisal*, particularly the discussion of badger surveillance and molecular typing. These sources emphasise the relevance of cattle movement and herd-history data, badger abundance and distribution, landscape context, molecular evidence and local epidemiology, while also identifying limitations in individual data sources. The TBSPG appraisal specifically notes that molecular strain information can assist in identifying source areas and cattle–badger relationships and anticipated increased resolution from WGS

whether changes in cattle or badger disease are attributable to the wildlife intervention, concurrent cattle controls or wider temporal trends. Where practicable, DAERA should also define the counterfactual *(what would be expected to happen without the intervention)* against which change will be judged, using suitable comparator areas, historical trends or other appropriate analytical methods. [536] The output from this stage should be an explicit assessment of:

the likely pathways by which infection is being introduced, maintained and amplified within the area; the evidence for and degree of confidence in a material wildlife contribution; the geographical extent of the problem; the starting cattle and wildlife infection and population conditions; the principal uncertainties; and the objective against which intervention success will subsequently be judged.

The objective itself should be clear. Depending on circumstances, it might involve rapid reduction of infection pressure, containment or prevention of geographical spread, maintenance of a lower-prevalence badger population, or transition towards a longer-term vaccination strategy. Different objectives may justify different interventions or intervention sequences. [537] The information proposed for this diagnostic stage is also consistent with the 2024 STAR-IDAZ international bTB control-strategies roadmap. That roadmap treats transmission pathways, cattle and wildlife contact networks, wildlife-host demographics and population density, disease prevalence, diagnostics, molecular typing, environmental factors and mathematical modelling as interconnected inputs to disease-control decisions. It specifically identifies the importance of integrating cattle location, testing and movement histories with wildlife population and disease surveillance, and cautions that molecular or genomic evidence should be interpreted alongside conventional epidemiological information when identifying likely sources and transmission pathways. STAR-IDAZ is a research-priority framework rather than

[536] **DAERA (2025),** *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, p. 24; Smith, G.C., Budgey, R. and Delahay, R.J. (2013), *A simulation model to support a study of test and vaccinate or remove (TVR) in Northern Ireland*, National Wildlife Management Centre/AHVLA; **DARD (2014),** *Test and Vaccinate or Remove Wildlife Intervention Research Project: Year 1 Report*. DAERA's subsequent evidence review notes that interpretation of the TVR cattle outcome was limited by the absence of replicate and control areas. The pre-intervention modelling identified use of a matched area with comparable cattle herd-breakdown levels as one means of improving scientific rigour, while Year 1 of TVR deliberately collected baseline badger movement data before removals commenced so that subsequent behavioural change could be assessed.

[537] Smith, G.C. et al. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192; **DAERA (2025),** *Annotated scientific bibliography*, p. 23; **TBSPG (2016),** *Bovine Tuberculosis Eradication Strategy for Northern Ireland*, Wildlife chapter. Smith et al. distinguish objectives including disease elimination, containment and mitigation. Earlier Northern Ireland policy similarly envisaged a multiplicity of wildlife-intervention tools applied according to local circumstances, including removal, TVR and subsequent vaccination.

operational policy guidance, but it provides useful independent support for the evidence requirements underlying a locally resolved diagnostic approach. [538]

10.2 Select - match the intervention to the starting conditions

Once the local epidemiological position has been characterised, DAERA should determine which intervention - or sequence of interventions - most appropriate to the starting conditions and the objective identified at the diagnostic stage. The analysis in this response suggests that the decision should take account not only of expected disease-control efficacy, but also of starting infection prevalence and population density, the strength of evidence for a material wildlife contribution, the required speed of disease reduction, achievable capture or treatment coverage, landscape and boundary conditions, operational feasibility, scientific uncertainty and economic cost. [539] This would allow the strengths and limitations of the different interventions to be considered in context. For example, where there is strong evidence of substantial infection pressure in badgers and of a material wildlife contribution to the local cattle disease problem, an intervention containing a removal component may have greater initial value because it can directly reduce the existing infected population. Where badger infection prevalence is already low, or has first been reduced, and sustained high coverage is achievable, vaccination may offer a stronger proposition as a longer-term intervention. [540] Where the disease dynamics or spatial distribution of infection

[538] STAR-IDAZ International Research Consortium (2024), Roadmap for development of disease control strategies for bovine tuberculosis (bTB), published 26 November 2024, particularly Lead 4 'Mathematical models', Lead 5 'Transmission pathways', Lead 6 'Contact networks', Lead 7 'Host demographics – including wildlife hosts', Lead 13 'Molecular typing' and Lead 14 'Environment', pp. 14–19 and 27–29. The roadmap identifies the value of integrating animal location, test and movement histories with geographical information; establishing cattle and wildlife contact networks; obtaining wildlife population-density and prevalence data over time; and combining molecular epidemiology with conventional epidemiological data and modelling. It notes that molecular source tracing should be supported by animal- and herd-level movement and test-history data.

[539] **Department of Agriculture, Environment and Rural Affairs (DAERA) (2025),** *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII to the 2026 consultation, particularly pp. 1–9; **DAERA (2026),** *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, particularly sections 1.2 and 4.1–4.4; **DAERA (2026),** *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, particularly sections 2.7, 2.10 and 2.14. DAERA's Scientific Opinion emphasises that intervention performance is context-dependent and that robust population data, spatial distribution, coverage and local conditions are important. The consultation identifies cattle disease burden, badger density and infection, local veterinary epidemiology and physical boundaries as area-selection considerations, while the economic assumptions show that population density, access, trapping method and operational conditions materially affect intervention effort and cost.

[540] **DAERA (2025),** *Scientific Opinion*, pp. 7–9; **More, S.J. (2016),** *The Bovine Tuberculosis Eradication Programme in Northern Ireland: Proposals from the Tuberculosis Strategic Partnership Group – Scientific Peer Review*, particularly pp. 47–52; **TBSPG (2016),** *Annex B: Wildlife & Vaccination – Scientific Appraisal*, particularly sections 1.2–1.3 and the discussion of post-cull vaccination. DAERA concludes that vaccination is slower to act and less effective where badger infection prevalence is high unless preceded by a reduction in infection pressure. More similarly concluded that mass vaccination would be unlikely to

remain uncertain, an initial approach capable of generating additional epidemiological information may also have value, provided its information-gathering purpose, decision thresholds and limitations are defined in advance. [541]

These examples should not become rigid prescriptions. The key principle is that the intervention should follow the epidemiological assessment rather than the epidemiological justification being developed after an intervention has already been selected.

DAERA should publish the criteria by which this decision will be made, including how the principal evidence streams, uncertainties and practical constraints will be weighed and what circumstances would favour one intervention or sequence over another, so that landowners, farmers and wider stakeholders can understand why a particular approach has been selected for their area. [542]

10.3 Intervene - define the intended intervention before implementation

Once an intervention has been selected, its intended scale, intensity or coverage, duration, geographical boundaries, delivery requirements and resourcing should be defined in advance.

This is particularly important because implementation quality is not separate from efficacy. An intervention designed to remove a particular proportion of the badger population cannot be properly evaluated without a reliable estimate of the starting population and subsequent measurement of the proportion actually removed. Similarly, vaccination cannot be assessed solely by the number of doses administered without understanding what proportion of the estimated target population has actually been

perform well in a high-prevalence population, while the TBSPG considered BCG more likely to succeed once infection prevalence had been reduced. Earlier NI policy therefore envisaged removal followed by vaccination as a potential transition or exit strategy.

[541] **DAERA (2025),** *Scientific Opinion*, pp. 8–9. DAERA describes as conceptually attractive a flexible approach in which TVR could initially be used to assess the spatial pattern of *M. bovis* infection, followed by area-specific use of culling, vaccination or continued TVR. However, the Opinion expressly notes that this adaptive strategy has not yet been trialled and lacks specific modelling or field evidence. The Northern Ireland TVR project nevertheless demonstrated the practical feasibility of real-time trap-side testing and generated information on local badger infection alongside intervention.

[542] **DAERA (2026),** *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, pp. 8 and 11–12; **DAERA (2025),** *Scientific Opinion*, pp. 8–9. The consultation states that no preferred intervention has been predetermined, emphasises transparency and public confidence in setting out the evidence and examining options openly, and proposes targeted intervention informed by local conditions. The Scientific Opinion concludes that there is no “one-size-fits-all solution” and that future policy should be evidence-based and tailored to local areas and conditions.

reached. [543] DAERA should therefore specify the intended intervention coverage, geographical boundaries, expected duration, land-access requirements, delivery method and minimum operational standards before implementation. It should also define how achieved coverage or removal will be estimated and the minimum delivery thresholds below which the intervention would be reviewed or adapted. [544] The programme should also identify the cattle measures operating concurrently. DAERA's Scientific Opinion concludes that wildlife and cattle form a two-host transmission system and that wildlife intervention without effective parallel cattle controls is unlikely to achieve eradication. [545]

This matters for subsequent evaluation. If cattle controls change materially during a wildlife intervention, those changes need to be recorded and considered when interpreting cattle outcomes. The same applies to other material changes in delivery, including land access, trapping effort, intervention window or achieved coverage, so that differences between the intervention as designed and the intervention actually delivered are transparent. [546]

Intervention areas should also be adequately resourced for the period required to achieve the intended coverage. The scientific evidence reviewed by DAERA emphasises

[543] **Department of Agriculture, Environment and Rural Affairs (DAERA) (2025),** *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII to the 2026 consultation, particularly pp. 1–4; **DAERA (2025),** *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, particularly pp. 5–6 and 27–31. DAERA identifies robust badger population data as necessary to inform intervention and states that proactive culling requires consideration of population size, spatial distribution and the spatial and temporal extent of removal. For vaccination, population-level effectiveness depends on vaccine efficacy and achieved vaccination coverage; Smith et al. (2020), as reviewed by DAERA, demonstrated methods for estimating coverage in free-ranging badger populations.

[544] **DAERA (2026),** *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4, particularly sections 4.1–4.4, pp. 26–28; **DAERA (2026),** *Strategic Environmental Assessment*, Annex IV, particularly section 7.2. The consultation already proposes defined intervention areas, physical boundaries, an intervention period of up to five years and specified seasonal intervention windows. The SEA also envisages DAERA oversight to ensure that interventions are implemented in accordance with required protocols and standards and that performance and best practice are monitored.

[545] DAERA (2025), Scientific Opinion, pp. 6–9. DAERA concludes that cattle and badgers form a two-host transmission system involving bidirectional M. bovis transmission and that strengthened parallel cattle controls are essential; wildlife intervention alone is unlikely to achieve eradication. The Opinion also notes that many culling studies were undertaken alongside enhanced cattle measures and that the Northern Ireland TVR findings similarly highlight the need for concurrent cattle controls.

[546] **DAERA (2025),** *Scientific Opinion*, pp. 3–6; **Smith, G.C., Budgey, R. and Delahay, R.J. (2013),** *A simulation model to support a study of test and vaccinate or remove (TVR) in Northern Ireland*. The scientific interpretation of wildlife intervention depends on the intervention actually delivered: the TVR modelling specifically notes that intervention area, trapping effort and the proportion of the badger population subjected to management must be considered when interpreting outcomes. DAERA's evidence review similarly emphasises spatial and temporal extent, population size and coverage as relevant to intervention performance.

that thorough preparation, appropriate methodology and sufficient resources are fundamental to successful wildlife intervention. [547]

10.4 Monitor - measure delivery and epidemiological outcomes

Monitoring should be designed as part of the intervention rather than added retrospectively.

DAERA already proposes that interventions will be subject to continuing review and that future approaches will take account of surveillance data, disease trends and emerging scientific evidence. AgriSearch supports this, but considers that the indicators on which those reviews will be based should be specified before intervention begins. [548]

Monitoring should distinguish between delivery measures, intermediate wildlife outcomes and ultimate cattle-disease outcomes. An intervention can be delivered according to plan without necessarily achieving its epidemiological objective, while apparent epidemiological failure may be difficult to interpret if intended coverage was never achieved. Equally, a change in badger infection measures may precede, and should not automatically be equated with, a measurable cattle benefit. [549] A core monitoring framework could therefore include:

- cattle herd incidence, recurrent and prolonged breakdown patterns and other relevant cattle epidemiological indicators;
- badger infection prevalence or test positivity, with appropriate recognition of diagnostic limitations;
- badger population density and changes in distribution;

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[547] DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, p. 23; see also Smith, G.C. et al. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', Ecological Solutions and Evidence, 3(4), e12192. DAERA's review concludes that, irrespective of the intervention method, "thorough preparation, sound methodologies and sufficient resources are paramount". Smith et al.'s framework similarly identifies Resource, ensuring that sufficient resources are available to achieve the intended objective, as one of the four considerations required before local wildlife intervention begins.

[548] **DAERA (2026),** *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 4.3, p. 27; **More, S.J. (2016),** *The Bovine Tuberculosis Eradication Programme in Northern Ireland: Proposals from the TB Strategic Partnership Group – Scientific Peer Review*, pp. 12–15. DAERA proposes close continuous review of wildlife intervention, with future approaches informed by surveillance data, disease trends and emerging scientific evidence. More similarly supported an ongoing process to review targets and progress, identify reasons for variance and adapt the programme accordingly.

[549] **More (2016),** op. cit., pp. 12–15. The review distinguishes overall programme measures such as herd prevalence and incidence from measures intended to illuminate the biological processes maintaining and spreading *M. bovis*, and cautions that cattle-level indicators alone cannot reliably distinguish between cattle- and wildlife-associated sources of infection.

- actual capture, removal or vaccination coverage relative to the estimated population, including capture and repeat-capture frequency for trapping-based interventions;
- WGS and strain evidence where this can help identify changes in local transmission;
- movement, immigration or recolonisation where relevant;
- where removal is used, appropriate monitoring within and immediately outside intervention boundaries for evidence of adverse displacement or perturbation effects;
- operational delivery, land access and resource requirements;
- economic costs compared with those assumed in the original appraisal; and
- relevant welfare and environmental monitoring. [550]

The precise indicators will vary between interventions, but the important principle is that the evidence required to judge both whether the intervention was delivered as intended and whether it achieved the intended epidemiological effect should be established before the result is known.

The monitoring plan should also specify how frequently results will be reviewed, who will undertake that review, how material departures from expected delivery or disease trends will be handled and how results will be reported transparently. This would build on the CVO Review's proposal for clearer programme measurements, key performance indicators and a public-facing dashboard showing progress towards eradication. [551] The Strategic Environmental Assessment itself identifies a need for greater clarity on how wildlife-intervention targets will be determined and monitored. In relation to culling, it notes that vaccination may subsequently be used as an exit strategy depending on the local disease situation and whether intervention continues, and calls for further information on how interim monitoring and review will safeguard long-term badger

[550] **DAERA (2025),** *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, particularly pp. 19–20 and 33–35; **DAERA (2026),** *Consultation*, Chapter 7. DAERA's evidence review highlights the importance of population reduction, coverage, prevalence and spatial effects in interpreting intervention outcomes. It also notes evidence from culling studies that cattle incidence should be monitored beyond intervention boundaries where perturbation is a relevant risk. The consultation notes that TVR additionally provides a mechanism for monitoring disease prevalence within the badger population.

[551] **DAERA (2024),** *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 39–40. The CVO Review proposes clearer programme measurements and indicators, including recurrent breakdowns, duration and severity, and recommends development of a dashboard presenting current information on eradication progress, key performance indicators and associated trends.

population viability. [552] Australian experience provides a useful programme-level example of the importance of translating an eradication objective into measurable intermediate stages. During Australia's successful national bTB eradication programme, dynamic herd and area classifications were used to demonstrate progress, alongside multi-year strategic plans, annual operational plans and periodic review. [553] Progressive changes in disease status provided readily understood milestones and allowed programme requirements to evolve as areas moved closer to freedom. The Australian wildlife and production context differs materially from Northern Ireland, but this programme-level principle is transferable: implementation should be accompanied by predefined epidemiological milestones that show whether an intervention area is progressing from disease reduction towards control, elimination and ultimately a lower-intensity surveillance phase.

10.5 Adapt - establish predefined criteria for changing approach

Adaptive management should mean more than periodically reviewing the programme. It should provide a structured means of deciding when the evidence is sufficient to continue, intensify, reduce, modify or transition from an intervention. [554]

The CVO Review provides one example of this concept. It suggests that first-year TVR could generate information on apparent prevalence and the density of DPP-positive badgers, allowing different approaches subsequently to be applied in different sub-areas. Higher-infection areas might continue with TVR or move towards proactive removal, while lower-infection areas might move towards vaccination. Annual review could then allow those approaches to change further. [555]

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[552] **DAERA (2026),** *Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication*, Annex IV, pp. 111 and 123. The SEA states that the information currently available does not explain how a proposed 70% population-reduction target would be determined or monitored; notes that culling may be followed by vaccination as an exit strategy depending on local disease conditions and whether intervention continues; and recommends further information on how interim monitoring and review will protect long-term badger population viability.
[553] More, S.J., Radunz, B. and Glanville, R.J. (2015), 'Lessons learned during the successful eradication of bovine tuberculosis from Australia', Veterinary Record, 177, 224–232, https://doi.org/10.1136/vr.103163. The Australian programme used a dynamic system of herd and area classification to provide transparent measures of progress, alongside multi-annual strategic plans, annual operational plans, interim targets, associated budgets and periodic review. The authors identify objective measures of programme progress as one of the factors critical to successful eradication.
[554] **DAERA (2025),** *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, p. 23; Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Vaclavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192. Smith et al. include measurement and adaptation within the intervention process after surveillance, definition of the infected area and implementation of control.
[555] **DAERA (2024),** *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 64–65. The Review proposes that first-year TVR could be used to estimate apparent *M. bovis* prevalence and the density of DPP test-positive badgers, with subsequent sub-area use of proactive culling, continued TVR or

As discussed in Section 5.4, this particular model is scientifically plausible but remains novel. DAERA's Scientific Opinion states that the proposed adaptive hybrid has not itself been trialled and has no specific modelling or field-data support, while the Options Analysis did not shortlist it because its design would be complex and would require significant further exploratory work. [556] AgriSearch nevertheless considers that the broader adaptive-management principle is sound and is supported by both earlier Northern Ireland policy thinking and the wider wildlife-intervention literature. It could apply whether the initial intervention selected is culling, TVR or vaccination. [557] For example, an initial removal-based programme could have a defined route towards vaccination once badger infection pressure had fallen sufficiently and sustained vaccination coverage was considered achievable. Conversely, an area under vaccination could be reviewed if infection remained persistently high or cattle disease outcomes failed to improve. Intervention intensity could also be reconsidered where achieved coverage, land access, population estimates, infection prevalence or other surveillance evidence differed materially from the assumptions on which the original decision was based. [558] This means that adaptation may be triggered for different reasons. A delivery trigger might arise where the intended population coverage or operational intensity cannot be achieved; an epidemiological trigger where badger or cattle disease indicators are not moving in the expected direction; and an evidence trigger where improved population, diagnostic, genomic or other information materially changes the original assessment of the area.

AgriSearch does not consider that the available evidence presently supports prescribing universal numerical thresholds for these decisions. A single DPP test-positive prevalence, cattle herd-incidence level or population-density figure is unlikely to provide a sufficient basis in isolation. DPP results are affected by imperfect diagnostic sensitivity, while population estimates, disease distribution and the relative

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vaccination according to observed conditions. It also envisages annual review to determine whether those approaches should subsequently be modified.

[556] **DAERA (2025),** *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 8–9; **DAERA (2026),** *Badger Intervention – Options Analysis Paper*, Annex VIII, p. 14. The Scientific Opinion describes the CVO's flexible hybrid approach as theoretically attractive but notes that it has not yet been trialled and has no specific modelling or field-data support. The Options Analysis included the hybrid in the long list but did not shortlist it because of its novelty, complexity and the need for significant further exploratory work.

[557] TB Strategic Partnership Group (TBSPG) (2016), Annex B: Wildlife & Vaccination – Scientific Appraisal, particularly sections 1.2–1.3. The TBSPG recommended a multiplicity of wildlife-intervention tools to be used according to local circumstances and stated that further intervention should be considered on the basis of evaluation and available scientific evidence. It also envisaged vaccination following removal. See also DAERA (2025), Annotated scientific bibliography, p. 23, summarising Smith et al. (2022).

[558] **DAERA (2025),** *Scientific Opinion*, pp. 7–9; **TBSPG (2016),** *Annex B: Wildlife & Vaccination – Scientific Appraisal*, pp. 2–5. DAERA considers vaccination a potential long-term or exit strategy from an intervention containing a removal component because vaccination acts more slowly where infection prevalence is high. Earlier TBSPG analysis similarly envisaged removal to reduce infection pressure followed by vaccination and recommended subsequent intervention according to evaluation and available evidence.

contribution of cattle and wildlife may vary spatially. Appropriate thresholds would therefore require further scientific development and may differ according to intervention, objective and local circumstances. [559] However, DAERA should establish in advance the indicators to be reviewed, the direction or scale of change that would prompt reconsideration, the decision process to be followed and the range of possible responses. Any subsequent change in intervention should be documented against those criteria. Otherwise there is a risk that an ostensibly adaptive programme becomes one in which the criteria for success or failure are determined retrospectively.

10.6 An explicit transition and exit strategy

A particularly important element of the framework should be consideration of the end point from the outset.

The objective of wildlife intervention should not necessarily be to continue the initial intervention indefinitely. DAERA's Scientific Opinion identifies vaccination as the long-term goal and considers it potentially more suitable after infection pressure has first been reduced. It specifically identifies proactive culling or TVR followed by long-term vaccination as conceptually supported approaches and describes vaccination as potentially more suitable as an exit strategy from an intervention containing a removal component. The wider consultation suite also explicitly recognises post-intervention vaccination following an initial period of non-selective culling or TVR. [560] Where removal is used, DAERA should therefore explain before intervention begins what evidence would allow an area to transition towards vaccination and what level of vaccination coverage and subsequent surveillance would be required to provide confidence that infection remained adequately controlled. Those criteria should take account of badger infection measures, population and coverage information, cattle outcomes and evidence concerning the continuing local wildlife contribution rather than relying on

[559] DAERA (2024), Chief Veterinary Officer Review, pp. 64–65; DAERA (2025), Annotated scientific bibliography, pp. 23–24. The CVO's proposed use of DPP-positive badger density is based on a diagnostic with estimated median sensitivity of 69% and specificity of 98%, while the NI TVR evidence also demonstrates spatial heterogeneity in badger density and DPP test positivity. DAERA's evidence review emphasises that intervention assessment should account for population density, spatial distribution, trapping performance, infection prevalence and diagnostic performance rather than relying on a single measure in isolation.

[560] **DAERA (2025),** *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly pp. 7–9; **DAERA (2026),** *Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication*, Annex IV, section 2.7.2.9. The Scientific Opinion identifies vaccination as the long-term goal, notes that it is slower and less effective where infection prevalence is high unless preceded by reduced infection pressure, and describes vaccination as potentially more suitable as an exit strategy from an intervention containing a removal component. The SEA explicitly identifies post-intervention vaccination as one of three potential vaccination settings, including transition following an initial five-year non-selective cull or TVR intervention.

elapsed time alone. Likewise, if vaccination-only is selected initially, there should be predefined review points and expectations concerning the direction and rate of change in relevant disease indicators, together with a process for reconsidering the approach if progress is materially different from that expected. [561] An exit strategy should therefore not simply mean ending wildlife intervention. In many circumstances it may mean moving from an intensive disease-reduction phase into a lower-intensity maintenance and surveillance phase. Equally, surveillance during that phase should be capable of triggering renewed or intensified intervention if evidence of persistent or re-emerging infection is detected. The Riding Mountain experience provides a useful international example of such a transition. CFIA ended the special Riding Mountain Eradication Area in 2019 after more than a decade without detection of an infected livestock herd and five years without detection of an infected wild cervid. Importantly, removal of the special eradication-area controls did not mean that surveillance ceased: routine livestock slaughter surveillance continued, alongside targeted wildlife surveillance and promotion of biosecurity measures intended to minimise livestock–wildlife interaction. The species and epidemiological circumstances differ from Northern Ireland, but the programme illustrates the principle that withdrawal of an intensive intervention can be evidence-led and followed by a defined maintenance-surveillance phase rather than representing an abrupt end to disease management. [562] Minnesota provides a further example in which transition was linked to an explicit surveillance standard. The last infected free-ranging deer was detected in 2009, but intensive wildlife surveillance continued through 2012. Following three consecutive years without a further positive deer, cumulative surveillance was considered sufficient to detect a prevalence above 0.5% with 99% confidence, and dedicated deer bTB surveillance was subsequently suspended. The epidemiological context differs materially from Northern Ireland and the particular numerical threshold is not transferable. The underlying principle is relevant, however: transition or exit criteria should specify not only the disease outcome required, but also the level of surveillance and statistical confidence necessary to conclude that the required outcome has been achieved. [563] Michigan provides a

[561] **DAERA (2025),** *Scientific Opinion*, pp. 7–9; **DAERA (2026),** *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, pp. 62–64. DAERA concludes that vaccination-only generally acts more slowly than interventions containing a lethal component and may require sustained high coverage over many years where infection is endemic; required coverage is also dependent on starting prevalence and previous intervention history.
[562] **Canadian Food Inspection Agency (CFIA) (2019),** *Riding Mountain Eradication Area is no longer required by the CFIA for the management of bovine tuberculosis*, 18 November 2019. CFIA reported that the last infected livestock herd was detected in 2008 and the last infected wild cervid in 2014. Following removal of RMEA controls, routine slaughter inspection continued, while Manitoba retained targeted wild-cervid surveillance and promotion of measures reducing livestock–cervid interaction.
[563] Minnesota Department of Natural Resources (2012), 2012 Wildlife Health Summaries, 'Bovine Tuberculosis Surveillance in Wild White-tailed Deer in Northwestern Minnesota', p. 76. Following three consecutive years without detection after the final infected deer in 2009, cumulative surveillance was considered sufficient to detect prevalence greater than 0.5% with 99% confidence and dedicated bTB monitoring was suspended.

complementary caution to the Riding Mountain and Minnesota experiences. Although apparent bTB prevalence in the core white-tailed deer population has declined substantially over the longer term, infection remains endemic and continues to be detected in wildlife and cattle. Wildlife surveillance, deer population management, restrictions on baiting and feeding, cattle surveillance and farm biosecurity consequently remain important components of disease control. The Michigan experience illustrates why an exit decision should not be based simply on completion of a predetermined intervention period or achievement of a substantial reduction from baseline. Exit or transition criteria should instead demonstrate that infection and transmission have fallen sufficiently to make a lower-intensity maintenance phase epidemiologically sustainable. [564] New Zealand provides a useful operational example of how transition and exit criteria can be made explicit. Its TBfree programme uses a Bayesian "Proof of Freedom" framework which combines the history and effectiveness of wildlife control with spatial modelling and empirical wildlife surveillance to estimate the probability that M. bovis has been eliminated from a defined area. [565] An independent expert panel considers quantitative and qualitative evidence, including whether the modelling indicates at least a 95% probability of freedom, before Vector Risk Area status is revoked and TB-specific possum control ceases. Livestock, slaughter and, where required, wildlife surveillance continue after control, providing an assurance mechanism capable of identifying residual or re-emerging infection. [566] The ecological, legal and operational context differs materially from Northern Ireland, and the particular numerical threshold should not be assumed to be transferable. However, the underlying decision principle is relevant: transition or cessation of wildlife intervention should depend on predefined evidence concerning disease status and intervention performance rather than elapsed time alone. Australia provides a national-scale parallel. Following declaration of bTB freedom in 1997, dedicated Tuberculosis Freedom Assurance Programmes were established to manage the continuing risk of residual or

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[564] **Michigan Department of Natural Resources (2026),** *Bovine Tuberculosis* and *2025 bTB testing goals and results*; **Michigan Department of Agriculture and Rural Development (2026),** 'MDARD Announces Detection of Bovine Tuberculosis-Positive Herds in Alpena and Presque Isle Counties', 6 April 2026. Michigan continues to regard bTB as endemic in free-ranging white-tailed deer in northeastern Lower Michigan. Eighteen positive deer were identified among 4,177 tested in the principal TB surveillance area for 2025, and two cattle herds were confirmed infected in April 2026, illustrating the continuing need for wildlife and cattle surveillance and biosecurity.

[565] **Nugent, G., Gormley, A.M., Anderson, D.P. and Crews, K. (2018),** 'Roll-Back Eradication of Bovine Tuberculosis (TB) From Wildlife in New Zealand: Concepts, Evolving Approaches, and Progress', *Frontiers in Veterinary Science*, 5, 277. https://doi.org/10.3389/fvets.2018.00277. The Proof of Freedom framework combines the history and effectiveness of possum control, spatial modelling and empirical wildlife surveillance within a Bayesian estimate of the probability that TB has been eliminated locally.

[566] **OSPRI (2025),** *OSPRI 2024–2025 Annual Report*, particularly pp. 64–66; see also OSPRI, *Proving freedom from TB*. Current OSPRI practice uses an independent review process incorporating qualitative control and disease history and quantitative Proof of Freedom modelling; the model uses a 95% probability of freedom as the basis for expert consideration of Vector Risk Area revocation. After TB-specific possum control ceases, assurance continues through livestock testing, slaughter surveillance and wildlife surveillance where required.

isolated infection, followed by nationally coordinated surveillance. This reinforces the principle that achieving an intervention or eradication end point should lead into an appropriately designed assurance phase rather than the cessation of surveillance. [567]

10.7 Proposed decision framework

The approach can be summarised as follows. It is intended as a structured decision process rather than a prescriptive algorithm: the detailed indicators, review criteria and any numerical thresholds would need to be developed according to the intervention, objective and epidemiological circumstances of the area. [568]

Table 5. Proposed evidence-led decision framework for wildlife intervention

Stage	Principal question	Expected output
Diagnose	What is driving persistent bTB in this area, what is the evidence for a material wildlife contribution, and what are the starting cattle and wildlife conditions?	Epidemiological characterisation, baseline and clearly stated objective
Select	Which intervention or sequence best matches those starting conditions, the stated objective and the required speed of response?	Transparent intervention decision and rationale

[567] **More, S.J., Radunz, B. and Glanville, R.J. (2015),** 'Lessons learned during the successful eradication of bovine tuberculosis from Australia', *Veterinary Record*, 177, 224–232. https://doi.org/10.1136/vr.103163. Following declaration of freedom on 31 December 1997, the first Tuberculosis Freedom Assurance Programme operated from 1998–2002, followed by TFAP2 from 2003–2006 and the nationally integrated Australian Bovine Tuberculosis Surveillance Project from 2007–2010, recognising that isolated or residual infections could still occur after formal freedom had been achieved.

[568] DAERA (2025), Annotated scientific bibliography relating to badger intervention and bovine tuberculosis, p. 23; Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Vaclavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', Ecological Solutions and Evidence, 3(4), e12192; DAERA (2024), Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland, particularly pp. 64–65; DAERA (2026), Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication, particularly Chapter 4. Smith et al. propose a staged process beginning with confirmation of wildlife involvement, clarification of the objective and resources and consideration of exit requirements, followed by surveillance, definition of the infected area, selection and implementation of control, measurement and adaptation. DAERA's CVO Review subsequently proposed an adaptive approach capable of varying intervention between sub-areas and over time, while the current consultation describes wildlife intervention as proportionate, evidence-led and adaptable, with intervention areas selected according to local conditions and subsequently subject to continuing review.

Stage	Principal question	Expected output
Intervene	What scale, coverage, duration, resources and parallel cattle measures are required?	Defined delivery plan, operational standards, intended coverage and success criteria
Monitor	Is the intervention being delivered as intended and are cattle and wildlife disease indicators responding as expected?	Regular reporting against predefined delivery, intermediate wildlife and cattle-outcome measures
Adapt	Does the evidence support continuing, intensifying, reducing, modifying or transitioning from the intervention?	Documented decision against predefined review criteria to maintain, modify or transition
Transition/Exit	When can intensive intervention end or change, and what ongoing control and surveillance is required?	Defined move to vaccination, maintenance surveillance or other appropriate next phase, with criteria for re-escalation if required

The framework is deliberately cyclical rather than linear: monitoring may lead back to diagnosis or selection where the evidence indicates that the original assumptions about disease dynamics, population conditions or deliverability no longer hold.

AgriSearch assessment

AgriSearch considers that DAERA's consultation already contains many of the components required for an evidence-led and adaptive wildlife intervention programme. It proposes targeted area characterisation, recognises the importance of local epidemiology, badger density, infection evidence and physical boundaries, provides for close continuing review, and allows for more than one intervention to be deployed in an adaptable way according to the local disease picture. The CVO Review provides a more developed example of adaptive management, including the possibility of changing intervention between sub-areas and over time. [569]

[569] **Department of Agriculture, Environment and Rural Affairs (DAERA) (2026),** *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, particularly Chapter 4, pp. 26–27 and section 5.1, p. 29; **DAERA (2024),** *Chief Veterinary*

The opportunity is therefore not to create an entirely new policy concept, but to **bring these existing components together into an explicit and transparent decision framework**. That framework should define, before intervention begins, the baseline and objective, the criteria used to select an intervention, the intended scale and coverage, the indicators used to judge delivery and epidemiological effect, the circumstances that would trigger reconsideration, and the evidence required for transition to a lower-intensity phase or renewed intervention if disease persists or re-emerges. [570]

AgriSearch therefore recommends that any future wildlife programme operates on the principle:

Diagnose → Select → Intervene → Monitor → Adapt → Transition/Exit

This should be regarded as a **structured decision process rather than a rigid algorithm**. The relevant indicators and any numerical thresholds may differ according to intervention, epidemiological objective and local circumstances, but the decision rules and review process should be established before implementation rather than determined retrospectively. [571]

Such an approach would recognise that the initial choice of intervention is not the end of the evidence-based decision-making process. It would allow Northern Ireland to respond to local epidemiological circumstances, distinguish between whether an intervention was delivered as intended and whether it achieved its disease-control objective, learn systematically from implementation, move towards less intensive intervention and maintenance surveillance where disease conditions permit, and

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Officer Review of Bovine Tuberculosis in Northern Ireland, pp. 64–65. The consultation describes the proposed approach as proportionate, evidence-led and adaptable; identifies cattle disease history, badger density and infection, local veterinary and epidemiological information and physical boundaries as area-selection considerations; provides for close continuous review; and allows one or more intervention options to be combined according to the local disease picture. The CVO Review develops this further by proposing that intervention could vary between sub-areas and be modified through annual review.

[570] **DAERA (2025),** *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, p. 23; Smith, G.C., Brough, T., Podgórski, T., Ježek, M., Šatrán, P., Vaclavek, P. and Delahay, R.J. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192; **TB Strategic Partnership Group (TBSPG) (2016),** *Annex B: Wildlife & Vaccination – Scientific Appraisal*, particularly section 1.2. Smith et al. identify **Confirm, Clarify, Resource and Exit** as considerations before intervention, followed by surveillance, definition of the infected area, implementation, measurement and adaptation. Earlier Northern Ireland policy similarly recommended a multiplicity of tools applied according to local circumstances, with further intervention considered on the basis of evaluation and available scientific evidence.

[571] **DAERA (2024),** *Chief Veterinary Officer Review*, pp. 64–65; **DAERA (2025),** *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, particularly Conclusions 4 and 7; **DAERA (2026),** *Consultation*, section 4.3. These sources support adaptive and sequenced approaches but do not establish universal numerical thresholds for changing intervention. DAERA's Scientific Opinion identifies vaccination as a long-term goal and recognises the scientific rationale for culling or TVR followed by vaccination, while the particular adaptive hybrid proposed by the CVO remains novel. The consultation instead proposes continuing review informed by surveillance data, disease trends and emerging scientific evidence.

reconsider or intensify the approach where expected outcomes are not being achieved. **It would also help ensure that implementation progressively reduces current uncertainties and strengthens the Northern Ireland evidence base on which subsequent wildlife-policy decisions are made.**

11. Monitoring, evaluation and the evidence base

If Northern Ireland proceeds with a wildlife intervention programme, AgriSearch considers that implementation should be designed not only to deliver disease control but also to strengthen the evidence base on which future decisions are made. The principal monitoring indicators, baselines and evaluation questions should therefore be defined before intervention begins, so that subsequent decisions are based on pre-specified evidence rather than retrospective interpretation.

This is particularly important because several of the uncertainties identified in this response relate directly to Northern Ireland conditions: contemporary badger population density and distribution, spatial variation in infection prevalence, achievable intervention coverage, the relative contribution of cattle and badger transmission in different areas, and the cattle-level effectiveness of interventions such as TVR under operational deployment. [572]

DAERA already recognises the need for monitoring and review. Annex VIII states that any badger intervention will require close monitoring and regular review and that the approach is likely to evolve as monitoring data and new scientific evidence become available. [573] The consultation document also proposes monitoring based on field information, surveillance and epidemiological data, together with reporting from delivery partners, to inform ongoing management, periodic review and wider evaluation of the eradication strategy. [574]

The Strategic Environmental Assessment supports this approach but identifies a need for greater specificity. It recommends that the parameters used to assess the effectiveness and success of intervention should be defined more clearly and suggests annual monitoring of measures including badgers culled or vaccinated, herd breakdowns, cattle reactors and bTB infection rates. [575]

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[572] DAERA (2025b), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII. DAERA concludes that robust badger population data are required to inform interventions; that the relative contribution of cattle and wildlife to maintenance of *M. bovis* varies between hotspots; and that the NI TVR trial was limited by the absence of replicate and control areas and did not demonstrate a cattle herd-incidence effect.

[573] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, section 3.3. DAERA states that any badger intervention will require close monitoring and regular review and that the approach is likely to evolve as monitoring data and emerging scientific evidence become available.

[574] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 5.6. DAERA proposes monitoring based on operational oversight, field information, surveillance and epidemiological data and reporting from delivery partners, with findings used for ongoing management, periodic review and wider programme evaluation.

[575] Tetra Tech (2026), *Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication*, section 8.4.1. The SEA recommends that specific monitoring parameters for effectiveness and success should be set out and suggests annual

AgriSearch has not undertaken an independent review of the SEA and does not seek to duplicate its environmental assessment. However, environmental monitoring should remain an integral part of programme evaluation alongside epidemiological monitoring. The SEA identifies potential effects including changes in local badger populations, unintended effects on non-target species associated with capture methods, and cumulative or synergistic effects arising from the combined implementation of measures. Where relevant, these should be monitored during delivery so that unforeseen adverse effects can be identified and proportionate mitigation or operational changes introduced. [576]

AgriSearch supports this approach but considers that monitoring should extend beyond demonstrating that operational activity has taken place. It should be capable of answering two separate questions:

Was the intervention delivered as intended?

and

Did it produce the intended epidemiological effect?

A programme which records only how many badgers were culled or vaccinated would answer the first question only partially. Without reliable information on the local population and intervention coverage, the number treated or removed does not establish what proportion of the target population was reached. More importantly, operational activity alone cannot establish whether bTB infection in badgers was reduced or whether cattle disease subsequently declined.

11.1 Establishing a robust baseline

Evaluation needs to begin before intervention starts.

Each intervention area should have a clearly documented, area-specific baseline covering the cattle disease situation, badger population and infection evidence, local epidemiology and relevant operational conditions. Wherever possible, this should draw on several years of preceding cattle data rather than a single baseline year, given the natural year-to-year variation in bTB incidence. The baseline measures and definitions

use of information including numbers of badgers culled and vaccinated, herd breakdowns, reactors and bTB infection rates to inform adjustments to the intervention.

[576] etra Tech (2026), *Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication*, Annex IV, particularly sections 7.2–7.3 and 8.4. The SEA considers potential effects on biodiversity, flora and fauna, including local badger populations and accidental by-catch of other species; assesses cumulative and synergistic effects between measures; and provides an environmental monitoring framework intended to identify unforeseen adverse effects and enable remedial action.

used should be specified in advance and applied consistently through subsequent monitoring.

The baseline should include measures such as cattle herd incidence, recurrent and prolonged breakdowns, reactor numbers, badger population density and distribution, available badger infection information, relevant WGS or strain evidence, cattle movements and other identified epidemiological risks. [577] It should also record the cattle-control measures operating within the intervention area and any material changes to those measures during the evaluation period, so that changes in cattle disease are not attributed to wildlife intervention without considering other concurrent influences. [578]

Relevant operational characteristics should also be documented, including intervention boundaries, land access, anticipated capture or removal coverage and any landscape or ecological factors likely to influence delivery. DAERA itself proposes selecting intervention areas on the basis of long-term cattle bTB, badger social-group density, evidence of infection in local badgers, local veterinary and epidemiological information and suitable natural or physical boundaries. [579]

Establishing these measures prospectively would provide a much stronger basis for subsequent evaluation than attempting retrospectively to reconstruct starting conditions once intervention is already underway.

It would also help address an important limitation of the previous Northern Ireland TVR project. That project generated valuable evidence on badger infection and the operational feasibility of trap-side testing, but it was undertaken in a single intervention area and lacked replicated intervention and untreated control areas. DAERA's own scientific opinion recognises that these design limitations constrain interpretation of the observed decline in badger test positivity and that the study did not demonstrate an effect on cattle herd incidence. [580] Any future operational deployment should therefore,

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[577] DAERA (2025b), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 2–5. DAERA notes that WGS evidence indicates that the relative contribution of different host species varies between bTB hotspots and that modelling identifies cattle movements, testing frequency and interspecies transmission rates as important determinants of variation in cattle bTB levels.

[578] DAERA (2026), Annex VII, pp. 3, 6–9. DAERA notes that wildlife interventions have generally operated alongside cattle-control measures and concludes that effective cattle controls are required to reduce reintroduction of infection and enable wildlife intervention to succeed in the longer term.

[579] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 1.2 and Chapter 4. DAERA proposes targeted intervention areas taking account of long-term high cattle bTB levels, higher-than-average badger social-group density, evidence of local badger infection, veterinary and epidemiological information and natural boundaries.

[580] DAERA (2025b), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, pp. 3 and 7–8. DAERA identifies the absence of replicate and control areas as a design limitation of the Northern Ireland TVR project and states that analysis did not demonstrate an effect on cattle herd incidence.

as far as practicable, be designed from the outset to distinguish intervention effects from background disease trends and from changes in other cattle or wildlife control measures.

11.2 Contemporary badger population and infection surveillance

Reliable population information is fundamental to monitoring all three interventions.

DAERA's annotated scientific bibliography concludes that robust badger population data are required to inform the modelling and progression of interventions. It also cautions that capture-based measures such as Minimum Number Alive (MNA) can be biased by differences in age, trapping behaviour and previous control pressure and should not automatically be treated as reliable population estimates in isolation. [581]

AgriSearch therefore considers that contemporary badger population assessment should not be treated simply as a one-off exercise undertaken before intervention begins. Population density and distribution should be reassessed periodically, particularly where substantial removal is taking place or where immigration and recolonisation could alter the denominator against which intervention coverage is being calculated.

The emerging Queen's University Belfast work provides useful contemporary evidence on how this might be achieved under Northern Ireland conditions. Interim findings indicate that thermal imaging binoculars and drones can directly record free-ranging badgers across a range of land classes and can reveal substantial local variation in density. In concurrent comparisons, QUB reports that indirect counting methods returned lower density estimates than direct thermal survey techniques. Thermal observation also makes fewer assumptions about sett occupancy and social-group size than methods which infer abundance from field signs. It should nevertheless be regarded as providing a direct minimum number observed within the survey area rather than an infallible census. AgriSearch therefore considers that thermal surveying should be explicitly considered, alongside other appropriate methods, as part of both pre-intervention baseline assessment and periodic reassessment of badger populations. [582]

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[581] DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis for the period 1 January 2015 to 31 May 2024 (with later extension to 30 November 2024)*, Annex VI, pp. 5–6. The review concludes that robust population information is required and summarises evidence that Minimum Number Alive estimates may be affected by age structure, individual trapping behaviour and previous control pressure.

[582] Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, written communication to AgriSearch, 4 September 2026, reproduced at Appendix 4. Fieldwork and analysis remain ongoing and the findings should not be interpreted as providing a final Northern Ireland-wide population estimate.

The same principle applies to infection surveillance. The Northern Ireland-wide RTA survey provides valuable background information but has recognised limitations as a geographically representative measure of badger infection. The CVO Review identifies concerns over the validity and precision of the survey arising from its convenience-sample nature, while earlier TBSPG work noted that sample sizes and geographical coverage were insufficient to detect anything other than relatively large spatial or temporal variation. The SEA also recommends that DAERA clarify how information from the RTA survey will be used within future wildlife management. [583]

RTA surveillance remains valuable for identifying broad spatial and temporal patterns of infection and for molecular comparison of *M. bovis* isolates. However, intervention-area selection and subsequent assessment should not rely on the percentage of RTA badgers testing positive as a direct estimate of local true prevalence. In candidate intervention areas, DAERA should seek contemporary local evidence of infection and clearly specify the diagnostic methods used. Where practicable, targeted enhanced post-mortem examination and culture of suitable carcasses, or other complementary surveillance approaches, should be considered to improve detection of infection that may be missed by less intensive examination. [584] Diagnostic protocols should also remain sufficiently consistent over time to allow apparent changes in prevalence during intervention to be interpreted reliably.

Monitoring should therefore be designed, as far as practicable, to establish comparable trends in infection within individual intervention areas over time rather than relying solely on a Northern Ireland-wide prevalence estimate. TVR has a particular advantage in this regard because captured animals are individually tested and the consultation explicitly states that TVR facilitates monitoring of infection within the badger population and hence the impact of intervention. [585] Such results must, however, be interpreted in the context of diagnostic-test performance, capture probability and the representativeness of the animals sampled, rather than treating observed DPP test

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[583] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 65–66; TBSPG (2016), *Bovine Tuberculosis Eradication Strategy for Northern Ireland*, p. 52; Tetra Tech (2026), *Strategic Environmental Assessment*, section 7.1/8.2. The CVO Review identifies validity and precision concerns associated with the convenience-sample nature of RTA surveillance; the earlier TBSPG strategy notes limitations in detecting regional and temporal variation; and the SEA recommends clarification of how RTA information will be used in future wildlife policy.

[584] Murphy, D., Gormley, E., Costello, E., O'Meara, D. & Corner, L.A.L. (2010), 'The prevalence and distribution of *Mycobacterium bovis* infection in European badgers (*Meles meles*) as determined by enhanced post mortem examination and bacteriological culture', *Research in Veterinary Science*, 88(1), 1–5; DAERA (2024), *Chief Veterinary Officer Review*, pp. 28–29. The CVO Review notes that RTA-based badger prevalence may understate infection in some hotspot areas and cites enhanced post-mortem evidence from the Republic of Ireland.

[585] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 7. DAERA states that TVR facilitates monitoring of disease prevalence within the badger population and hence the impact of intervention; the same section reports estimated whole-blood DPP sensitivity of 69% and specificity of 98%.

positivity as an exact measure of underlying population prevalence. For culling and vaccination-only, alternative surveillance approaches will be needed if comparable information on infection trends is to be obtained.

Emerging Northern Ireland research may also provide additional non-invasive approaches to wildlife infection surveillance. QUB has developed a phage-based PhMS-qPCR approach for detection of viable mycobacteria. Interim, unpublished findings from the current badger population project report detection of viable *M. bovis* and MAP, both separately and in combination, in badger faecal samples collected during the study. [586] If sufficiently validated for faecal or environmental surveillance, such an approach could potentially complement RTA surveillance and capture-based testing by providing more geographically resolved and non-invasive information on the presence of infection within wildlife populations.

Important uncertainties remain before such results could be used as an operational measure of badger infection prevalence. These include analytical and field performance in the relevant sample types, sampling design, the effects of intermittent bacterial shedding, and the relationship between detection of viable *M. bovis* in an environmental or faecal sample and the underlying prevalence of infection in the local badger population. A positive sample demonstrates the presence of viable bacteria but does not identify the number or proportion of infected animals, while failure to detect bacteria cannot necessarily be equated with absence of infection. AgriSearch therefore considers the approach promising for surveillance, but it should not be treated as an established prevalence measure until appropriate validation is complete.

11.3 Measuring actual intervention coverage

One of the most important distinctions should be between planned coverage and achieved coverage. Monitoring should distinguish, as far as practicable, between **operational coverage**, the extent, intensity and consistency with which the intervention was delivered across the target area, and **population coverage,** the estimated proportion of the local badger population actually reached.

Recent English operational evidence illustrates this distinction. Natural England's monitoring of the 2025 intensive badger-control programme recorded not only the number of badgers removed but also contractor effort and its spatial distribution across accessible land. Ten of the eleven continuing intensive-control areas were judged to

[586] Dick, J.T.A. (2026), interim findings from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, project update presented to AgriSearch and project partners, 4 September 2026 (unpublished interim results); Dane, H., Gilbride, B., Thomas, M. and Grant, I.R. (2026), 'Evidence of mycobacteraemias and mycobacterial co-infections uncovered in cattle at slaughter using a novel phage-based PhMS-qPCR assay for viable *Mycobacterium bovis* and *Mycobacterium avium* subsp. *paratuberculosis*', *Irish Veterinary Journal*, 79, 2

have completed an effective cull. In one area, however, sufficient spatial coverage was achieved but the sustained and coordinated level of effort was inadequate and the minimum removal number was not reached; the cull was therefore judged ineffective. [587] This demonstrates that an intervention should not be assumed to have been effectively delivered simply because an area has been designated or some operational target has been met.

The English programme also illustrates the uncertainty surrounding the population denominator itself. Minimum and maximum removal numbers were reviewed after operations had begun and adjusted upwards or downwards in response to field evidence on badger abundance. [588] AgriSearch considers that Northern Ireland monitoring should similarly allow population and coverage assumptions to be reviewed where operational evidence indicates that the pre-intervention estimate may no longer be appropriate.

A statement that an intervention is intended to remove **up to 70%** of a badger population, or that vaccination modelling suggests annual coverage of around 30–40% may be required, has limited evaluative value unless the underlying population denominator is sufficiently reliable and the number or proportion of animals actually reached can be estimated. [589] The vaccination figure should also be interpreted in its original context: DAERA notes that the modelled 30–40% requirement was based on conditions where previous culling had already reduced badger bTB prevalence.

For trapping-based interventions, systematic recording should therefore include capture location, trapping effort, individual identification where appropriate, capture and recapture history, test result, vaccination history and outcome. DAERA already envisages an IT system recording sett and trap locations, badgers captured, treatments applied and other monitoring information. [590] Within TVR, microchipping provides a

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[587] Natural England and Department for Environment, Food & Rural Affairs (2026), *Summary of 2025 badger control operations*, published 30 July 2026, sections "Effectiveness", "Progress towards minimum and maximum numbers" and "Conclusions". Natural England monitored removals, effort and spatial distribution; Area 72 achieved sufficient spatial coverage but was judged not to have completed an effective cull because sustained and coordinated effort was insufficient and the minimum removal number was not achieved.

[588] Natural England and Department for Environment, Food & Rural Affairs (2026), *Summary of 2025 badger control operations*, section "Updating minimum and maximum numbers". Population-based minimum removal numbers were reviewed during operations and adjusted upwards in seven intensive-control areas and downwards in four in response to evidence of badger abundance observed in the field.

[589] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, sections 5.2 and 5.4. DAERA describes non-selective culling as potentially reducing the local badger population by up to 70%. For vaccination-only, it cites modelling suggesting annual vaccination of around 30–40% of the population, while noting that this outcome was predicated on previous culling having reduced badger bTB prevalence.

[590] DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, para. 2.5.2. DAERA envisages an IT database recording information including badger sett and trap locations, badgers trapped, treatments applied and other monitoring information.

mechanism for identifying previously captured animals, while DAERA's proposed methodology involves annual repeat trapping and revaccination of animals that again test negative. [591]

Capture and recapture information is also scientifically valuable because it can improve understanding of trappability and population size. However, DAERA's annotated bibliography cautions that capture-derived measures such as Minimum Number Alive can be biased by age structure and by "trap-shy" and "trap-happy" behaviour, and may also be affected by previous control pressure. [592] Capture data should therefore inform, rather than substitute for, independent assessment of population abundance.

For non-selective culling, monitoring should similarly distinguish between the **number of animals removed**, the **effort and spatial coverage achieved**, and the **estimated proportion of the starting population removed**. Where the population estimate is revised during implementation, both the original and updated denominators and the basis for the revision should be reported transparently.

This distinction matters because inadequate coverage or insufficiently sustained delivery could explain poor disease outcomes without necessarily demonstrating that the underlying intervention is ineffective. Conversely, apparently successful implementation should not be claimed solely from meeting an activity target if the actual population coverage or spatial delivery remains uncertain.

11.4 Cattle outcomes must remain the principal epidemiological endpoint

Because the purpose of wildlife intervention is ultimately to reduce bTB in cattle, cattle disease outcomes should remain the principal measure of epidemiological success.

The SEA already identifies cattle bTB outcomes as relevant indicators and recommends annual monitoring of herd breakdowns, reactors detected through testing and bTB infection rates alongside wildlife-intervention data. [593]

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[591] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, sections 5.3 and Chapter 7; *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, paras. 2.14.8–2.14.10. Under the proposed TVR methodology, test-negative badgers are microchipped and released; intervention is repeated annually and recaptured test-negative animals are revaccinated.

[592] DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, pp. 5–6. The review notes limitations in Minimum Number Alive estimates arising from age structure, "trap happy" and "trap shy" behaviour and differences associated with previous control pressure.

[593] Tetra Tech (2026), *Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication*, section 8.4.1. The SEA recommends annual monitoring using information including herd breakdowns, reactors found during testing and bTB

AgriSearch considers that evaluation should go beyond a single headline herd-incidence measure. Both herd-level and animal-level disease measures should be reported, together with more detailed indicators capable of showing how the pattern and burden of disease are changing within affected herds. The CVO Review itself argues that programme measurements should provide insight into the biological processes driving persistence and spread and specifically identifies breakdown recurrence, duration and severity as measures which should be considered. [594]

This is particularly relevant to wildlife intervention. An intervention might, for example, have different effects on the incidence of new breakdowns, the recurrence of disease in previously affected herds, the duration of restrictions and the number or proportion of reactor animals identified within breakdowns. Monitoring a range of pre-specified cattle outcomes would therefore provide a more informative assessment than relying on one aggregate incidence measure alone.

The principal cattle outcomes, their definitions and the time period over which improvement is expected should therefore be specified before intervention begins. Trends should also be interpreted in the context of the number of cattle and herds tested and any material changes in cattle testing or control policy during the intervention period. This would reduce the risk of retrospectively selecting whichever measure appears most favourable once results are known and would strengthen the ability to distinguish a genuine intervention effect from changes arising through other parts of the bTB programme. [595]

11.5 Comparator arrangements and attribution

One of the most difficult challenges will be determining whether changes in cattle bTB can be reasonably attributed to the wildlife intervention rather than to other changes occurring at the same time.

This is particularly important because wildlife intervention will be introduced alongside changes in cattle controls, surveillance, breakdown management and other elements of the Blueprint. DAERA itself emphasises that cattle and wildlife measures must

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infection rates, alongside information on badgers culled or vaccinated, to assess performance and inform adjustment of the intervention.

[594] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 39–40, "Programme Measurements". The CVO states that programme measurements should provide insight into the biological processes contributing to persistence and spread of *M. bovis* and proposes that more detailed measures including breakdown recurrence, duration and severity should be considered.

[595] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 43–44. The Review notes that future herd bTB risk is associated with factors including breakdown size/severity and previous history and proposes changes to herd classification and test interpretation intended to increase detection sensitivity. This reinforces the need to interpret cattle outcome trends alongside changes in testing and control policy.

operate in parallel and that strengthened cattle controls remain essential to eradication. [596]

Wherever feasible, AgriSearch considers that intervention design should therefore include appropriate comparator arrangements. These need not necessarily take the form of a new randomised controlled trial, but could include matched non-intervention areas, phased or staggered implementation, difference-in-differences analysis or other robust quasi-experimental approaches. Comparator areas should, as far as practicable, be similar in their pre-intervention cattle disease history, herd structure and movement patterns, badger population and infection evidence, local epidemiology and other material risk factors.

The appropriate design, outcome measures and analytical approach should be developed with epidemiological and statistical expertise before implementation. The previous Northern Ireland TVR project illustrates the importance of this: DAERA's own scientific review identifies the absence of replicate and control areas as an important design limitation and notes that the study did not demonstrate a cattle herd-incidence effect. [597]

Where suitable comparator areas cannot be established, this limitation should be acknowledged explicitly and greater emphasis placed on pre-intervention and post-intervention time-series evidence, local epidemiology, WGS and other information capable of helping distinguish intervention effects from wider disease trends. WGS can provide valuable evidence on transmission pathways and on the relative contribution of cattle and badgers in different hotspots, but should be used as part of a wider attribution framework rather than treated as a standalone measure of intervention effect. [598]

Any analysis should also document material changes in cattle testing, herd management or other disease-control measures within intervention and comparator

[596] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Chapter 4; DAERA (2025b), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Scientific Opinion Conclusion 3. DAERA states that wildlife interventions are intended to operate alongside cattle and people measures and concludes that strengthened parallel cattle controls are essential.

[597] DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, p. 24; DAERA (2026b), *Scientific Opinion*, Annex VII. DAERA identifies the absence of replicate and control areas as a design limitation of the Northern Ireland TVR project and notes that the analysis did not demonstrate a cattle herd-incidence effect.

[598] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, p. 29; DAERA (2026b), *Scientific Opinion*, Annex VII, Transmission Dynamics. Both documents identify WGS as providing insight into transmission pathways and the relative contribution of cattle and badgers, with Annex VII noting that this contribution varies between bTB hotspots.

areas during the evaluation period. Without this, an observed change in cattle disease could be incorrectly attributed either to the wildlife intervention or to its failure.

The objective should be to avoid reaching the end of the planned intervention period with substantial operational data but still being unable to answer with reasonable confidence whether cattle disease changed **because of the intervention**, and not simply while the intervention was taking place.

11.6 Whole-genome sequencing and transmission evidence

Whole-genome sequencing (WGS) should form an important component of the evaluation framework, particularly in intervention areas where sufficient cattle and badger *M. bovis* isolates can be obtained over time.

The CVO Review identifies WGS as providing valuable spatial and temporal information on transmission pathways and states that its use should be advanced so that the bTB programme has access to the full range of epidemiological information needed to inform existing and future intervention strategies. [599] The Blueprint similarly proposes expanded use of WGS to better understand transmission pathways and support breakdown case management, followed by its integration into epidemiological investigation and routine case management. [600]

Northern Ireland evidence already illustrates its potential value. Genomic analysis within the former TVR area found that the inferred transmission dynamics were dominated by cattle-associated transmission, with 35 of 37 inferred direct transmission events occurring within cattle and only two involving inter-species transitions. The CVO Review cites this as evidence that the relative contribution of different transmission pathways may vary between locations. [601] DAERA's wider scientific review reaches the same general conclusion: WGS studies from different bTB hotspots have produced

[599] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 50–51. The Review states that WGS provides spatial and temporal insight into infection dynamics and transmission pathways, improves disease tracing relative to earlier strain-typing approaches and should be advanced to support informed decisions on disease-intervention strategies.
[600] TB Partnership Steering Group (2025), *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, p. 23. The Blueprint proposes expanded use of WGS to understand transmission pathways and support breakdown case management, followed by integration into epidemiological investigations and continued development of genetic analysis to inform intervention decisions.
[601] DAERA (2024), *Chief Veterinary Officer Review*, pp. 49–50, citing Akhmetova et al. (2023), *Genomic epidemiology of Mycobacterium bovis infection in sympatric badger and cattle populations in Northern Ireland*. Within the NI TVR area, 35 of 37 inferred direct transmission events were cattle-associated, with two inter-species transitions identified.

divergent results, indicating that transmission dynamics are context-dependent and that the role of wildlife should not be assumed to be uniform across areas. [602]

Within future intervention areas, WGS could therefore help assess whether, over time, there are changes in the persistence and spatial distribution of particular *M. bovis* lineages, the clustering of infection within cattle herds, evidence consistent with cattle–badger exchange, geographical spread, or the introduction and dissemination of infection associated with cattle movements.

To maximise its value, sampling should be planned prospectively. Where practicable, representative isolates from cattle and badgers should be obtained before and during intervention, linked to location, date and relevant epidemiological information, and analysed using sufficiently consistent methods to allow comparison over time. Historical isolates may also provide useful pre-intervention context where suitable material is available.

WGS should not, however, be expected to provide definitive direction-of-transmission answers in every case. Inferences depend on the completeness and representativeness of sampling, the genetic resolution available and the epidemiological context. The CVO Review itself describes the developing WGS platform as having the potential to "Track & Trace" infection and estimate direction of transmission in **well-sampled case studies**, which underlines the importance of sampling design. [603]

Used alongside conventional epidemiology, cattle-movement information, local badger surveillance and comparator or time-series evidence, WGS could nevertheless substantially improve understanding of why an intervention is or is not succeeding. It should therefore be treated as part of an integrated attribution framework rather than as a standalone measure of intervention effect.

11.7 Independent evaluation and transparency

AgriSearch considers that major wildlife interventions should be subject to independent scientific evaluation and scrutiny, particularly where operational deployment is also intended to address important evidence gaps.

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[602] DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, "Whole-genome sequencing (WGS)"; DAERA (2025b), *Scientific Opinion*, Annex VII, "Transmission dynamics". DAERA concludes that WGS studies across different hotspots have produced differing results and that the relative contribution of cattle and badgers to maintenance of infection varies between locations.

[603] DAERA (2024), *Chief Veterinary Officer Review*, pp. 36–37. One of the current DAERA/AFBI projects is developing WGS as an epidemiological investigative platform to track infection and estimate direction of transmission in well-sampled case studies.

This recommendation is consistent with the wider direction of the CVO Review and Blueprint. The CVO Review states that scientific quality is fundamental to providing assurance to stakeholders and taxpayers, proposes an ongoing source of independent scientific advice and describes continual expert review and amendment as necessary as the eradication programme develops. It also identifies publication of DAERA-commissioned research in international peer-reviewed journals as an important means of providing assurance on scientific quality. [604] The Blueprint subsequently commits DAERA to evaluate options for the provision of independent science advice and, in the medium term, to evaluate and review completed research projects so that their findings inform future policy and eradication measures. [605]

AgriSearch considers that these principles should be applied directly to the evaluation of any substantial wildlife intervention programme. Independent evaluation does not imply that DAERA, AFBI or delivery partners are incapable of undertaking robust analysis. Nor does it require all data collection or analysis to be undertaken outside Government. Its value is to provide scrutiny independent of those responsible for policy design and delivery and thereby increase confidence that the evaluation design, analytical methods and interpretation of outcomes are robust.

Wherever practicable, the evaluation protocol should be agreed and published before intervention begins. It should specify the principal outcomes, baseline and comparator arrangements, analytical methods, anticipated review points and the criteria by which intervention performance will be judged. Material departures from the agreed protocol during implementation should subsequently be documented and explained.

Independent scientific scrutiny should therefore operate at more than one stage: first, to review whether the proposed evaluation design is capable of answering the principal questions before implementation begins; and subsequently, to review the analysis and interpretation of the resulting evidence before major policy conclusions are drawn.

AgriSearch also recommends that evaluation findings, analytical methods and supporting data are made as openly available as legal, commercial, animal-location and confidentiality considerations permit. Where individual-level or location-sensitive information cannot be released, appropriately aggregated or anonymised data should

[604] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 34–37, particularly "Independent Science Advice" and "Research". The CVO Review states that scientific quality is essential to provide assurance to stakeholders and taxpayers, identifies publication in international peer-reviewed journals as a quality-assurance mechanism, proposes ongoing independent scientific advice and describes the eradication pathway as requiring continual expert review and amendment.
[605] TB Partnership Steering Group (2025), *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, Delivery Plan, p. 20, "Independent Science Advice / Research & Development". The Blueprint proposes evaluation of options for independent science advice and, in the medium term, review of recently completed research projects to ensure their outputs inform future policy and eradication measures.

be considered. Publication should include results showing limited, uncertain or no measurable intervention effect as well as positive findings.

Where the work is of sufficient scientific importance, results should also be submitted for peer-reviewed publication. This would allow the Northern Ireland programme to contribute to the wider international bTB evidence base and help avoid repetition of one of the problems identified throughout this consultation: important policy decisions having to rely on evidence or analytical assumptions that external parties cannot readily reproduce or scrutinise.

11.8 Periodic reassessment of intervention strategy

Monitoring and evaluation should feed directly into the adaptive process proposed in Section 10.

Annex VIII already states that wildlife intervention will require close monitoring and regular review and that the approach is likely to evolve as monitoring data and emerging scientific evidence become available. It further states that potential evolutions or enhancements should be considered at regular intervals where these could help drive further reductions in herd incidence. [606] The SEA similarly envisages monitoring outcomes informing the development, amendment and implementation of measures. [607]

AgriSearch considers that formal review points should therefore be established in advance. These should include both scheduled reviews at defined intervals and, where appropriate, earlier review triggered by material divergence from expected outcomes, for example, substantially different badger population estimates, failure to achieve required intervention coverage, unexpected disease trends, materially higher costs or new scientific evidence affecting the rationale for the chosen approach.

Recent New Zealand experience provides a useful programme-level illustration of this principle. The 2025 review of its National Pest Management Plan for bovine TB concluded that the existing 2026 livestock-freedom milestone could not be achieved and sustained while infection remained in the possum reservoir. It therefore proposed replacing that milestone with an objective of freedom from TB in cattle, deer and

[606] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, paras. 3.3.1–3.3.2. DAERA states that any badger intervention will require close monitoring and regular review; that the approach is likely to evolve in response to monitoring data and emerging scientific evidence; and that potential evolutions or enhancements will be considered at regular intervals where these could help drive further reductions in herd incidence.

[607] Tetra Tech (2026), *Strategic Environmental Assessment: Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland Blueprint for Eradication*, section 8.4. The SEA states that monitoring should be undertaken alongside plan reviews so that monitoring outcomes can influence the development, amendment and implementation of measures.

possums by 2040. [608] The New Zealand Government accepted the review proposals in June 2026. [609] The specific target and reservoir system are not directly transferable to Northern Ireland, but the experience illustrates why long-term eradication milestones and their underlying assumptions should be periodically tested against emerging epidemiological evidence rather than treated as immutable.

Those reviews should consider not only whether operational activity targets have been met, but whether the assumptions underlying the original intervention remain valid. Relevant questions could include:

- Has badger population density or distribution differed materially from that assumed?
- Has the required population and spatial coverage been achieved and sustained?
- Are local indicators of badger infection changing in the expected direction?
- Are cattle outcomes improving at the anticipated rate?
- Does WGS, interpreted alongside conventional epidemiology, continue to implicate wildlife as an important component of local transmission?
- Have cattle-focused measures or other relevant epidemiological conditions changed materially?
- Have intervention costs or resource requirements differed significantly from the original appraisal?

The outcome of such reviews could be to continue the intervention unchanged, alter its intensity or geographical extent, transition towards vaccination where epidemiological conditions support this, strengthen cattle-focused measures, undertake further investigation or, where appropriate, discontinue an approach that is not achieving its objectives.

Wherever practicable, the broad criteria informing these decisions should be identified before implementation begins, and the outcome and reasoning from each formal review should be published. This would make adaptive management a transparent, evidence-led process rather than a series of ad hoc policy changes.

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[608] TB Plan Review Plan Governance Group (2025), *Review of the Bovine Tuberculosis National Pest Management Plan – Final Proposal*, proposed amendments to Clause 5. The review proposed removal of the 2026 cattle and deer freedom milestone and replacement of the existing 2040 possum-freedom milestone with an objective of freedom from tuberculosis in cattle, deer and possums by 2040, on the basis that sustainable livestock freedom was not possible while infected wildlife reservoirs remained.
[609] New Zealand Government (2026), 'Government approves new plan to eliminate bovine TB', Minister for Biosecurity, 3 June 2026. The Government stated that it had accepted the independent review team's proposals and that the revised plan would focus on eradicating TB from both possums and livestock by 2040.

Such adaptation should not be regarded as policy failure. The purpose of monitoring and evaluation is precisely to allow intervention strategy to change when evidence shows that the original assumptions no longer hold or that a different approach is now more likely to achieve eradication objectives.

11.9 Proposed monitoring and evaluation framework

A practical framework could be summarised as follows:

Table 6. Proposed monitoring and evaluation framework for wildlife intervention.

Evidence area	Examples of measures	Purpose
Baseline cattle epidemiology	Herd- and animal-level incidence; recurrent and prolonged breakdowns; breakdown severity; reactor numbers; cattle movement history	Establish the pre-intervention disease position against which change can be assessed
Badger population	Contemporary density and distribution; social-group structure; periodic reassessment; evidence of immigration or recolonisation	Establish the population denominator for coverage and detect ecological change over time
Badger infection	RTA surveillance; intervention-area surveillance; TVR DPP test results; enhanced post-mortem/culture where available; other validated surveillance methods	Establish local infection indicators and monitor change within intervention areas
Operational delivery	Numbers captured, removed or vaccinated; trapping/removal effort; land and spatial coverage; treatment history; capture/recapture records	Determine whether the intervention was delivered with the intended intensity, consistency and spatial extent
Achieved population coverage	Estimated proportion of the local population reached, vaccinated or removed; revised population estimates where field evidence warrants	Distinguish planned coverage from the proportion of the population actually reached

Evidence area	Examples of measures	Purpose
Concurrent cattle controls and other influences	Testing regime; breakdown-management measures; cattle-movement controls; other relevant policy or operational changes	Identify factors other than wildlife intervention that could affect cattle outcomes
Molecular epidemiology	WGS and strain relationships in cattle and badgers, linked to location and time	Assess changing transmission patterns and support interpretation of likely sources and pathways of infection
Cattle outcomes	New, recurrent and prolonged breakdowns; herd- and animal-level incidence; reactor numbers/proportions; duration and severity	Determine whether the ultimate cattle disease-control objective is being achieved
Economic performance	Actual labour, trapping, treatment, equipment and total intervention costs; resource use against assumptions	Test and update the assumptions underpinning DAERA's economic appraisal
Comparative evaluation	Matched comparator areas, phased implementation, difference-in-differences or other robust quasi-experimental/time-series analysis where feasible	Improve attribution of cattle outcomes to the wildlife intervention
Independent evaluation and transparency	Pre-specified protocol; independent review of design and results; publication of methods, outcomes and material deviations	Increase confidence in the robustness and transparency of evaluation
Periodic review and adaptation	Scheduled review points and predefined triggers based on disease, coverage, population, cost or new scientific evidence	Determine whether to continue, intensify, modify, transition or discontinue the intervention

Within this framework, vaccination-based approaches require a clear distinction between **biological vaccine efficacy**, **vaccination coverage** and **programme effectiveness**. Evidence that BCG reduces susceptibility to *M. bovis* in individual badgers does not, by itself, demonstrate that an operational vaccination programme has reached a sufficient proportion of the population or produced the intended effect on badger infection and cattle disease.

Monitoring and evaluation should therefore include, as far as practicable, annual and cumulative vaccination coverage, capture and recapture rates, revaccination rates, changes in local badger infection indicators and cattle outcomes alongside measures of delivery effort. The Republic of Ireland experience illustrates this distinction: the biological efficacy of BCG is well supported, but DAERA's own review notes that the effectiveness of the large-scale Irish vaccination programme depends on both vaccine efficacy and coverage logistics and remains the subject of ongoing evaluation. [610]

AgriSearch assessment

AgriSearch considers that monitoring and evaluation should be regarded as a core component of wildlife intervention rather than simply an administrative requirement attached to its delivery. DAERA already recognises the need for close monitoring, regular review and adaptation as evidence emerges; the opportunity is to translate that commitment into a prospective evaluation framework with clearly defined baselines, outcomes, analytical methods and review points. [611]

Northern Ireland has an opportunity to design future intervention in a way that addresses some of the major evidence gaps identified through this consultation: contemporary badger population density and distribution; geographically resolved indicators of badger infection; the distinction between planned and achieved intervention coverage; changes in transmission dynamics; and, particularly for TVR and

[610] DAERA (2025b), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, "Badger vaccination"; DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, pp. 25–33; Robertson, A., Chambers, M.A., Smith, G.C., Delahay, R.J., McDonald, R.A. and Brotherton, P.N.M. (2025), 'Can badger vaccination contribute to bovine TB control? A narrative review of the evidence', *Preventive Veterinary Medicine*, 238, 106464. DAERA concludes that BCG reduces badger susceptibility but that programme effectiveness depends on vaccine efficacy and achievable vaccination coverage, with the large-scale Republic of Ireland programme still being evaluated.

[611] DAERA (2026), *Badger Intervention – Options Analysis Paper*, Annex VIII, paras. 3.3.1–3.3.2; Tetra Tech (2026), *Strategic Environmental Assessment*, section 8.4.1. DAERA states that any badger intervention will require close monitoring and regular review and may evolve as monitoring data and scientific evidence emerge. The SEA recommends greater clarity on the specific parameters to be used to judge effectiveness and success.

vaccination, the relationship between favourable badger-level outcomes and subsequent cattle disease. [612]

The central principle should therefore be:

Implementation itself should be designed to generate better evidence.

This requires more than recording the number of badgers culled, tested or vaccinated. Evaluation should begin before intervention starts, with clearly documented baselines and pre-specified cattle and wildlife outcomes. Monitoring should distinguish between operational delivery, achieved population coverage and epidemiological effect. Cattle disease outcomes should remain the principal endpoint, supported by local badger surveillance, WGS and conventional epidemiology. Where feasible, comparator arrangements or other robust analytical designs should be used to strengthen attribution of any observed change to the intervention rather than to concurrent changes in cattle controls or wider disease trends. [613]

The evaluation framework should also be independently scrutinised and as transparent as legal, commercial and confidentiality constraints permit. Principal protocols and outcomes should, wherever practicable, be defined in advance; null or disappointing findings should be reported alongside positive results; and the resulting evidence should contribute to the wider scientific evidence base. This is consistent with the CVO Review and Blueprint emphasis on independent scientific advice, peer-reviewed research and continual review of the evidence underpinning the eradication programme. [614]

Monitoring should then feed directly into adaptive management. Formal review points, together with predefined triggers for earlier reassessment where appropriate, should test not only whether delivery targets have been met but whether the underlying assumptions remain valid: whether badger density and infection indicators are changing as expected; whether adequate coverage has been achieved; whether cattle

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[612] DAERA (2025b), *Scientific Opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII; DAERA (2025), *Annotated scientific bibliography*, Annex VI. DAERA identifies the need for robust population information, notes that transmission dynamics vary between hotspots and recognises limitations in translating badger-level TVR outcomes into demonstrated cattle herd-incidence effects.

[613] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 39–40; DAERA (2025b), *Scientific Opinion*, Annex VII. The CVO Review argues that programme measurements should provide insight into the biological processes contributing to persistence and spread and recommends more detailed measures including breakdown recurrence, duration and severity. DAERA's scientific review also emphasises that cattle and wildlife measures operate within a multi-host system and that transmission dynamics vary between locations.

[614] DAERA (2024), *Chief Veterinary Officer Review*, pp. 34–36; TB Partnership Steering Group (2025), *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, pp. 20 and 23. The CVO Review calls for ongoing independent science advice, continual expert review and peer-reviewed publication of DAERA-commissioned research. The Blueprint provides for independent science advice, review of completed research and expanded use of WGS to inform future intervention decisions.

outcomes are improving; whether transmission evidence still supports the chosen intervention; and whether actual costs remain consistent with the economic appraisal.

The objective should be to ensure that, several years after intervention begins, Northern Ireland can say not only **what was done**, but with much greater confidence:

- **whether it was delivered as intended;**
- **whether cattle disease changed;**
- **whether that change can reasonably be attributed to the intervention;**
- **why the intervention did or did not succeed;**
- **whether it represented value for money; and**
- **whether the intervention should continue, change, transition or cease.**

That, in AgriSearch's view, is the standard against which the monitoring and evaluation framework should be designed.

12. Recommendations

AgriSearch recognises the complexity of determining an appropriate wildlife intervention for bovine tuberculosis and does not consider that the available evidence supports a simple conclusion that one intervention will be optimal in all circumstances. The scientific evidence differs in its strength and directness between interventions, while the likely effectiveness, speed, cost and practical delivery of each approach are influenced by local epidemiological and ecological conditions.

The recommendations below reflect the principal conclusions arising from AgriSearch's assessment of the scientific and economic evidence. They are intended to be considered collectively. In particular, AgriSearch does not regard the choice of wildlife intervention as a stand-alone decision: intervention selection, area targeting, cattle disease controls, monitoring, economic assessment and the capacity to adapt the approach over time are interdependent.

These recommendations operate at different stages of the policy and implementation process and should not be interpreted as requiring every remaining evidence gap to be resolved before wildlife intervention can begin. Some relate to the evidence and analysis required to support the final policy decision; others concern information and safeguards that should be established before intervention is deployed within a particular area; and others are intended to ensure that a properly monitored programme generates better evidence during implementation. AgriSearch’s intention is therefore to support proportionate, evidence-led action while ensuring that material uncertainties are made explicit, monitored and progressively reduced.

On the basis of the evidence considered in this response, AgriSearch recommends that DAERA:

1. Apply a consistent evidential framework across all wildlife intervention options

DAERA should assess non-selective culling, TVR and vaccination using the same criteria and evidential standards. Direct cattle-outcome evidence, observational evidence, badger-level biological evidence, operational studies, modelling and expert inference should each be clearly identified and given weight appropriate to the question they are capable of answering.

The limitations and uncertainties associated with each intervention should be described with a **comparable level of prominence and qualification.**

This principle should apply not only to technical assessments and option analyses, but also to consultation summaries and other public-facing or accessible material**.**

DAERA should revise the Easy Read Summary to ensure that all three options are described accurately and consistently, with their principal evidential strengths, limitations and uncertainties preserved. Accessibility should be assessed separately from scientific accuracy, including the clarity of explanations and illustrations, accessibility of the consultation questions, currency of key information and involvement of the intended audience.

Future updates of the scientific evidence base should also state their search scope and cut-off clearly and, where relevant to policy appraisal, take account of material subsequent peer-reviewed evidence and credible official or other grey literature not captured by the original badger-specific search strategy

2. Clearly distinguish demonstrated, observed, modelled and inferred outcomes

Statements about expected intervention effects should make clear the nature of the supporting evidence.

In particular, DAERA should distinguish between:

- effects demonstrated in controlled or replicated field studies;
- associations observed during operational deployment;
- biological or infection outcomes measured in badgers;
- outcomes projected by mathematical models; and
- effects inferred from biological principles or evidence generated in materially different circumstances.

Modelled outcomes are valuable for comparing potential interventions but should not acquire the same evidential status as directly observed cattle outcomes simply because both can subsequently be expressed numerically within an appraisal.

3. Update and make greater use of contemporary Northern Ireland badger population information

The design, coverage and cost of every intervention depend on the number and spatial distribution of badgers within the intervention area.

DAERA should therefore incorporate the best available contemporary evidence on badger population size, density and spatial variation before operational coverage targets and costs are finalised. This should include the emerging Queen's University Belfast thermal-survey findings and any subsequent final project results, while recognising the

methodological differences between contemporary direct observation and the historic national survey. DAERA should also sensitivity-test its scientific and economic conclusions against a range of population-density assumptions relevant to Northern Ireland conditions, including higher-density local scenarios where appropriate, rather than relying on a single indicative population figure.

Population assessment should not be treated as a one-off pre-intervention exercise. Density and distribution should be reassessed periodically using appropriate methods, potentially including thermal surveying, particularly where removal, immigration or recolonisation could materially alter the population against which coverage is calculated. Any revised denominator and its implications for reported coverage should be explained transparently.

4. Base intervention decisions on locally resolved infection and transmission evidence

Northern Ireland-wide averages for badger infection prevalence provide useful context but are unlikely to be sufficient for deciding how intervention should operate within individual areas.

As far as practicable, DAERA should bring together:

local cattle disease patterns; badger infection information; population density; WGS and strain information; cattle movements; landscape; and local veterinary epidemiology.

This should be used to distinguish, as far as practicable, the principal pathways through which infection is being introduced, maintained and amplified locally, including within-herd persistence, cattle-mediated transmission between herds and wildlife-associated introduction or reintroduction, and to determine which intervention or sequence of interventions is most appropriate to the local starting conditions.

Local infection assessments should state the sampling and diagnostic methods used, distinguish apparent test positivity from estimated infection prevalence, and identify material limitations in geographical coverage or detection sensitivity. RTA surveillance should contribute to, rather than substitute for, local assessment. Complementary approaches, including enhanced post-mortem examination and culture where practicable, should be considered, while emerging assays should undergo appropriate validation before being relied upon for intervention decisions.

5. Give explicit consideration to the required speed of disease reduction

The time required to produce a meaningful cattle-level benefit should be considered explicitly alongside eventual intervention efficacy.

Northern Ireland currently has a high cattle bTB burden and substantial recurrent disease, with significant costs to farmers and Government. An intervention capable of producing an eventual benefit only after a prolonged period may still have an important long-term role, but the consequences of the time taken to achieve that benefit should form part of the comparison between options.

DAERA should therefore distinguish clearly between the expected speed of reduction in badger infection and the evidence for the speed of reduction in cattle herd breakdowns.

DAERA should also explain how the ethical implications of the expected timescale and uncertainty of cattle benefit have been weighed, including continuing effects on farming families, cattle welfare and public expenditure, and justify any decision to prefer an approach expected to deliver slower or less certain disease reduction.

6. Strengthen and publish the framework for selecting intervention areas

AgriSearch supports DAERA's proposal to undertake a characterisation exercise before intervention areas are established. This should be developed into a transparent published framework incorporating:

- recurrent and prolonged cattle breakdown patterns;
- evidence of wildlife linkage;
- WGS and strain information interpreted alongside conventional epidemiological evidence;
- evidence as to whether wildlife infection represents established local maintenance or more recent/localised spillover or introduction;
- cattle movement history;
- badger infection prevalence;
- badger population density;
- landscape and suitable hard boundaries;
- local veterinary epidemiology; and
- operational deliverability and achievable land coverage.

Comparable international frameworks demonstrate how these factors can be brought together within a risk-based decision process rather than considered individually or on an ad hoc basis. Spain's PATUBES framework, for example, links wildlife surveillance, livestock epidemiology, reservoir status, host density, molecular evidence and opportunities for wildlife–livestock contact to graded intervention decisions, with risk reassessed as new surveillance information becomes available. This broad principle is also consistent with WOAH guidance and the STAR-IDAZ bTB research roadmap. [615]

Recent all-island WGS research further reinforces that molecular evidence should be interpreted alongside cattle movements, herd epidemiology, wildlife surveillance and spatial information rather than used as a stand-alone test of wildlife involvement. [616] The objective should be to distinguish, as far as practicable, persistent local transmission from infection introduced or maintained through other pathways and to adjust intervention accordingly.

The 100 km^2 figure should be regarded as an analytical or minimum reference rather than an assumed epidemiological optimum. The actual size and configuration of intervention areas should reflect local disease and ecological circumstances.

7. Ensure that wildlife intervention operates alongside effective cattle disease-control measures

The evidence supports bovine TB in Northern Ireland being regarded as a multi-host disease involving transmission within and between cattle and wildlife. Wildlife intervention should therefore form part of an integrated eradication programme and should not be regarded as a substitute for effective cattle controls.

DAERA should ensure that the cattle measures operating within intervention areas are clearly identified and maintained, including measures addressing residual infection, cattle movements, recurrent and prolonged breakdowns and other recognised transmission risks. Changes in cattle controls during wildlife intervention should be recorded and taken into account when evaluating cattle outcomes. This is important

[615] Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente (MAPAMA) (2017), *PATUBES: Plan de Actuación sobre Tuberculosis en Especies Silvestres*; Gobierno de España (2020), Real Decreto 138/2020; World Organisation for Animal Health (WOAH) (2024), *Terrestrial Animal Health Code*, Chapter 8.12: Infection with *Mycobacterium tuberculosis* complex; STAR-IDAZ International Research Consortium (2024), *Roadmap for development of disease control strategies for bovine tuberculosis (bTB)*. See also Section 7.7 and Appendix 2.6.

[616] O'Shaughnessy, J., Harvey, N., Byrne, B. et al. (2026), 'The genomic diversity and spatial patterns of *Mycobacterium bovis* in Ireland revealed by whole genome sequencing', *Irish Veterinary Journal*, 79, 6; Harvey, N., McGrath, G., O'Shaughnessy, J. et al. (2026), 'Integrating whole-genome sequencing and epidemiology to characterise *Mycobacterium bovis* transmission in Ireland: a proof of concept', *Irish Veterinary Journal*, 79, 3. See Sections 7.3 and 7.7.

not only to reduce cattle-to-cattle transmission, but also to limit continuing or renewed infection pressure on wildlife. [617]

The integrated approach should also include practical, farm-specific measures to reduce opportunities for wildlife–cattle transmission, particularly around cattle housing, feed and forage stores, water sources and other locations where indirect contact may occur. Northern Ireland evidence indicates that badger use of cattle-grazed land varies substantially between farms and fields, supporting targeted rather than generic wildlife-biosecurity advice. [618]

AgriSearch therefore welcomes DAERA's recent appointment of Veterinary Resources Northern Ireland to deliver a new on-farm bTB biosecurity advice service, providing participating farmers with tailored advice from trained veterinary professionals. This is a positive development and should help farms identify and reduce practical opportunities for disease transmission. Such measures should, however, operate alongside rather than in place of effective action on other important transmission pathways. Where infection in wildlife is contributing materially to local disease persistence, farm biosecurity alone is unlikely to deliver the sustained reduction in bTB required unless the wildlife reservoir is addressed concurrently. [619]

DAERA should also continue to support the development and appropriate validation of improved diagnostic and surveillance methods capable of strengthening understanding of residual infection and transmission. Emerging approaches, including direct pathogen-detection methods, may prove valuable, but should not be treated as replacements for established statutory diagnostics or surveillance until their performance has been adequately validated. [620]

The central principle is that cattle controls, wildlife intervention and practical measures at the wildlife–livestock interface should operate as complementary components of a single eradication programme. International guidance and experience support this

[617] DAERA (2025), Scientific Opinion, pp. 6–9; Allen, A. et al. (2025), 'Assessing the potential role of deer in the dissemination of Mycobacterium bovis infection to cattle in Northern Ireland', Infection, Genetics and Evolution, 128, 105721. DAERA concludes that strengthened parallel cattle controls are essential to wildlife intervention; the Northern Ireland genomic evidence further illustrates transmission within an interconnected multi-host system. See Sections 3.2 and 7.7.
[618] Holmes, E.L. et al. (2025), 'Landscape as a shared space for badgers and cattle: insights into indirect contact and bovine tuberculosis transmission risk', *Ecology and Evolution*, 15(4), e71114; see also the earlier Northern Ireland evidence on badger–cattle biosecurity considered in Section 7.7.
[619] DAERA (2026g), 'Veterinary group appointed to deliver DAERA's new bTB biosecurity advice service', press release, 11 September 2026.
[620] Dane, H., Gilbride, B., Thomas, M. and Grant, I.R. (2026), 'Evidence of mycobacteraemias and mycobacterial co-infections uncovered in cattle at slaughter using a novel phage-based PhMS-qPCR assay for viable *Mycobacterium bovis* and *Mycobacterium avium* subsp. *paratuberculosis*', *Irish Veterinary Journal*, 79, 2. The study was proof-of-concept, showed poor agreement with conventional culture and identified the need for further assay development and validation. See Section 7.7.

integrated approach, while also demonstrating that reducing infection pressure in one host does not by itself guarantee eradication of a multi-host disease. [621]

8. Interpret the Northern Ireland TVR evidence according to what the study was designed to demonstrate

AgriSearch considers the Northern Ireland TVR project to be an important and valuable study. It demonstrated operational feasibility, provided locally relevant information on diagnostic performance and badger behaviour, and recorded a substantial decline in estimated badger infection prevalence during the intervention.

However, the single-area, non-replicated study did not demonstrate a causal reduction in cattle herd incidence.

DAERA should therefore avoid presenting favourable badger-level outcomes or operational feasibility as equivalent to demonstrated cattle-level efficacy. Expectations of cattle benefit from TVR should be identified as arising from a combination of badger-level evidence, biological rationale and modelling until stronger cattle-outcome evidence becomes available.

9. Interpret vaccination evidence in the context in which it was generated

AgriSearch considers that there is strong evidence that BCG vaccination reduces badger susceptibility to *M. bovis* infection and supports an important long-term role for vaccination.

However, the most relevant direct cattle-outcome field evidence from the Republic of Ireland was generated largely in areas which had experienced several years of preceding badger removal. Evidence that vaccination can successfully replace or follow targeted culling should not automatically be interpreted as evidence that vaccination-only will achieve the same speed or magnitude of cattle benefit when introduced into a previously untreated Northern Ireland population with potentially higher starting infection prevalence.

DAERA should therefore consider vaccination performance explicitly against starting prevalence and previous intervention history.

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[621] World Organisation for Animal Health (WOAH) (2024), *Guidelines for the control of Mycobacterium tuberculosis complex in livestock: Beyond test and slaughter*; STAR-IDAZ International Research Consortium (2024), *Roadmap for development of disease control strategies for bovine tuberculosis (bTB)*. Comparative programme experience, including Canada and Michigan, is summarised in Section 7.7 and Appendix 2.6.

10. Develop sequenced and adaptive intervention pathways rather than assuming that the initial intervention must remain unchanged

DAERA should build on its existing proposals for area characterisation, monitoring and continuing review by publishing an explicit framework for adapting intervention to local conditions and measured outcomes.

Before implementation, the framework should specify the objectives, review points and evidence required to continue, intensify, reduce, change or cease an intervention. It should also set out the surveillance arrangements following transition or cessation and the circumstances that would trigger renewed investigation or intervention.

This should not impose the same intervention sequence or a fixed transition date on every area. An initial reduction in infection pressure followed by vaccination may be appropriate in some circumstances, but progression should depend on epidemiological evidence and achieved coverage rather than elapsed time alone.

The broad principle can be summarised as:

reduce infection pressure → transition where appropriate → maintain surveillance and adapt

The general rationale for adaptive management should remain distinct from evidence validating any particular novel hybrid scheme.

11. Improve the transparency and sensitivity testing of the economic appraisal

AgriSearch welcomes the substantial additional costing information subsequently supplied by DAERA in response to Andersons' information request. However, information of this nature should, as far as practicable, form part of the evidence available to consultees when options are being compared. DAERA should publish sufficient underlying information to allow the principal economic assumptions and calculations to be understood, reproduced and sensitivity-tested, while protecting genuinely commercially confidential information where necessary. Where detailed source data cannot be disclosed, as with the DAFM stopped-restraint information, DAERA should provide sufficient aggregated information, methodological explanation and sensitivity analysis to allow the robustness of the assumptions to be assessed independently.

DAERA should also update and sensitivity-test key assumptions around badger population density, operational scale, labour, intervention duration, the value of avoided breakdowns and modelled intervention effectiveness, and present headline cost estimates in a manner that more accurately reflects the underlying uncertainty.

The appraisal should distinguish clearly between the intervention method, the delivery model and the funding model, retain the separate economic ranking alongside any composite assessment, and explain the rationale for the weighting applied to wider policy considerations. In particular, uncertainty in the expected cattle-level benefit of each intervention should be carried explicitly through into the economic appraisal rather than being lost when modelled epidemiological outputs are converted into monetary benefits.

12. Revisit the economic value attributed to avoiding cattle breakdowns and clearly separate economic ranking from wider policy judgement

The independent Andersons review indicates that DAERA's estimate of the costs borne by farmers as a result of bTB is likely to be lower than more recent estimates. As the value attributed to preventing a herd breakdown directly influences the apparent economic benefit of wildlife intervention, DAERA should update and sensitivity-test this assumption using contemporary Northern Ireland evidence. This should distinguish costs attributable to an individual breakdown from wider programme and compliance costs, avoiding omission or double counting when translating aggregate farmer-cost estimates into a value per breakdown avoided.

DAERA should also clearly distinguish between the economic ranking of intervention options and the eventual multi-criteria policy ranking. Welfare, environmental, operational and societal considerations are legitimate factors in decision-making, but the weighting applied to them should be explicit and should not alter the description of the underlying scientific or economic evidence. DAERA should retain the separate economic ranking alongside any composite assessment, explain and justify the weighting applied to the different categories, and sensitivity-test the overall ranking using plausible alternative weights, including scenarios in which greater weight is assigned to economic performance. Separate economic and composite rankings should be presented for each material epidemiological scenario so that the effects of scientific assumptions can be distinguished from the effects of policy weighting. Within the non-monetary assessment, DAERA should also make explicit where multiple criteria are derived from the same underlying modelled outcome and test whether alternative groupings or weightings materially affect the resulting assessment.

13. Undertake a separate and transparent assessment before determining how wildlife intervention should be funded

AgriSearch considers that the question of who delivers an intervention should be distinguished from who ultimately pays for it. A private-sector delivery model may offer operational or cost advantages without necessarily implying that the private sector or farming industry should bear the full cost.

Before determining any future funding model, DAERA should assess the distribution of costs and benefits between Government, farmers and the wider economy, taking account of the substantial existing financial burden of bTB on farm businesses.

Any proposal for an industry contribution should therefore be supported by a transparent analysis of the public and private benefits, affordability, distributional impacts and the respective responsibilities of Government and industry within the wider eradication programme.

AgriSearch does not consider that the current economic appraisal provides a sufficient basis on its own to determine the appropriate funding split.

AgriSearch's participation in this consultation should not be interpreted as agreement to any particular funding split or levy mechanism. Any proposal involving AgriSearch's levy income would require separate consideration and approval through AgriSearch's own governance arrangements.

14. Design implementation to generate better evidence and provide for independent evaluation

Any future intervention programme should be designed from the outset so that its effectiveness can be evaluated with substantially greater confidence than would be possible from operational activity data alone.

DAERA should establish:

- robust pre-intervention baselines;
- contemporary badger population estimates;
- geographically resolved infection surveillance;
- systematic capture and recapture records;
- measures of actual rather than assumed intervention coverage;
- pre-specified herd-level and animal-level cattle outcomes, including incidence, breakdown recurrence, duration and severity;

- appropriate comparator arrangements wherever feasible;
- greater use of WGS to understand changing transmission;
- independent scientific evaluation;
- publication of data and analytical methods; and
- predetermined periodic review points.

The evaluation design should be independently scrutinised before implementation, including the suitability of baselines, comparator arrangements and analytical methods. Principal outcomes, definitions and review criteria should be specified in advance, and material changes to the intervention or concurrent cattle controls should be documented.

Evaluation should distinguish operational delivery, achieved population coverage and epidemiological effect, and should compare actual costs with the appraisal. Findings showing limited, uncertain or no measurable benefit should be published alongside positive results, subject to appropriate confidentiality and animal-location safeguards.

The resulting evidence should be used to determine whether an intervention should continue, be intensified, reduced, transitioned to vaccination or otherwise modified.

The central principle should be:

Diagnose → Select → Intervene → Monitor → Adapt → Transition/Exit

Implementation should therefore be regarded not simply as delivery of a predetermined policy, but as an opportunity to reduce disease while systematically improving the evidence available for subsequent decisions.

13. Conclusion

Bovine tuberculosis remains one of the most serious and persistent animal health challenges facing Northern Ireland agriculture. AgriSearch accepts the substantial body of evidence that badgers form an important wildlife reservoir within the cattle–badger transmission system in Northern Ireland and that effective eradication will require disease to be addressed in both cattle and wildlife. At the same time, the evidence also demonstrates the importance of within-herd cattle-to-cattle amplification, residual infection and cattle-mediated spread between herds and the need for effective cattle controls to operate alongside any wildlife intervention. DAERA's own Scientific Opinion reaches the same broad conclusion, describing bTB as a two-host system and emphasising that wildlife intervention alone is unlikely to achieve eradication. [622]

AgriSearch therefore considers that Northern Ireland needs effective intervention in the wildlife reservoir as part of a comprehensive bTB eradication programme, but that the intervention selected should be based on a transparent and consistent assessment of the evidence, local epidemiological conditions, the expected speed of impact, cost and uncertainty.

AgriSearch has approached this consultation without a predetermined preference for non-selective culling, Test and Vaccinate or Remove (TVR), or vaccination-only. Its assessment nevertheless identifies important differences in the nature, directness and strength of the evidence supporting the three approaches. Large-scale, sustained proactive non-selective culling has the strongest direct field evidence for reducing cattle bTB herd incidence, although the magnitude and transferability of benefit remain uncertain and outcomes depend materially on intervention design and concurrent cattle controls. The Northern Ireland TVR project provides valuable local evidence on operational feasibility, badger infection indicators and behaviour, but did not establish a causal reduction in cattle herd incidence. Vaccination has a strong biological evidence base and an important long-term role. However, its speed and magnitude of cattle benefit as an initial intervention in previously untreated, higher-prevalence Northern Ireland populations remain less directly established, and the most relevant Irish cattle-outcome evidence arose in areas with a history of badger removal. DAERA's Scientific Opinion itself recognises many of these distinctions. [623]

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[622] DAERA (2025), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly pp. 2 and 7–9; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly pp. 28–30 and 61–64. Both recognise transmission within and between cattle and badgers and the need for wildlife intervention to operate alongside effective cattle disease-control measures.

[623] DAERA (2025), *Scientific Opinion*, Annex VII, sections on proactive culling, TVR and badger vaccination and Scientific Opinion Conclusions 4–6; Donnelly, C.A. et al. (2006), 'Positive and negative effects of widespread badger culling on tuberculosis in cattle', *Nature*, 439, 843–846; Griffin, J.M. et al. (2005), 'The impact of badger removal on the control of tuberculosis in cattle herds in Ireland', *Preventive Veterinary*

AgriSearch's concern is therefore not that DAERA has failed to consider the scientific evidence. The Scientific Opinion and annotated bibliography represent a substantial body of work and in many places acknowledge uncertainty and limitations clearly. Rather, as the evidence is carried forward into modelling, option comparison and ranking, the level of qualification and evidential emphasis does not always appear consistent between options. In particular, demonstrated cattle outcomes, badger-level outcomes and modelled projections should remain clearly distinguishable. Mathematical modelling has an important role in exploring interventions which cannot readily be compared experimentally, but DAERA's own Scientific Opinion cautions that models are context-dependent abstractions rather than field trials. [624]

The economic evidence reinforces the need for this distinction. The independent review undertaken for AgriSearch by The Andersons Centre considers DAERA's broad costing methodology logical and reasonably consistent, but concludes that the level of published detail is insufficient to independently verify a number of important assumptions and that the presentation of single-point cost estimates can imply greater precision than is warranted. It also identifies badger population density as an important untested cost uncertainty and concludes that DAERA's estimate of the costs borne by farmers is likely to understate the value of avoiding cattle breakdowns. These limitations do not remove the potential economic case for wildlife intervention, but its value remains conditional on the number and timing of cattle breakdowns actually prevented. Under DAERA's principal no-perturbation economic scenario, controlled shooting is the highest-ranked option, but when perturbation is applied to non-selective culling alone, restraint-based TVR becomes the highest-ranked option on illustrative net present value. TVR also ranks highest in DAERA's composite assessment under both scenarios, but that composite ranking additionally depends on the weighting assigned to economic, non-monetary and risk criteria. The eventual preferred option should therefore be presented transparently with both the epidemiological assumptions and the policy weighting made explicit, rather than as the inevitable conclusion of either the scientific or economic evidence alone. [625]

Medicine, 67, 237–266; Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers', *PLoS ONE*, 16, e0246141; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151; Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland?', *Preventive Veterinary Medicine*, 179, 105004. See Sections 5.1–5.3 for detailed assessment.

[624] DAERA (2025), *Scientific Opinion*, Annex VII, 'Modelling', particularly pp. 6–8. DAERA cautions that mathematical models are highly abstracted and context-dependent representations and should not be interpreted as equivalent to field trials. See also Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*.

[625] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, prepared for AgriSearch, September 2026, particularly sections 5.4–

A further conclusion from this assessment is that starting conditions matter. Badger infection prevalence and population density, cattle breakdown history, cattle movements, WGS and other transmission evidence, landscape and boundaries, achievable intervention coverage and the required speed of disease reduction can all influence which approach is most appropriate. DAERA's Scientific Opinion itself concludes that there is no one-size-fits-all solution and that effective control will need to be tailored to local conditions. AgriSearch therefore considers that intervention selection should follow a transparent diagnosis of the epidemiological circumstances of an area rather than rely principally on an abstract NI-wide ranking of intervention types. The emerging QUB population findings reinforce the importance of locally resolved assessment rather than reliance on historic averages, while not establishing a revised Northern Ireland-wide population estimate or a directly comparable national trend. Infection indicators likewise require interpretation in the light of sampling coverage, diagnostic methods and diagnostic sensitivity. Both population and infection assumptions should therefore be reassessed periodically as implementation generates further evidence. [626]

This also means that the initial intervention should not necessarily be regarded as the intervention that must remain in place indefinitely. There is a credible scientific rationale for sequenced and adaptive approaches, including reducing infection pressure where necessary before transitioning towards vaccination and longer-term surveillance. The precise hybrid approach discussed in the CVO Review remains novel and should not be treated as already validated, but the broader principle of adapting intervention in response to evidence is sound. DAERA's own Scientific Opinion similarly identifies vaccination as a potential long-term goal while recognising that higher-prevalence areas may first require a reduction in infection pressure. [627]

Welfare, ethical considerations, environmental effects, operational deliverability, public acceptability and cost are all legitimate matters for Government in reaching a final decision. AgriSearch does not suggest that the intervention with the strongest

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5.7; DAERA (2026), *Badger Intervention Options Analysis Paper*, Annex VIII, particularly sections 6.1 and 9.3 and Table 29. Under DAERA's principal no-perturbation economic analysis, controlled shooting ranks first on illustrative NPV; when perturbation is applied to the non-selective culling options, restraint-based TVR ranks first. TVR using restraints ranks first in DAERA's composite assessment under both scenarios.

[626] DAERA (2025), *Scientific Opinion*, Annex VII, particularly the sections on badger ecology, transmission dynamics and modelling; DAERA (2026), *Badger Intervention Options Analysis Paper*, Annex VIII, particularly para. 5.3.29; Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, written communication to AgriSearch and other project funders, 4 September 2026, with methodological clarification provided at the Badger Population Assessments Project meeting on 8 September 2026. See Sections 3.3–3.5, 7 and Appendix 4.

[627] DAERA (2025), *Scientific Opinion*, Annex VII, particularly Scientific Opinion Conclusions 4 and 7 and the Opinion Summary; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 62–65; Smith, G.C. et al. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192. See Section 5.4 and Section 10.

epidemiological evidence must automatically be selected. However, those wider considerations should be brought together after the underlying scientific and economic evidence has been described transparently, rather than being allowed to alter the characterisation of what that evidence demonstrates.

Finally, whatever intervention or combination of interventions DAERA adopts, implementation should be designed to reduce rather than perpetuate the present uncertainties. This requires proportionate pre-intervention baselines, contemporary local population and infection assessment, measurement of actual coverage, pre-specified cattle outcomes, appropriate comparator arrangements where feasible, and independent scrutiny of both the evaluation design and the resulting findings. Monitoring should distinguish whether the intervention was delivered as intended, whether cattle disease changed, whether that change can reasonably be attributed to intervention, and whether the programme represented value for money.

DAERA already recognises the importance of monitoring, review and adaptation. The opportunity is to translate those commitments into an explicit decision framework with defined criteria for continuation, modification, transition and exit. [628]

The broad principle can be summarised as:

Diagnose → Select → Intervene → Monitor → Adapt → Transition/Exit.

AgriSearch has not undertaken a comprehensive action-by-action audit of all 34 measures within the Blueprint and therefore does not seek to offer a categorical judgement that it contains every action that may ultimately be required to achieve eradication. Within the areas considered in this response, however, AgriSearch supports the Blueprint's integrated approach across People, Cattle and Wildlife and considers that many of the necessary programme components are already identified. [629]

The priority should now be to translate those commitments into practical delivery. In particular, education and knowledge exchange should be practical, targeted and two-way, drawing on the experience of farmers, private veterinary practitioners and others directly involved in disease control. Major actions should have clearly identified delivery ownership, realistic resource and capacity requirements, implementation milestones

[628] See DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, particularly its discussion of adaptive management; DAERA (2025), *Scientific Opinion*, Annex VII; World Organisation for Animal Health (WOAH) (2024), relevant guidance on control of *Mycobacterium tuberculosis* complex infection in livestock and wildlife; and Smith, G.C. et al. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192. See Sections 10 and 11 of this response for the detailed rationale and evidence base.
[629] TB Partnership Steering Group (2025), *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, particularly sections 4.3–4.4 and the delivery plan. The Blueprint provides for collaborative working, communications, education and knowledge transfer, scientific advice, capacity and capability, data and technology, and actions across the People, Cattle and Wildlife pillars.

and measurable outcomes. Progress reporting should show not only which actions have commenced, but whether they are being delivered at the intended scale and whether they are contributing to improved disease outcomes. Regular public reporting, supported by engagement with farmers, veterinary practitioners and other stakeholders, would help maintain accountability, identify implementation problems early and allow the Blueprint to evolve in response to evidence and experience. [630]

Uncertainty should inform the design and evaluation of action, rather than become a reason for indefinite inaction or be obscured by apparently precise projections. The objective is a locally informed, deliverable and adaptive wildlife programme that operates alongside effective cattle controls, measures its contribution to disease reduction and changes course when the evidence requires it.

[630] TB Partnership Steering Group (2025), *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, sections 4.4, 5 and 6. The Blueprint commits to education and knowledge transfer for industry and herd keepers, enhanced training including veterinary involvement, improved programme measures and indicators, monitoring, review and continuous improvement, and publication by DAERA of an annual update on delivery and improved performance reporting on progress towards eradication.

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Appendix 1 – Scope and methodology of the AgriSearch scientific evidence review

A1.1 Purpose of the review

AgriSearch undertook this scientific evidence review to support its consideration of DAERA's consultation on potential wildlife intervention options as part of the *Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*. [631]

The purpose of the review is to assess whether the scientific evidence relating to non-selective culling, Test and Vaccinate or Remove (TVR) and vaccination-only has been represented and interpreted consistently and proportionately, with appropriate regard to Northern Ireland conditions.

The review is not intended to advocate for a predetermined wildlife intervention option. AgriSearch has sought instead to identify where conclusions are well supported by evidence, where important uncertainty remains, and whether comparable evidential standards have been applied across the different intervention approaches.

The work was undertaken by AgriSearch as a focused critical review of the available evidence. It is not a new systematic review, meta-analysis or primary research exercise.

A1.2 Scope of the review

The review focuses principally on the scientific evidence relevant to the potential effect of wildlife intervention on the control of bTB in cattle and badgers. Particular attention has been given to the strength and directness of the evidence supporting the different intervention approaches, their likely speed of effect, the circumstances in which the evidence was generated and its applicability to Northern Ireland.

The assessment has considered, in particular:

1. whether the consultation fairly represents the scientific evidence relating to non-selective culling, TVR and vaccination-only;
2. whether material relevant evidence has been omitted or given insufficient consideration;
3. whether the relative merits, limitations and uncertainties of the three approaches are presented consistently;

[631] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*.

4. the weight that can reasonably be attached to controlled field trials, observational and operational evidence, experimental studies, modelling and other forms of evidence;
5. evidence of effects on cattle bTB outcomes, distinguishing these from effects measured only in badgers or from evidence of operational feasibility;
6. likely speed of effect and the period over which material reductions in cattle disease might reasonably be expected;
7. evidence relating to badger perturbation and other behavioural responses;
8. the transferability of evidence from Great Britain, the Republic of Ireland and other jurisdictions to Northern Ireland;
9. the implications of starting badger infection prevalence, population density, intervention coverage and diagnostic performance;
10. the limitations of the Northern Ireland TVR study and the extent to which its findings can support conclusions about cattle disease;
11. the relevance of local cattle epidemiology, cattle movements, recurrent breakdowns, genomic evidence, badger infection and population information to the selection and targeting of intervention areas; and
12. the principal remaining evidence gaps and the qualifications that should accompany conclusions drawn from the available evidence.

A1.3 Evidence considered

The principal starting point for the review was the evidence provided within DAERA's consultation suite, particularly:

- the main consultation document;
- Annex VI, the annotated scientific bibliography;
- Annex VII, DAERA's updated scientific opinion;
- Annex VIII, the Badger Intervention Options Analysis;
- Annex IX, the calculation assumptions;
- the Chief Veterinary Officer's 2024 Review; and
- the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication.

These documents were considered alongside the primary studies cited within them where examination of the underlying research was necessary to assess the interpretation placed upon it.

AgriSearch also undertook targeted searches for material evidence beyond that included in the consultation suite. This was particularly important because DAERA's annotated bibliography was designed principally to identify peer-reviewed badger-specific literature published to November 2024 and was not designed systematically to capture subsequent publications, official or other grey literature, or the wider

international evidence from multi-host systems involving wildlife reservoirs other than badgers. [632]

These additional searches were targeted rather than systematic. They were directed particularly towards evidence published or becoming available beyond DAERA's literature-search period; Northern Ireland-specific evidence; subsequent analyses and re-analyses of studies materially relied upon in the consultation; official scientific reviews and programme evaluations; and relevant international evidence capable of informing questions of intervention design, targeting, surveillance and adaptive management. The purpose was to identify evidence potentially material to the conclusions of this response, rather than to establish exhaustive capture of all literature on bovine tuberculosis or wildlife intervention.

Additional material considered therefore included relevant peer-reviewed research published after the DAERA search period; official evaluations, scientific reviews and programme reports from Great Britain and the Republic of Ireland; and relevant evidence from other jurisdictions where wildlife reservoirs have formed an important component of bTB control or eradication programmes.

International evidence involving species other than badgers has been treated as comparative rather than directly transferable evidence. It may inform questions such as programme design, surveillance, targeting, population management, wildlife–livestock interface control and adaptive intervention, but has not been treated as direct evidence of the efficacy of a particular intervention in European badgers under Northern Ireland conditions.

For the purposes of Question 6 of DAERA's consultation, the additional scientific evidence to which AgriSearch particularly draws the Department's attention comprises relevant peer-reviewed research and scientific or official evaluations not captured by Annex VI, including material published or becoming available around or after its 30 November 2024 cut-off and material falling outside its badger-specific search scope. These sources are identified and assessed in Appendices 2 and 3 and are referenced in full in Section 14. Policy strategies, programme documents and international guidance cited elsewhere in this response are used principally as contextual or comparative evidence and should not be treated as equivalent to peer-reviewed intervention studies. Emerging Northern Ireland evidence, including the QUB badger population work reproduced in Appendix 4, is identified separately as interim evidence and is not presented as peer-reviewed research.

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[632] DAERA (2025), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis for the period 1 January 2015 to 31 May 2024 (with later extension to 30 November 2024)*, Annex VI, Annex 1, 'Detailed methodology', pp. 65–66. The literature search was restricted to peer-reviewed material, used search terms specifically requiring reference to badgers or *Meles meles*, and was subsequently extended to 30 November 2024.

Appendix 3 does not represent the complete evidence base considered in this response. The 32 sources included in its paper-level assessment were selected for additional source-level scrutiny because they underpin propositions material to the consultation assessment, including key cattle-outcome evidence, Northern Ireland-specific findings, important modelling or diagnostic assumptions, population and coverage estimates, and areas in which interpretation of the evidence is contested or particularly dependent on qualification.

As a further source-verification step, the full main text of each of the 32 distinct scientific publications and technical reports included in the paper-level assessment at Appendix 3 was examined. For each source, particular attention was given to the study design and methods relevant to the proposition being assessed, the outcome actually measured, the reported results, the authors' principal limitations and conclusions, and whether the strength and scope of the proposition made in this response were supported by the source. Where this exercise identified a need for greater precision or qualification, the relevant wording in the response was amended. This was a focused source-level appraisal rather than a formal risk-of-bias assessment, statistical reanalysis or independent peer review of the underlying studies.

A1.4 Approach to assessing the evidence

AgriSearch has not applied a rigid hierarchy in which study design alone determines the value of evidence. Study quality, scale, outcome measured, relevance, consistency with other evidence and applicability to Northern Ireland are also important.

Terms such as "strong", "limited" and "supportive" are used qualitatively in this review and do not represent scores generated through a formal evidence-grading system. They reflect an overall assessment of factors including study design and scale, directness to the outcome being claimed, replication, consistency with other evidence, important sources of uncertainty or confounding, and transferability to Northern Ireland. Accordingly, evidence may be strong for one proposition — for example biological efficacy or operational feasibility — while remaining limited in relation to a different proposition, such as reduction in cattle herd incidence.

Particular weight has, however, been given to the **directness of evidence to the outcome being claimed**. Evidence that an intervention changes susceptibility, infection prevalence or behaviour in badgers is relevant but is not equivalent to evidence that it reduces cattle herd breakdowns. Similarly, evidence that an intervention can be delivered operationally is not in itself evidence of epidemiological effectiveness.

The review therefore distinguishes, where relevant, between:

- **demonstrated outcomes**, observed directly in field or experimental studies;

- **inferred outcomes**, derived from epidemiological, genomic or other analysis of observed data; and
- **modelled outcomes**, projected under stated assumptions.

Mathematical modelling has been treated as an important source of evidence where it assists understanding of mechanisms, alternative scenarios or longer-term outcomes that cannot readily be tested experimentally. Model outputs have nevertheless been interpreted in light of their assumptions and have not been presented as equivalent to observed field effects. [633]

Where evidence is limited or uncertain, that limitation has been stated. Conversely, the presence of uncertainty has not been treated as meaning that the available evidence has no value. Uncertainty instead informs the level of confidence that can reasonably be attached to a conclusion.

A1.5 Common comparative framework

To minimise the risk of applying different evidential standards to different intervention approaches, AgriSearch has sought to assess non-selective culling, TVR and vaccination-only against a common framework.

For each intervention the review considers its underlying biological and epidemiological rationale; the field evidence of effectiveness; evidence of an effect on cattle bTB outcomes; likely speed of effect; important sources of uncertainty; transferability to Northern Ireland; perturbation and other behavioural effects; scalability from research or local deployment to wider implementation; sensitivity to starting badger infection prevalence, population density and achievable coverage; and the principal remaining evidence gaps.

The assessment also takes account of the fact that intervention performance may be conditional on the circumstances in which it is deployed. The review therefore considers not only the average or modelled performance of an intervention under a single set of assumptions, but how the relative merits of different approaches may change with local disease prevalence, badger density, landscape, capture conditions and cattle–badger transmission dynamics.

Where the evidence supports consideration of sequential or adaptive intervention, for example, initial reduction of infection pressure followed by vaccination, this has also

[633] DAERA (2025), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly pp. 3–9. The Scientific Opinion itself distinguishes field evidence from modelling and notes that mathematical models are context-dependent, highly abstracted representations rather than field trials.

been considered, while distinguishing between strategies supported directly by field evidence and those that remain plausible or modelled propositions. [634]

A1.6 Relationship with the economic review and wider policy considerations

AgriSearch separately commissioned The Andersons Centre to undertake an independent economic review of DAERA's appraisal of the wildlife intervention options. The scientific and economic assessments are complementary but distinct. [635]

This scientific review does not seek to duplicate the economic appraisal. Where scientific assumptions have material implications for costs or benefits, including badger population density, infection prevalence, intervention coverage, diagnostic performance or likely speed of effect, those assumptions are identified and their scientific basis considered. Their detailed economic consequences are addressed principally through the economic review.

Similarly, scientific efficacy has been distinguished from other legitimate considerations involved in policy choice. Animal welfare, environmental impacts, public acceptability, legal considerations, operational deliverability and economic cost are all relevant to the eventual decision on wildlife intervention. They should, however, be considered transparently alongside the scientific evidence rather than altering the description or weighting of that evidence. [636]

A1.7 Limitations

This review was undertaken within the timetable of DAERA's consultation and should be interpreted in that context. It is a focused critical assessment rather than a formal systematic review, and no new quantitative meta-analysis or primary scientific research has been undertaken.

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[634] See DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 64–65; DAERA (2025), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, Scientific Opinion Conclusion 7 and Opinion Summary; Smith, G.C. et al. (2022), 'Defining and testing a wildlife intervention framework for exotic disease control', *Ecological Solutions and Evidence*, 3(4), e12192.

[635] The Andersons Centre (2026), Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB, prepared for AgriSearch, September 2026.

[636] DAERA (2026), *Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication*, section 5.8, pp. 37–38; DAERA (2026), *Badger Intervention Options Analysis Paper*, Annex VIII. DAERA's decision framework itself considers monetary, non-monetary and risk factors in addition to scientific evidence.

Because the additional evidence search was targeted rather than systematic, the review cannot demonstrate that every potentially relevant publication has been identified. Its conclusions should therefore be interpreted as a critical assessment of the evidence considered, informed by DAERA's extensive existing evidence review and supplemented where material gaps or subsequent evidence were identified, rather than as an exhaustive systematic synthesis of the literature.

The evidence base itself has important limitations. Intervention studies differ in design, scale, epidemiological setting, cattle-control measures, badger population characteristics and outcome measures. Some interventions have substantially more direct evidence of effects on cattle disease than others. Evidence generated in other jurisdictions may not transfer directly to Northern Ireland because of differences in badger density, infection prevalence, landscape, cattle management, previous wildlife intervention and disease epidemiology. [637]

The review has therefore sought to distinguish clearly between established findings, reasonable inference, modelled outcomes and areas where evidence remains insufficient to draw a firm conclusion.

A1.8 Interpretation

The purpose of this methodology is not to produce a simple hierarchy or numerical ranking of the three intervention approaches. It is to provide a consistent basis for assessing what the available evidence demonstrates, how directly it addresses cattle disease, how applicable it is to Northern Ireland, what uncertainty remains and how strongly particular conclusions can reasonably be expressed.

This framework underpins the comparative assessment of non-selective culling, TVR and vaccination-only presented in Section 5 and the subsequent consideration of how the scientific evidence has been interpreted and brought together within DAERA's consultation.

[637] DAERA (2025), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly pp. 3–9. See also the discussion of transferability and context-dependence in Sections 5 and 6 of this response.

Appendix 2: Scientific evidence matrix.

The purpose of this matrix is to summarise the principal scientific studies considered by AgriSearch in assessing the wildlife intervention options. It is not intended to reproduce DAERA's annotated bibliography. Rather, it identifies studies particularly relevant to the principal questions addressed in this response and distinguishes the **type of outcome actually demonstrated** from subsequent inference or modelling.

Full bibliographic details for studies identified in Tables 6–12 are provided in Section 14. Where the matrix refers specifically to DAERA's interpretation of the evidence, the relevant DAERA source is cited separately.

A2.1 Transmission between cattle and badgers

Table 7. Selected scientific evidence on cattle–badger transmission

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Donnelly & Nouvellet (2013)	Epidemiological modelling using Randomised Badger Culling Trial data, England	Direct badger-to-cattle transmission may account for a minority of herd infections, but infection introduced from badgers can subsequently be amplified through cattle-to-cattle transmission.	Estimates are model-derived and relate to high-incidence areas of England. Direct badger-to-cattle events should not be equated with the total downstream contribution of badgers to cattle disease.	Supports a **multi-host interpretation**. Relatively infrequent cross-species transmission can remain epidemiologically important because of subsequent cattle amplification.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Crispell et al. (2019)	Whole-genome sequencing and epidemiological analysis, Woodchester Park, England	Demonstrated transmission of *M. bovis* both within and between cattle and badger populations. Within-species transmission was more frequent than between-species transmission, with evidence supporting transmission in both directions.	Intensive study from a particular English system; relative transmission rates should not be assumed to apply unchanged to NI. Directional estimates depend on sampling and model assumptions.	Strong evidence that cattle and badgers form an interconnected transmission system, but also that **local transmission structure matters**.
Rossi et al. (2022)	Genomic epidemiology, Cumbria	An introduced *M. bovis* genotype circulated initially in cattle, subsequently spilled into badgers and later spilled back into cattle.	Particular outbreak rather than a general estimate of transmission proportions.	Important demonstration that the wildlife reservoir can itself arise following cattle introduction and subsequently contribute to persistence.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Akhmetova et al. (2023)	WGS analysis of sympatric cattle and badgers in the NI TVR area	Most inferred transmission occurred within cattle. Cattle-to-badger transmission was inferred more frequently than badger-to-cattle transmission; badger-to-badger transmission was below detectable limits.	One NI study area. Only a small number of inferred interspecies events were detected and incomplete sampling limits inference. The authors caution that a small number of badger introductions may still matter if subsequently amplified in cattle.	Particularly important NI evidence. Demonstrates why **local epidemiology should be characterised before intervention** and why findings from the TVR area should not automatically be generalised to other NI hotspots. DAERA's bibliography similarly concludes that WGS indicates differing transmission dynamics between hotspots. [638]

[638] DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, section 'Whole-genome sequencing (WGS)'; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 49–50. DAERA concludes that WGS studies from different hotspots have produced differing results and that the relative contribution of cattle and badgers to maintenance of infection varies between locations.

A2.2 Non-selective/proactive badger culling

Table 8. Selected scientific evidence on non-selective/proactive badger culling

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Griffin et al. (2005a; 2005b) – Four Area Trial	Large-scale field trial, Republic of Ireland	Sustained proactive badger removal was associated with a substantial reduction in the risk of confirmed cattle herd breakdowns in treatment areas relative to reference areas.	Areas were matched rather than randomised. Reference areas were subject to reactive removal rather than no intervention. Irish cattle-control arrangements, landscape and badger ecology differ from NI.	Provides **strong direct field evidence of a cattle-level benefit** from sustained badger removal and is especially relevant geographically to NI. DAERA itself identifies the Four Area Trial alongside the RBCT as demonstrating significant benefit from multi-annual proactive culling.
Donnelly et al. (2006) – Randomised Badger Culling Trial (RBCT)	Large-scale randomised controlled field trial, England	Proactive culling reduced confirmed cattle bTB incidence inside culled areas but increased incidence in adjoining areas during intervention.	English badger density, landscape and disease-control context differ from NI. Peripheral adverse effect associated with perturbation may depend on intervention scale, boundaries and coverage.	**Strongest experimental cattle-outcome evidence** for proactive culling, while also providing the strongest evidence of possible adverse epidemiological perturbation around intervention boundaries.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Jenkins et al. (2010)	Post-intervention follow-up of RBCT	Beneficial effect within proactively culled areas persisted initially after culling ceased and then diminished; adverse peripheral effect was no longer apparent after culling ended.	Follow-up of the RBCT rather than a separate intervention.	Shows that culling effects are **time-dependent** and that both benefit and perturbation need to be considered over and beyond the active intervention period. DAERA also cites extended post-cull benefits.
Downs et al. (2019)	Observational evaluation of industry-led culling, England	Lower cattle bTB incidence was associated with culling in Gloucestershire and Somerset after four years; equivalent evidence was not demonstrated in Dorset after two years.	Not randomised. Culling occurred alongside other cattle-control changes and observational adjustment cannot eliminate all confounding.	Supports the possibility of cattle benefit under operational deployment but should be described as **observational evidence**, not equivalent to the RBCT.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Birch et al. (2024)	Difference-in-differences observational analysis of English Badger Control Policy	Reported substantial reductions in confirmed cattle breakdowns associated with the English badger-control policy.	Policy included badger control alongside contemporaneous cattle measures. Observational design and attribution remain important limitations.	Adds to operational evidence that large-scale culling can be associated with reduced cattle bTB, while reinforcing the need to distinguish **policy association from controlled experimental evidence**. DAERA's bibliography includes the study within its updated culling evidence.
Langton, Jones & McGill (2022)	Alternative statistical analysis of English routine surveillance data	Reported no meaningful broad evidence that industry-led badger culling reduced cattle bTB incidence.	Exposure to culling intensity and timing was necessarily approximated from routine data; methodology and conclusions have been disputed.	Important because it demonstrates genuine continuing **statistical disagreement over the size and attribution of the English operational effect**. It does not invalidate the separate controlled RBCT/Four Area evidence.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Torgerson et al. (2024)	Statistical reanalysis of English culling evidence	Challenged aspects of published estimates and demonstrated sensitivity of conclusions to model specification and outcome definition.	Statistical reanalysis of RBCT trial data	Supports caution in presenting a single estimate of culling effect from observational English data.
Mills, Woodroffe & Donnelly (2024)	Reanalysis/model-comparison using RBCT data	Reported that alternative statistical models continued to support a beneficial effect of proactive culling on confirmed breakdowns within intervention areas and an adverse effect in adjoining areas during intervention.	Reanalysis of the same experimental evidence rather than a new independent trial.	Useful response to the statistical debate: indicates that disagreement over analysis does **not mean that the RBCT evidence disappears**, although effect size and interpretation remain contestable.

Overall evidential interpretation – culling

The culling literature contains the strongest direct cattle-outcome evidence of the three intervention approaches, including two major field trials. DAERA's own scientific assessment describes the Four Area Trial and RBCT as demonstrating significant cattle-herd benefit from multi-annual proactive culling. [639]

The main uncertainties concern the magnitude of benefit under NI conditions, perturbation, scale and boundaries, population coverage, duration and the interaction with simultaneous cattle controls. The later English observational literature should not be represented as having the same evidential status as the controlled or large-scale comparative field trials.

[639] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII. The opinion concludes that the RBCT and the Irish Four Area Trial demonstrate a significant benefit from multi-annual proactive culling in reducing cattle herd bTB incidence, citing Donnelly et al. (2006) and Griffin et al. (2005).

A2.3 Test and Vaccinate or Remove (TVR)

Table 9. Selected scientific evidence on Test and Vaccinate or Remove (TVR)

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Menzies et al. (2021)	NI field intervention; methodology and operational study	Demonstrated the operational feasibility of repeated trapping, anaesthesia, DPP trap-side testing, selective removal and vaccination within an approximately 100 km^2 NI study area.	Single research area and intensive research delivery. Operational feasibility does not itself demonstrate an effect on cattle disease.	**Strong NI-specific operational evidence** and highly relevant to deliverability, capture rates and implementation assumptions.
Arnold et al. (2021)	Bayesian analysis of NI TVR study	Estimated DPP whole-blood sensitivity at approximately **69%** and specificity at approximately **98%**. Estimated badger infection prevalence declined substantially during the intervention, from around 14% initially to around 1.9% by the end of the study.	Imperfect test sensitivity means infected badgers can remain in the released/vaccinated population. Study lacked replicated untreated control areas, limiting causal attribution of the prevalence decline.	Strong evidence of a favourable **badger-level disease trajectory**, but it should not be converted into demonstrated cattle-level efficacy. DAERA itself highlights the lack of replicate/control areas and the DPP performance limitations.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
O'Hagan et al. (2021b)	Badger movement analysis during NI TVR	Did not detect significant sustained expansion of home ranges during the selective-removal programme.	Perturbation was assessed under the relatively low selective-removal intensity occurring in this particular TVR study. Absence of detected effect is not evidence that perturbation is impossible at higher removal rates.	Supports a **lower observed perturbation concern for TVR under the conditions studied**, but should be qualified accordingly.
Allen et al. (2022)	Mark-recapture/relatedness study, NI TVR area	Found no evidence of major social disruption following low-intensity selective removal.	Specific to low-intensity selective removal within one NI population.	Reinforces the favourable NI evidence concerning social stability under the TVR intensity studied. DAERA's updated scientific opinion describes the TVR project as showing no signs of increased perturbation.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Redpath et al. (2023)	Fine-scale movement analysis associated with NI TVR	No evidence of a broad sustained increase in badger ranging; some short-term movement changes associated with trapping were identified.	Again relates to selective removal at the observed prevalence/removal intensity.	Supports careful wording: **no sustained home-range expansion detected**, rather than "TVR causes no perturbation".
Doyle et al. (2023)	Cattle epidemiological analysis associated with NI TVR area and neighbouring areas	Analysis did not demonstrate a statistically robust causal reduction in cattle herd incidence attributable to TVR.	Intervention was not designed as a replicated controlled cattle-outcome trial and statistical power was limited. Failure to demonstrate an effect is not the same as demonstrating that TVR has no effect.	Central to AgriSearch's distinction between **valuable NI badger/operational evidence and absence of demonstrated cattle-level efficacy**.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Akhmetova et al. (2023)	WGS, NI TVR area	Cattle-associated transmission dominated within the study area; only rare interspecies transmission was inferred.	Locality-specific and affected by sampling intensity.	Provides a plausible epidemiological explanation for why reductions in badger infection need not automatically produce a readily detectable cattle-incidence response in that area.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Budgey & Smith (2019)	DAERA-commissioned APHA individual-based simulation model; NI-parameterised technical report	Modelled the Banbridge TVR intervention and alternative future NI interventions. In the comparable alternative-zone scenario, non-selective culling and TVR produced very similar modelled cattle outcomes within the intervention core, while vaccination-only produced a slower and generally smaller reduction. Scenarios were examined at 10% and 40% background badger prevalence and both with and without perturbation.	Technical report rather than a peer-reviewed journal article; completed in 2019 and previously unpublished until September 2026. Cattle outcomes are simulation outputs rather than observed field effects. Results depend materially on assumptions including perturbation, population parameters, trapping performance, diagnostic performance and vaccine efficacy. Banbridge land-access and trapping assumptions were applied to future intervention scenarios, although the authors cautioned that equivalent participation could not be assumed elsewhere.	Provides the primary source for the NI Parameterised Model subsequently used in Annex VIII. Supports the plausibility of a cattle-level benefit from TVR and illustrates its potential comparative performance, but does not provide direct cattle-outcome evidence. Particularly relevant to AgriSearch's distinction between modelled and demonstrated effects.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Smith & Budgey (2025)	Mathematical modelling calibrated against NI TVR badger data	Model was able to reproduce aspects of the observed short-term badger prevalence trajectory and explore alternative intervention strategies.	Calibration against badger outcomes is not validation of predicted cattle outcomes. Model conclusions remain dependent on assumptions including perturbation and transmission parameters.	Useful for prospective comparison, but should remain clearly labelled **modelled evidence**. DAERA itself states that model outputs are context-dependent abstractions and not field trials.
Jinks et al. (2025)	Bayesian latent-class analysis of DPP VetTB diagnostic performance using samples from captive and free-ranging badger populations, including Northern Ireland data	For visual interpretation of Band 1 using fresh whole blood, estimated DPP sensitivity was **79.9% (95% CrI 66.1–91.4%)** and specificity **93.3% (90.7–95.7%)**. Sensitivity was therefore higher, but specificity lower, than the corresponding estimates from Arnold et al. (2021).	Used a different Bayesian latent-class model and datasets from several badger populations, rather than reanalysing the NI TVR study alone. The authors identify differences in study population and analytical assumptions that may contribute to the difference from Arnold et al.; the newer estimates should therefore not simply replace the earlier figures.	Strengthens the evidence that DPP whole-blood testing is suitable for field use, while reinforcing diagnostic performance as an important uncertainty for TVR. Higher sensitivity would increase detection of infected captured badgers, but lower specificity would increase removal of uninfected animals. The comparison with Arnold et al. also supports sensitivity-testing TVR assumptions across plausible diagnostic-performance values.

Overall evidential interpretation – TVR

TVR has a particularly valuable Northern Ireland-specific evidence base for feasibility, diagnostic performance, badger infection trends and behaviour. DAERA's options analysis, drawing on Arnold et al. (2021), records DPP sensitivity of about 69% and specificity of about 98%. More recent analysis by Jinks et al. (2025), using Bayesian latent-class methods, produced a higher estimate of sensitivity (79.9%) but a lower estimate of specificity (93.3%) [640] for visual interpretation of Band 1 using whole blood. The estimates should not be treated as directly interchangeable because the studies used different datasets and analytical approaches, but together they reinforce diagnostic performance as an important source of uncertainty in assessing TVR. The Northern Ireland evidence also records a substantial decline in estimated badger prevalence and no sustained perturbation under the conditions studied, while DAERA acknowledges the absence of replicate/control areas and the absence of a reduction in cattle herd incidence during the study. [641]

The publication of Budgey & Smith (2019) also provides the primary technical source for the NI-parameterised modelling subsequently used in Annex VIII. The model projects cattle-level benefits from TVR under specified assumptions and, in comparable scenarios, produces outcomes close to those projected for non-selective culling. These remain modelled rather than observed cattle outcomes, however, and are conditional on assumptions including perturbation and achievable operational performance. [642]

The principal evidence gap is therefore direct demonstration of a cattle-level benefit at intervention scale. This is materially different from saying that TVR has been shown to be ineffective.

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[640] Jinks, R.C., Lesellier, S., Smith, F., Menzies, F.D., Ashford, R.T., Waring, L., Dave, D., Anderson, P., Stringer, L.A., Pascual-Linaza, A.V., Corbett, D., Thompson, S. and Arnold, M.E. (2025). Evaluating sensitivity and specificity of the DPP Vet TB assay in badgers using Bayesian latent class models. PLOS ONE, 20(3), e0313825. https://doi.org/10.1371/journal.pone.0313825

[641] Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (Meles meles)', *PLoS ONE*, 16(1), e0246141; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151; DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII, TVR section; DAERA (2025b), *Scientific Opinion*, Annex VII, TVR section and Scientific Opinion Conclusion 6.

[642] Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*, National Wildlife Management Centre, Animal and Plant Health Agency, Final Report; see also DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII.

A2.4 Badger vaccination

Table 10. Selected scientific evidence on badger vaccination

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Carter et al. (2012)	Controlled badger BCG field/experimental study, GB	BCG vaccination substantially reduced the risk of progressive infection and reduced broader infection risk. When more than one-third of a social group was vaccinated, unvaccinated cubs experienced substantial indirect protection.	Vaccination does not provide sterile immunity and does not cure animals already infected. Study measured badger infection outcomes rather than cattle herd incidence.	**Strong biological evidence** that BCG can reduce badger susceptibility and generate indirect population protection. DAERA summarises reductions of approximately 76% for progressive infection, 54% for infection more broadly and up to 79% indirect protection of cubs under specified conditions.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Gormley et al. (2017) – Kilkenny field trial	Field vaccination trial, Republic of Ireland	BCG vaccination reduced infection/susceptibility and disease progression in naturally exposed badgers.	Previous intervention history was mixed rather than simply a period of continuous prior culling. Approximately one-third of the study area had formed part of a Four Area Project reference area where breakdown-related culling was limited, and the Kilkenny area was protected from culling for two years before the vaccination trial began. Primary outcomes were in badgers rather than cattle	Important field confirmation of vaccine biological efficacy under natural exposure. The study should not be characterised as vaccination immediately following sustained culling and does not provide direct cattle-outcome evidence.
Aznar et al. (2018)	Analysis/modelling based on Kilkenny badger vaccination trial	Estimated vaccination reduced susceptibility by approximately **59%**. Modelling suggested infection could decline with vaccination coverage of around 30% or more under specified conditions.	Coverage threshold is model- and context-dependent. Model assumed, among other simplifications, no cattle-badger/environmental transmission component and spatial homogeneity.	Supports vaccination as a biologically credible control method but does **not establish a universal 30% coverage threshold**. DAERA's bibliography expressly records these assumptions.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Martin et al. (2020)	Controlled non-inferiority field trial, Republic of Ireland	Vaccination was non-inferior to continued targeted badger culling in **most, but not all**, trial areas in terms of subsequent cattle outcomes.	Crucially, study areas had already experienced years of targeted/reactive culling. It therefore tests transition from culling to vaccination more directly than vaccination as an initial intervention in an untreated high-prevalence badger population.	**Most important direct cattle-outcome evidence for vaccination**, but its previous-culling context must remain explicit. DAERA's Scientific Opinion makes the same qualification.
Ryan et al. (2023)	Operational evidence/review of RoI vaccination programme	Documents the large-scale transition from reactive culling to BCG vaccination across more than 20,000 km^2 and the practical challenges of measuring vaccine coverage and efficacy.	Ongoing operational programme; cattle effects can be difficult to attribute independently from other controls.	Demonstrates that vaccination can be **delivered at substantial geographic scale**, particularly as a post-cull strategy.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Chang et al. (2025)	Mathematical modelling of multi-host cattle/badger system	Highlights the importance of cattle and badger density, transmission assumptions and coverage. More recent modelling indicates that vaccination combined with existing cattle test-and-remove measures does not necessarily guarantee eradication under all parameter combinations.	Model rather than field experiment; results depend on assumed transmission structure and starting conditions.	Reinforces that vaccination efficacy at individual-animal level should not be equated automatically with eradication-level effectiveness.

Overall evidential interpretation – vaccination

The vaccination evidence provides strong support for a real biological effect of BCG in badgers, and the Republic of Ireland provides important operational and cattle-outcome evidence. However, DAERA itself notes that much of the most relevant Irish evidence arose after prolonged reactive badger removal and questions its direct generalisability to NI, where culling has not historically been policy. [643]

The key uncertainties relate to vaccination as an initial intervention in areas with substantial existing infection, the speed with which badger infection pressure and cattle disease would fall, required coverage, and the duration over which vaccination would have to be maintained.

[643] Martin, S.W. et al. (2020), 'Is moving from targeted culling to BCG-vaccination of badgers (Meles meles) associated with an unacceptable increased incidence of cattle herd tuberculosis in the Republic of Ireland?', *Preventive Veterinary Medicine*, 179, 105004; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger vaccination' and Scientific Opinion Conclusion 4; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–31.

A2.5 Population estimation, capture and intervention coverage

Table 11. Selected scientific evidence on badger population estimation, capture and intervention coverage

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Reid et al. (2012)	NI national badger survey/population estimation	Estimated approximately **34,100 badgers** in NI, with substantial uncertainty and spatial variation; historic average density approximately 2.5 badgers/km^2.	Survey relates to 2007/08 and is now nearly two decades old. National averages conceal important local variation.	Remains the principal historic NI benchmark but supports the need for **updated contemporary population information** before intervention coverage is interpreted. DAERA's bibliography itself identifies the estimate and its uncertainty.
Byrne et al. (2012)	Capture-recapture/population and trappability study, Ireland	Mean trappability was approximately 34–35% per trapping session; repeated trapping substantially increased the proportion of the accessible population encountered.	Capture probability varies between individuals; trap-shy/trap-happy behaviour means the trapped population is not necessarily a simple random sample of the total population.	Important for interpreting assumed capture rates, TVR/vaccination coverage and the distinction between **animals handled and proportion of the true population reached**. DAERA uses these figures in its consultation assumptions.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Byrne et al. (2021)	Badger ecology/population review, island of Ireland	Suggested historic assumptions around social-group size may not always be reliable and that group size varies with habitat suitability.	Does not itself provide a replacement contemporary NI population estimate.	Supports caution in converting sett/social-group measures into population numbers without locally validated assumptions.
Bright Ross et al. (2022)	Assessment of Minimum Number Alive population indices	Warned that MNA may be unreliable as a population estimator outside appropriate long-term datasets, because age groups and animals with differing capture behaviour may be over- or under-represented.	Does not mean capture-recapture data are unusable; rather, analytical method and biases matter.	Supports systematic collection of capture/recapture data but argues against treating raw capture totals as equivalent to a robust population denominator. DAERA's bibliography makes this distinction explicitly.

Overall evidential interpretation – population and coverage

Population size is not merely an ecological background variable. It directly affects the interpretation of culling percentages, TVR capture rates, vaccination coverage, programme cost and eventual effectiveness.

For this reason, AgriSearch considers that actual intervention coverage should be measured against the best available contemporary local population estimate rather than inferred from activity totals alone. [644]

[644] Reid, N. et al. (2012), 'Monitoring and population estimation of the European badger *Meles meles* in Northern Ireland', *Wildlife Biology*, 18(1), 46–57; Byrne, A.W. et al. (2012), 'Population estimation and trappability of the European badger (*Meles meles*): implications for tuberculosis management', *PLoS ONE*, 7(12), e50807; Bright Ross, J.G. et al. (2022), 'Preserving identity in capture-mark-recapture studies: increasing the accuracy of minimum number alive (MNA) estimates by incorporating inter-census trapping efficiency variation', *Mammalian Biology*, 102(3), 567–580; DAERA (2025a), *Annotated scientific bibliography*, Annex VI, pp. 5–11.

A2.6 Comparative international multi-host evidence

The following studies concern European wildlife reservoirs other than badgers and should not be interpreted as providing directly transferable estimates of the expected efficacy of badger intervention in Northern Ireland. They are included because they provide relevant comparative evidence on general intervention principles, including population reduction, selective removal, vaccination, starting infection pressure, intervention coverage, surveillance and adaptive management.

Table 12. Comparative international multi-host evidence relevant to wildlife bTB control

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Boadella et al. (2012)	Observational wildlife population-reduction study, wild boar, south-central Spain	An approximately 50% reduction in wild-boar abundance was associated with a 21–48% reduction in wild-boar TB prevalence at intervention sites, while prevalence remained stable at control sites.	Intervention occurred at only three treatment sites and was not a randomised trial. Species ecology, population dynamics and the Mediterranean multi-host system differ substantially from the cattle–badger system in NI.	Supports the general principle that sufficiently intensive reduction of an infected wildlife reservoir can reduce infection prevalence, but does not provide an effect estimate transferable to badger culling in NI.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Che'Amat et al. (2016)	Targeted/selective removal experiment, wild boar, fenced 60 km^2 Spanish hunting estate	Over three years, 929 wild boar were captured and tested. Although seroprevalence initially declined in captured piglets, targeted removal did not produce a significant reduction in culture-confirmed TB prevalence compared with the control site; persistent high infection pressure was identified.	Wild boar rather than badgers; very high infection pressure; fenced and intensively managed population; test-positive animals were transferred to a separate release area and subsequently hunted rather than removed immediately at capture.	Illustrates that selective removal is not inherently effective and that outcome can depend materially on starting prevalence, infection pressure, diagnostic performance, population access and achieved coverage. It should not be treated as direct evidence against TVR in badgers.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Díez-Delgado et al. (2018)	Four-year field vaccination study, free-ranging wild boar, Spain	Oral vaccination achieved high bait uptake, but a significant short-term reduction in TB prevalence was demonstrated at only one of the four vaccinated sites; outcomes varied substantially between settings.	Used oral BCG and heat-inactivated *M. bovis* vaccines in wild boar, not injectable BCG in badgers. Starting TB prevalence was very high and ecological/management conditions varied between sites.	Supports biological plausibility of wildlife vaccination but demonstrates that good vaccine delivery or uptake does not necessarily produce a uniform population-level effect. Reinforces the importance of starting conditions, coverage and site-specific management.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Nigsch et al. (2019)	Longitudinal surveillance and epidemiological assessment of *M. caprae* in red deer, Vorarlberg, western Austria	Surveillance distinguished core, edge and observation zones with different disease patterns. Control included intensified hunting, surveillance targeted according to risk, periodic adjustment of control areas and sampling, and management of winter feeding/contact risks. (Frontiers)	Red deer/*M. caprae* system in an Alpine environment; the study was primarily an epidemiological and surveillance analysis and does not isolate the causal effect of individual management measures.	Provides a useful European example of integrated and adaptive wildlife TB management in which surveillance, spatial epidemiology, host density/aggregation and livestock–wildlife contact inform the intensity and location of control.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Riding Mountain, Canada – Wobeser (2009); Shury & Bergeson (2011); CFIA (2019)	Longitudinal surveillance and operational management of a cattle–elk/white-tailed deer bTB system in and around Riding Mountain National Park, Manitoba	Infection was concentrated particularly in elk and in a defined higher-risk core area. A multi-component programme combined intensive cattle and wildlife surveillance, cattle movement controls, wildlife population management and selective removal, restrictions on wildlife aggregation and measures to reduce wildlife–livestock contact. CFIA subsequently reported that the last infected livestock herd was detected in 2008 and the last infected wild cervid in 2014; by 2019 the special eradication area was no longer required.	Not a controlled intervention trial. Multiple measures were implemented concurrently and their individual causal contributions cannot be separated. Elk and deer ecology, population structure and contact with cattle differ substantially from badgers in NI. Selective removal of elk should not be treated as equivalent evidence for NI TVR, and vaccination was not a central component of the programme.	Provides unusually strong **programme-level evidence** that sustained, integrated management of cattle infection, a wildlife reservoir and the wildlife–livestock interface can progress to regional disease freedom. Supports integrated, spatially targeted and adaptive management, but provides no transferable numerical estimate of badger-intervention efficacy.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Brook (2010); Brook et al. (2013); Gooding & Brook (2014)	Field studies of wildlife–livestock contact and targeted farm biosecurity around Riding Mountain	Elk and deer used cattle farms and feeding resources heterogeneously. Barrier fencing substantially reduced access to stored hay, and spatial risk modelling allowed mitigation to be focused where wildlife use of hay and proximity to infected animals coincided.	These studies principally measured wildlife access, contact opportunity and damage rather than demonstrating a causal reduction in cattle bTB. Transmission routes were incompletely resolved and disease prevalence had become too low for conventional epidemiological assessment of biosecurity effectiveness.	Supports farm-specific assessment and targeted mitigation of wildlife–livestock contact rather than uniform application of generic biosecurity measures. Complements the NI Holmes et al. (2025) evidence.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Michigan white-tailed deer programme – O'Brien et al. (2011); VerCauteren et al. (2018); O'Brien et al. (2023); Michigan DNR	Long-term management of an endemic cattle–white-tailed-deer *M. bovis* system in north-eastern Lower Michigan	Reduction of deer density through liberalised harvest, together with restrictions on baiting and feeding, was associated with a >60% reduction in apparent bTB prevalence in the core deer population. However, prevalence subsequently plateaued at a low level and the wildlife reservoir has persisted; current management continues to require population control, surveillance and restrictions on practices that aggregate deer.	Not a controlled intervention trial and several measures changed concurrently. White-tailed deer ecology and management differ substantially from badgers. Reliance on recreational hunting means intervention intensity is strongly influenced by hunter participation and social acceptability.	Provides evidence that reducing host density and artificial aggregation can substantially reduce infection in an established wildlife reservoir, but also demonstrates that a large reduction in prevalence does not necessarily achieve eradication. Supports sustained intervention, explicit epidemiological targets and avoidance of assuming that a low stable prevalence represents an adequate end point.
Note: Recent Michigan research is also evaluating oral BCG vaccination as an additional tool. A field study conducted in 2024 and published by VerCauteren et al. (2025) demonstrated high uptake of oral vaccine delivery units by free-ranging white-tailed deer. Separate modelling by Pandey et al. (2024) suggests that vaccination could complement existing population-management measures, but would require sustained deployment. These findings concern operational feasibility and modelled outcomes in deer and do not provide field evidence that vaccination reduces cattle bTB.				

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Michigan Wildlife Risk Mitigation / Enhanced Wildlife Biosecurity – Lavelle et al. (2015); MDARD	Long-term management of an endemic cattle–white-tailed-deer *M. bovis* system in north-eastern Lower Michigan	Measures include excluding deer from stored cattle feed and water, changing feeding practices, fencing higher-risk resources and targeted deer removal around cattle farms. GPS work showed that fencing stored feed changed the spatial behaviour of deer previously accessing it. Michigan now uses farm-specific risk assessments and, in higher-risk areas, links verified biosecurity and targeted deer removal to cattle movement requirements.	Evidence demonstrates reduction in wildlife access/contact opportunity rather than a directly measured causal reduction in cattle bTB incidence. Species and farm-interface conditions differ from NI.	Supports locally tailored wildlife biosecurity as a complement to population-level wildlife intervention. Demonstrates that wildlife–livestock interface measures can be incorporated formally into an integrated disease-control programme rather than treated solely as voluntary generic advice.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Australian Bovine Tuberculosis Eradication Campaign – More et al. (2015)	National 27-year eradication programme involving cattle and introduced water buffalo, with particularly difficult extensive pastoral systems in northern Australia	Australia achieved national bTB freedom following a sustained programme combining nationally agreed standards, dynamic risk-based herd and area classification, abattoir surveillance, movement controls, removal of residual infection, locally adapted herd-management approaches, applied research and progressive regional/national milestones. After declaration of freedom in 1997, dedicated freedom-assurance and surveillance programmes continued.	Australia did not have a persistent infected native wildlife reservoir analogous to the badger–cattle system in NI. Water buffalo were infected but interacted relatively little with cattle; feral pigs were principally spillover hosts. Multiple cattle-management and programme measures operated together, so the Australian experience cannot provide an effect estimate for any NI wildlife intervention.	Provides strong programme-level evidence for a clearly defined eradication objective, staged and measurable progress, risk-based regional management, consistent technical standards, sustained removal of residual infection and continuation of surveillance after apparent freedom. It supports programme architecture rather than the relative efficacy of culling, TVR or vaccination in badgers.

Minnesota bTB programme – Carstensen & DonCarlos (2011); Glaser et al. (2016); Minnesota DNR	Intensive response to a geographically localised cattle–white-tailed-deer *M. bovis* outbreak detected from 2005 in north-western Minnesota	Twelve cattle herds and 27 free-ranging deer were found infected between 2005 and 2009. WGS was consistent with a relatively recent introduction. The response combined cattle-herd depopulation and testing, movement controls, cattle removal from the highest-risk area, wildlife–livestock biosecurity, restrictions on deer feeding and intensive deer population reduction. Deer density in the core area declined by approximately 55% between 2007 and 2010 and infection subsequently became undetectable. No further infected cattle or deer were identified after 2009 despite continued surveillance, and Minnesota regained statewide TB-free status in 2011.	This was not a controlled intervention trial and multiple cattle, wildlife and biosecurity measures operated concurrently. The evidence indicates a relatively recent and geographically contained wildlife infection rather than a long-established endemic wildlife reservoir. White-tailed deer ecology and the intensity and methods of population reduction differ materially from badgers in NI. Strong public and political support also facilitated unusually intensive deer control.	Provides programme-level evidence that rapid, intensive and integrated intervention may prevent a recently seeded wildlife infection becoming an established maintenance reservoir. It reinforces the importance of distinguishing recent spillover/local introduction from established self-sustaining wildlife infection when diagnosing an area. It does not provide a transferable estimate of the efficacy of badger removal in NI.

Study	Evidence type / setting	Principal finding	Important qualifications	Relevance to AgriSearch assessment
Le Roex et al. (2016)	Longitudinal evaluation of a test-and-cull programme for *M. bovis* in free-ranging African buffalo, Hluhluwe-iMfolozi Park, South Africa	Between 1999 and 2006, 4,733 buffalo were tested and test-positive animals selectively removed. bTB prevalence was highly spatially variable (2.3–54.7%). Herds subjected to more intensive and frequent capture showed lower per-capita transmission risk and less increase in prevalence over time. The authors concluded that the programme reduced transmission, with capture effort and interval being critical determinants of performance.	African buffalo have very different ecology, social structure and capture logistics from badgers. The programme used a different diagnostic test and selective removal without vaccination. It was an operational evaluation rather than a replicated controlled trial, and it did not assess cattle outcomes. Infection remained at appreciable prevalence in parts of the park, particularly hotspot areas.	Provides comparative evidence that selective removal can reduce transmission under some conditions, but that its performance depends materially on how completely and how frequently the target population is reached. Supports treating capture coverage and intervention interval as components of epidemiological efficacy rather than simply operational variables. It does not provide an efficacy estimate transferable to NI TVR.

International guidance and research priorities

The comparative evidence above is also broadly consistent with current international guidance and research priorities. WOAH's 2024 MTBC guidelines emphasise that no single intervention is sufficient and that countries with significant wildlife reservoirs require integrated wildlife–livestock disease management tailored to local epidemiology. [645] The 2024 STAR-IDAZ bTB control-strategies roadmap similarly identifies knowledge of transmission pathways, contact networks, wildlife-host demographics, prevalence, diagnostics, molecular typing and environmental factors as interdependent requirements for effective disease-control strategies. [646] These sources do not provide additional intervention-effect estimates, but they provide an independent international benchmark for the integrated, locally informed and adaptive principles emerging from the comparative evidence.

Overall evidential interpretation – comparative European multi-host evidence

These studies do not alter the relative evidential assessment of non-selective culling, TVR or vaccination in badgers set out above. Their value is comparative rather than directly transferable. Collectively, they reinforce several broader principles: wildlife intervention outcomes depend on starting infection pressure and host density; population reduction can reduce infection under some conditions; selective removal may perform poorly where infection pressure remains high; vaccination effects can vary substantially between settings despite good delivery; and surveillance can be used to target, intensify or modify intervention over time. The principal implication for Northern Ireland is therefore not a numerical estimate of expected efficacy, but support for locally informed, adequately resourced and adaptively managed wildlife intervention.

The Riding Mountain experience adds a programme-level dimension to this comparative evidence. It demonstrates that sustained integration of livestock disease controls, wildlife surveillance and management, and measures to reduce wildlife–livestock contact can be followed by elimination of detectable infection from a regional livestock–wildlife system and eventual withdrawal of special

[645] World Organisation for Animal Health (WOAH) (2024). Guidelines for the control of Mycobacterium tuberculosis complex in livestock: Beyond test and slaughter. Paris: WOAH, 37 pp. https://doi.org/10.20506/woah.3538

[646] STAR-IDAZ International Research Consortium (2024). Roadmap for development of disease control strategies for bovine tuberculosis (bTB). Published 26 November 2024. STAR-IDAZ IRC.

eradication-area controls. Because these measures were implemented concurrently, however, the Canadian experience does not identify the causal contribution of any individual component and should not be used to infer a numerical effect for culling, selective removal or other intervention in Northern Irish badgers. [647]

The Michigan experience provides an important counterpoint. Long-term reductions in deer density and restrictions on practices that concentrate animals were followed by a substantial reduction in wildlife bTB prevalence, but infection subsequently persisted at a relatively low level and cattle infections continued to occur. Current management therefore remains focused on sustained deer population management, surveillance, farm biosecurity and limiting artificial aggregation. The principal lesson for Northern Ireland is not a transferable prevalence threshold, but that a substantial initial reduction in wildlife infection should not itself be regarded as evidence that the epidemiological objective has been achieved. Intervention intensity, duration and exit criteria need to be linked to whether transmission has actually been reduced to the required level across the connected cattle–wildlife system. [648]

Minnesota adds a further distinction to the comparative evidence. Genomic and epidemiological evidence indicated that infection in free-ranging deer represented a relatively recent and geographically contained introduction rather than a long-established wildlife reservoir. A rapid and intensive package of cattle, wildlife and wildlife–livestock interface measures was followed by disappearance of detectable infection. This does not provide a transferable effect estimate for wildlife intervention in Northern Ireland, where badger infection is established and endemic. It does, however, illustrate why the stage and apparent epidemiological role of wildlife infection should form part of the initial diagnosis: measures appropriate to a recently seeded and spatially contained wildlife problem may differ from those required to reduce infection in an established maintenance reservoir. [649]

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[647] Wobeser, G. (2009), 'Bovine tuberculosis in Canadian wildlife: an updated history', *Canadian Veterinary Journal*, 50(11), 1169–1176; Shury, T.K. and Bergeson, D. (2011), 'Lesion distribution and epidemiology of *Mycobacterium bovis* in elk and white-tailed deer in south-western Manitoba, Canada', *Veterinary Medicine International*, 2011, 591980; Canadian Food Inspection Agency (2019), *Riding Mountain Eradication Area is no longer required by the CFIA for the management of bovine tuberculosis*.

[648] O'Brien, D.J. et al. (2011), 'Management of bovine tuberculosis in Michigan wildlife: current status and near term prospects', *Veterinary Microbiology*, 151, 179–187; VerCauteren, K.C., Lavelle, M.J. and Campa III, H. (2018), 'Persistent spillback of bovine tuberculosis from white-tailed deer to cattle in Michigan, USA: status, strategies, and needs', *Frontiers in Veterinary Science*, 5, 301; O'Brien, D.J. et al. (2023), 'The devil you know and the devil you don't: current status and challenges of bovine tuberculosis eradication in the United States', *Irish Veterinary Journal*, 76(Suppl 1), 16.

[649] Carstensen, M. and DonCarlos, M.W. (2011), 'Preventing the establishment of a wildlife disease reservoir: a case study of bovine tuberculosis in wild deer in Minnesota, USA', *Veterinary Medicine International*, 2011, 413240; Glaser, L. et al. (2016), 'Descriptive epidemiology and whole genome sequencing analysis for an

Australia adds a national programme-level example in which a clearly defined eradication objective was translated into progressive herd and area classifications, measurable intermediate milestones and sustained surveillance after declared freedom. Its wildlife circumstances are not directly comparable with Northern Ireland, but the programme illustrates the value of treating eradication as a staged process with explicit technical standards, measurable progression criteria and continuing freedom assurance rather than simply as a sequence of individual control measures. [650]

The contrasting selective-removal studies also illustrate the importance of intervention intensity and epidemiological context. In Spanish wild boar, Che'Amat et al. (2016) found that targeted removal did not control infection under very high infection pressure, whereas Le Roex et al. (2016) found that test-and-cull in African buffalo reduced transmission most clearly in herds subjected to more intensive and frequent capture. Neither system is directly transferable to badgers, but together they reinforce that selective removal should not be regarded as having a fixed effect independent of starting prevalence, diagnostic performance, the proportion of the population reached and the frequency with which intervention is repeated. [651]

outbreak of bovine tuberculosis in beef cattle and white-tailed deer in northwestern Minnesota', *PLoS ONE*, 11(1), e0145735; Minnesota Department of Natural Resources (2012), *Bovine tuberculosis in white-tailed deer in northwest Minnesota: a 7-year effort to restore Minnesota's disease-free accreditation*.

[650] More, S.J., Radunz, B. and Glanville, R.J. (2015), 'Lessons learned during the successful eradication of bovine tuberculosis from Australia', *Veterinary Record*, 177, 224–232; World Organisation for Animal Health (2019), *Lessons learned from Australian success during the successful eradication of bovine tuberculosis*.

[651] Che'Amat, A. et al. (2016), 'Is targeted removal a suitable means for tuberculosis control in a wild boar population?', [full details as Section 14]; Le Roex, N. et al. (2016), 'Disease control in wildlife: evaluating a test and cull programme for bovine tuberculosis in African buffalo', *Transboundary and Emerging Diseases*, 63(6), 647–657.

A2.7 Overall synthesis of the scientific evidence

The matrix illustrates why AgriSearch does not consider the three intervention approaches to have **equivalent evidence bases**, even though all may be scientifically viable under appropriate circumstances.

Table 13. Comparative synthesis of the scientific evidence by intervention approach

Intervention	Strongest aspect of evidence base	Principal evidential limitation
Non-selective culling	Direct replicated/large-scale field evidence of reduced cattle herd incidence	Magnitude and transferability of effect to NI; perturbation; optimal scale, boundaries, coverage and duration
TVR	NI-specific operational feasibility, diagnostic, badger-prevalence and behavioural evidence	Absence of controlled evidence demonstrating a causal reduction in cattle herd incidence
Vaccination-only	Strong biological evidence of BCG protection plus important RoI field/operational evidence	Speed and cattle-level effect when introduced as the initial intervention into untreated populations with substantial existing infection
Sequenced/adaptive approaches	Strong biological and epidemiological rationale, supported by aspects of RoI experience and modelling	Specific proposed NI hybrid/adaptive scheme has not itself been field-tested or specifically validated

The distinction is important because DAERA's own scientific opinion states that the TVR intervention was undertaken in one area, limiting extrapolation; that much of the strongest vaccination evidence is context-dependent because of previous culling; and that modelling outputs, including the now-published NI Parameterised Model, are context-dependent projections rather than field trials. [652]

AgriSearch therefore considers that the appropriate question is not simply whether there is "evidence" for each option, but:
What outcome has actually been demonstrated, by what type of evidence, under what starting conditions, and how confidently can that finding be transferred to the epidemiological circumstances in Northern Ireland?

That is the principle on which the scientific assessment in this response has been based.

[652] DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, particularly the discussion of modelling and Scientific Opinion Conclusions 4–7. DAERA notes that model outputs are context-dependent and highly abstracted constructs rather than field trials, that the NI TVR intervention was undertaken in a single area, and that much of the relevant vaccination evidence arose in circumstances where previous badger removal had occurred.

Appendix 3: Paper-level source verification matrix

A3.1 Purpose and approach

This appendix provides a paper-level verification of selected scientific studies that are particularly important to the conclusions and assumptions underpinning DAERA's wildlife intervention analysis.

It is not intended to constitute a further peer review of the individual studies, nor does it seek to reproduce the 174-paper annotated bibliography prepared by DAERA. Rather, the purpose is to examine whether the principal proposition for which an individual paper is being used is supported by that paper; what type of outcome was actually measured; and whether important limitations, assumptions or contextual factors need to remain visible when the evidence is transferred into policy analysis.

For completeness, the matrix also considers selected technical reports or modelling outputs where these have been used materially in DAERA's analysis. Inclusion in this appendix should not be taken to imply that such material has undergone journal peer review; where relevant, its publication and peer-review status is identified explicitly as part of the verification assessment.

This differs from the approach taken in DAERA's Annotated Scientific Bibliography. Annex VI explains that, because the selected papers had already undergone journal peer review, no further critique of the papers was undertaken, and that its annotations provide only a high-level, policy-neutral summary rather than a substitute for reading the papers directly. [653]

[653] DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, Introduction, p. 4, and Annex 1, 'Detailed methodology', pp. 65–66. DAERA states that the selected papers had already undergone peer review, that no further critique of individual papers was undertaken, and that the annotations provide a high-level, factual and policy-neutral summary rather than replacing consideration of the original papers.

For the purposes of this matrix, the following verification descriptions are used:

Table 14. Verification descriptions used in the paper-level assessment

Verification description	Meaning
Supported	The proposition is a reasonable reflection of the study and its measured outcome.
Supported with important qualification	The central proposition is supported, but an important limitation or contextual condition should accompany it.
Model-dependent / conditional	The result is generated principally through modelling and depends materially on specified assumptions.
Context-specific	The finding is valid within the study setting but should not automatically be generalised to different epidemiological circumstances.
Requires more cautious wording	The underlying evidence is relevant, but broader wording risks implying an outcome which the study did not directly demonstrate.
Contested / analytically sensitive	The study represents one interpretation of a body of data for which materially different peer-reviewed analyses exist.

Full bibliographic details for the studies and technical reports included in Tables 15–19 are provided in Section 14. References to the proposition for which a paper is relevant in DAERA material relate principally to Annex VI and Annex VII unless otherwise indicated.

A3.2 Transmission between cattle and badgers

Table 15. Paper-level verification of cattle–badger transmission evidence

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Donnelly & Nouvellet (2013)	Direct badger-to-cattle transmission may account for only a relatively small proportion of confirmed cattle herd breakdowns, but the total contribution attributable to badgers can be much larger once onward cattle-to-cattle transmission following badger introduction is included.	The model estimated that approximately 5.7% of confirmed herd breakdowns were attributable directly to badgers, while the overall contribution attributable to badgers, including onward cattle-to-cattle transmission, was approximately 52% in the high-incidence RBCT areas.	**Supported with important qualification**	These are **model-derived estimates for high-incidence areas in England**, not universal transmission fractions. The modelling also incorporated important assumptions concerning transmission structure. The CVO Review appears to cite this paper as **2015**, whereas the paper was published in **2013**.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Crispell et al. (2019)	WGS demonstrates transmission between cattle and badgers and indicates that relative transmission between hosts can be quantified.	The Woodchester analysis found substantially more within-species than between-species transmission. Cattle were at greater risk from other cattle, although inferred badger-to-cattle transmission exceeded cattle-to-badger transmission in this particular study system.	**Supported; context-specific**	Strong evidence of bidirectional transmission, but **Woodchester transmission proportions should not be treated as NI-wide parameters**. Annex VI itself recognises substantial variation between different bTB hotspots.
Rossi et al. (2022)	Transmission can proceed from cattle into badgers and subsequently back into cattle.	The Cumbria outbreak was consistent with introduction into cattle, subsequent spillover into badgers and later spillback to cattle.	**Supported; context-specific**	Particularly useful evidence that the wildlife reservoir can itself become infected following cattle introduction. It is an outbreak reconstruction, however, not an estimate of the normal relative frequency of the two transmission directions.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Akhmetova et al. (2023)	Cattle-associated transmission dominated in the NI TVR study area.	WGS analysis inferred 35 of 37 direct transmission events as cattle-associated, with two interspecies events and no badger-to-badger direct transmission events inferred.. Models suggested cattle-to-badger transmission was more frequent than badger-to-cattle transmission in this area.	**Supported with important qualification**	This is especially valuable **NI-specific evidence**, but from one study area. The authors also caution that relatively rare badger introductions could remain important if subsequently amplified by cattle-to-cattle transmission. It should not be extrapolated to all NI hotspots.

Source-verification conclusion – transmission evidence

The principal DAERA interpretation that cattle and badgers constitute an interconnected multi-host system is well supported. The more important qualification is that **the relative contribution of each transmission pathway varies between areas**, and WGS findings from one hotspot should not be treated as fixed transmission parameters for Northern Ireland as a whole. DAERA's own annotated review reaches essentially this conclusion. [654]

[654] DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, 'Transmission dynamics', pp. 14–18; DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, 'Transmission dynamics', pp. 2–3. DAERA notes that WGS studies from different hotspots indicate variation in the relative contribution of cattle and badgers to transmission.

A3.3 Non-selective culling evidence

Table 16. Paper-level verification of non-selective culling evidence

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Griffin et al. (2005a; 2005b) – Four Area Trial	Sustained proactive badger removal can reduce cattle bTB herd-breakdown risk.	The Irish Four Area Trial provides direct field evidence that intensive sustained badger removal substantially reduced cattle breakdown risk in removal areas relative to reference areas.	**Supported**	Strong and particularly relevant Irish field evidence. The design was **matched rather than randomised**, and reference areas were subject to reactive rather than zero badger intervention. These design features should remain visible but do not negate the cattle-outcome finding. DAERA appropriately treats it as one of the two major field trials supporting proactive culling.
Donnelly et al. (2006) – RBCT	Proactive culling reduced cattle bTB incidence within intervention areas but could increase incidence around their periphery.	The randomised trial demonstrated a reduction in confirmed herd incidence within proactively culled areas and an adverse effect in surrounding areas during culling.	**Supported**	This remains the strongest experimental evidence for both a **central cattle benefit and an adverse peripheral cattle effect consistent with epidemiological perturbation**. The magnitude and transferability of those effects to NI remain separate questions.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Jenkins et al. (2010)	Benefits of proactive culling can persist following cessation, while the adverse peripheral effect does not necessarily persist.	Follow-up showed continuing central benefit for a period after culling ended, followed by attenuation; the adverse peripheral effect observed during culling was no longer evident after cessation.	**Supported**	Demonstrates that both beneficial and adverse effects are **time-dependent**. It does not establish a permanent post-cull benefit.
Downs et al. (2019)	Operational English culling was associated with reduced cattle bTB incidence.	After four years, central-area incidence was significantly lower in Gloucestershire and Somerset than in their respective comparison areas. Dorset had only two years of follow-up in this analysis, over which no significant reduction in central-area OTF-W incidence was detected.	**Supported with important qualification**	This is **observational policy evidence**, not a randomised trial. Area-to-area variation and contemporaneous cattle-control measures limit causal attribution. Annex VI reflects this variation.
Langton et al. (2022)	There is peer-reviewed analysis disputing a substantial beneficial effect from	Analysis of routine English data did not identify a meaningful broad reduction in cattle bTB attributable to culling and suggested cattle measures or	**Supported as a competing analysis**	Legitimate evidence of scientific/statistical disagreement. It should not, however, be treated as if it were a new randomised trial capable of nullifying the separate RBCT and Four Area experimental evidence. DAERA's

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
	the later English culling policy.	wider trends may explain much of the observed decline.		annotated bibliography appropriately records it under "No effect". [655]
Torgerson et al. (2024)	Conclusions from RBCT data can depend on statistical model and outcome definition.	Reanalysis found that conclusions varied with analytical specification and that effects were less evident when all breakdowns rather than confirmed breakdowns were considered.	**Contested / analytically sensitive**	Important evidence that effect estimates are sensitive to analytical choices. It is a **reanalysis of existing data**, not new field evidence.
Mills, Woodroffe & Donnelly (2024a; 2024b)	Alternative analyses continue to support the original RBCT finding for confirmed breakdowns.	Multiple frequentist and Bayesian models produced a beneficial effect within proactive cull areas and an adverse peripheral effect during culling, broadly consistent with the original RBCT analysis.	**Supported**	Strengthens confidence that the original confirmed-breakdown finding is not dependent on one statistical model. Again, these are reanalyses of the **same underlying experimental dataset**, not independent trials.
Hone (2025) – New Zealand	Sustained control of an infected wildlife reservoir, alongside livestock measures, can contribute to	National-scale causal-inference assessment of New Zealand's integrated livestock disease-control and brushtail possum population-control programme found evidence consistent with	**Supportive, but indirect comparator**	Does not isolate the effect of possum control from concurrent livestock measures and does not provide an effect estimate transferable to badger removal. Possum ecology and the New Zealand control system differ materially

[655] DAERA (2025a), Annex VI, 'Proactive badger culling', subsection 'No effect'.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
	long-term reduction of bTB in livestock.	sustained control effort contributing causally to the long-term decline in infected livestock herds.		from NI. Its relevance is principally to the broader proposition that sustained control of an established wildlife reservoir can contribute to eradication within an integrated programme.

Source-verification conclusion – culling evidence

DAERA's proposition that sustained proactive culling has direct field evidence of reducing cattle herd incidence is supported. The principal need is to retain distinctions between experimental field evidence, later observational policy evidence, and competing statistical reanalyses. DAERA's Scientific Opinion itself summarises the RBCT and Four Area Trial as two trials demonstrating a significant cattle-herd benefit while recognising perturbation and transferability concerns. [656]

Recent New Zealand analysis provides additional international support for the broader principle that sustained control of an established wildlife reservoir can contribute to declining livestock bTB within an integrated eradication programme, but it does not provide a directly transferable estimate of the effect of badger culling in Northern Ireland.

[656] **DAERA (2025a), *Annotated scientific bibliography relating to badger intervention and bovine tuberculosis*, Annex VI, 'Proactive badger culling', pp. 18–22; DAERA (2025b), *Scientific Opinion*, Annex VII, 'Proactive culling', Scientific Opinion Conclusion 5 and Opinion Summary. DAERA identifies the RBCT and Irish Four Area Trial as the principal controlled field evidence supporting a cattle benefit from sustained proactive culling, while also recognising perturbation, transferability and other limitations.**

A3.4 Test and Vaccinate or Remove

Table 17. Paper-level verification of Test and Vaccinate or Remove (TVR) evidence

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Menzies et al. (2021)	TVR can be implemented operationally under NI conditions, including live capture, trap-side testing, selective removal and vaccination.	The NI study provides substantial information on TVR methodology, logistics, capture and field operation.	**Supported**	It demonstrates **operational feasibility**, not cattle-level epidemiological efficacy. That distinction should be maintained wherever the paper is used. Annex VI explicitly describes its value principally in relation to logistics and resources. [657]

[657] DAERA (2025a), Annex VI, 'Test and Vaccinate or Remove (TVR)'. DAERA notes that the Menzies et al. paper provides information particularly relevant to the methodology, logistics and resources required for TVR delivery.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Arnold et al. (2021)	DPP testing has approximately 69% sensitivity and 98% specificity, and estimated badger prevalence declined markedly during TVR.	Estimated whole-blood DPP sensitivity was **69% (48–88%)** and specificity **98% (96–99%)**. Estimated prevalence declined from about **14% to 1.9%**, an estimated annual decline of 39.1%.	**Numerically supported; causal interpretation requires qualification**	The prevalence result is strong evidence of a favourable badger-level trajectory but the study lacked replicated untreated controls. It is safer to say prevalence **"declined substantially during the intervention"** than to attribute the entire decline causally to TVR. Some downstream DAERA material rounds the diagnostic figures differently; AgriSearch should use the paper estimates consistently.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
O'Hagan et al. (2021b)	Selective removal under TVR did not cause a perturbation effect.	No significant sustained increase in ranging behaviour was detected under the intervention conditions studied.	**Supported with important qualification**	The correct proposition is that **no sustained perturbation was detected at the selective-removal intensity studied**. It does not demonstrate that TVR could never generate perturbation if removal intensity or prevalence were materially higher. DAERA's earlier Scientific Opinion itself recognised the one-area/no-replicate limitation.
Redpath et al. (2023)	Later NI movement data reinforce the absence of broad behavioural perturbation during TVR.	The analysis did not identify a broad sustained increase in home-range size, although short-term movement changes associated with trapping were observed.	**Supported with qualification**	Supports the broader O'Hagan finding but argues against an absolute formulation such as **"TVR causes no perturbation"**.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Doyle et al. (2023)	The NI TVR project did not show a reduction in cattle herd bTB incidence.	Analysis did not demonstrate a statistically robust causal cattle-incidence effect associated with TVR.	**Requires more cautious wording**	This should **not** become "TVR had no effect on cattle". The intervention was not a replicated controlled cattle-outcome trial and had limited power for that purpose. Annex VI's phrase "no obvious impact" should therefore be interpreted as **failure to demonstrate an effect**, not proof of absence of effect. [658]

[658] DAERA (2025a), Annex VI, 'Test and Vaccinate or Remove (TVR)'; DAERA (2025b), *Scientific Opinion*, Annex VII, TVR section and Scientific Opinion Conclusion 6; Doyle, L.P. et al. (2023), 'Assessing the impact of a Test and Vaccinate or Remove badger intervention project on bovine tuberculosis levels in cattle herds', *Epidemiology and Infection*, 151. DAERA records the absence of a demonstrated cattle-incidence effect while also recognising the limitations of the single-area study design.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Smith et al. (2016)	Modelling suggests TVR may perform as well as or better than proactive culling if it does not cause perturbation.	The model projected substantial reductions in infected badgers and cattle breakdowns under TVR in the absence of perturbation. When perturbation was included, the relative performance changed materially.	**Model-dependent / conditional**	This is an important comparison tool but remains **modelled evidence**. The favourable TVR result depends strongly on the no-perturbation assumption and model structure. Annex VI itself emphasises that models are context-dependent abstractions rather than field trials.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Budgey & Smith (2019), APHA technical report	The NI Parameterised Model supports an expectation that TVR can reduce cattle herd breakdowns and may produce cattle outcomes broadly similar to non-selective culling under specified NI scenarios.	The report does generate reductions in modelled cattle herd breakdowns under TVR. In the comparable alternative-zone configuration, TVR and non-selective culling produced very similar projected core-area outcomes. The model also shows that results differ substantially according to the assumed perturbation effect and examines alternative starting prevalence scenarios.	**Model-dependent / conditional**	**DAERA-commissioned technical report, not a peer-reviewed journal article.** The projected cattle benefit is a simulation output and was not validated against a directly demonstrated TVR cattle-incidence effect. Perturbation under selective removal could not be empirically parameterised and was therefore represented through contrasting assumptions. Operational inputs were partly derived from Banbridge and may not transfer directly to wider deployment. The report's formal uncertainty analysis principally addresses stochastic model variation rather than comprehensively quantifying parameter and structural uncertainty.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Smith & Budgey (2025)	The model used to predict NI TVR outcomes has subsequently been evaluated against data from the field study.	When parameterised to the Banbridge study, including observed capture information, the updated model reproduced test-positive removals and the broad decline in badger prevalence reasonably well under the no-perturbation scenario.	**Supported, but the extent of model validation needs to be precise**	Agreement for quantities used in model parameterisation, such as capture numbers, should not itself be treated as independent validation. The study provides useful validation of aspects of the emergent badger-level behaviour of the model but does not validate the predicted cattle herd-incidence effect

Source-verification conclusion – TVR evidence

The NI TVR evidence is strong on operational feasibility, diagnostic performance, badger infection trends and behaviour. The main point requiring protection as the evidence moves into policy analysis is that these findings do not constitute equivalent direct evidence of a cattle herd-incidence effect. The now-published Budgey & Smith (2019) report confirms that the quantitative cattle benefits attributed to TVR in the NI Parameterised Model are simulation outputs conditional on the model structure and specified assumptions; its publication therefore strengthens transparency around the modelling but does not alter the evidential status of the projected cattle

effect. [659] DAERA's own earlier Scientific Opinion explicitly noted that the TVR study was not of sufficient scale or design to demonstrate such an effect. [660]

[659] Budgey, R. and Smith, G.C. (2019), A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland, National Wildlife Management Centre, Animal and Plant Health Agency, Final Report, particularly pp. 3–10 and 17–20; see also DAERA (2026b), Annex VIII – Badger Intervention Options Analysis Paper, paras. 5.3.12–5.3.21, for DAERA's use of the NI Parameterised Model outputs in the comparative intervention analysis.
[660] DAERA (2025b), *Scientific Opinion*, Annex VII, TVR section, Scientific Opinion Conclusion 6 and Annex 1, 'Scientific Opinion on the Available Evidence on Badger Intervention' (2019). The Department's own material records that the Northern Ireland TVR work was undertaken in a single area without replicate intervention and untreated control areas and was not of sufficient design or scale to demonstrate a statistically significant cattle-level effect.

A3.5 Vaccination evidence

Table 18. Paper-level verification of badger vaccination evidence

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Carter et al. (2012)	BCG materially reduces susceptibility/progression of infection in badgers and can provide indirect protection to unvaccinated cubs.	Intramuscular BCG substantially reduced measured infection risks; DAERA cites reductions of around 76% for progressive infection and 54% for infection more broadly, with indirect protection of unvaccinated cubs of up to 79% where more than one-third of the social group was vaccinated.	**Supported**	Strong **badger-level biological efficacy** evidence. It does not directly measure an effect on cattle herd incidence. DAERA's consultation presents the figures broadly consistently.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Gormley et al. (2017)	Vaccination reduces susceptibility to natural infection in free-living badgers.	In the Kilkenny field trial, vaccination significantly delayed seroconversion, providing evidence of protection against natural infection.	**Supported with important qualification**	Previous intervention history was mixed rather than continuous: approximately one-third of the area had formed part of a Four Area Project reference area where breakdown-related culling was limited, and the area was protected from culling for two years before vaccination began. The study's primary outcome was badger infection rather than cattle disease.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Gormley et al. (2022)	Vaccination principally reduces susceptibility rather than treating infection already established in a badger.	Subsequent Kilkenny analysis found significantly lower confirmed infection prevalence in the fully vaccinated zone than in the unvaccinated zone. Within the mixed 50:50 zone, however, the vaccinated–placebo post-mortem prevalence comparison was not statistically significant. Among animals which were infected, no significant difference was detected in the number of infected sites or disease severity	**Supported in principle; wording should be precise**	This supports the proposition that BCG is **preventive rather than therapeutic**. The broader statement that "vaccination of infected badgers is ineffective" is somewhat too categorical; more precisely, vaccination has little demonstrated effect on the course or infectiousness of established infection.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Aznar et al. (2018)	Vaccination can reduce badger susceptibility and modelling suggests eradication may be possible above a certain coverage level.	The model estimated vaccine efficacy against susceptibility at approximately **59%** and suggested eradication in badgers could be feasible with vaccination coverage of **≥30%**, provided existing controls remained in place.	**Model-dependent / conditional**	The 30% figure is **not a universal herd-immunity threshold**. The model assumed no cattle-badger/environmental transmission component and spatial homogeneity; DAERA's bibliography notes these limitations and indicates that the timescale could be decades.
Martin et al. (2020)	Vaccination can replace continued targeted culling without an unacceptable increase in cattle herd incidence.	In the Irish non-inferiority study, vaccination was non-inferior to continued targeted culling in **most, but not all**, study areas. The measured endpoint was new cattle herd breakdown incidence.	**Supported with critical contextual qualification**	This is important direct cattle-outcome evidence, but the study asks a **transition question**: vaccination versus continued culling in landscapes already exposed to years of badger removal. It does not directly demonstrate equivalent performance for vaccination as an initial intervention in an untreated high-prevalence NI badger population. DAERA's Scientific Opinion recognises this context.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Chang et al. (2025)	Vaccination of badgers combined with cattle test-and-removal may not be sufficient on its own to eradicate bTB.	The two-host, multi-route model concluded that this combination was unlikely to guarantee eradication and that additional measures targeting cattle, badgers and movements could be required.	**Model-dependent / conditional**	Useful evidence against assuming that vaccination plus existing cattle controls necessarily guarantees eradication. It remains a **mathematical model based principally on Irish parameters**, not a direct NI field result.

Source-verification conclusion – vaccination evidence

The biological case that BCG protects susceptible badgers is strong. The principal issue is context. DAERA is correct to rely on the Irish vaccination programme and Martin et al. as important evidence, but the prior history of removal in those areas is not incidental: it is central to assessing transferability to NI. DAERA's own Scientific Opinion explicitly says that much of the Irish landscape had already been subject to reactive culling for several years and questions whether the results can be generalised directly to Northern Ireland. [661]

[661] DAERA (2025b), *Scientific Opinion*, Annex VII, 'Badger vaccination', Scientific Opinion Conclusion 4 and Opinion Summary; DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, pp. 30–31 and 62–64. DAERA's own assessments note that much of the relevant Republic of Ireland vaccination evidence arose after several years of badger removal and identify this as an important consideration when assessing transferability to Northern Ireland.

A3.6 Badger population, prevalence and intervention coverage

Table 19. Paper-level verification of badger population, prevalence and intervention coverage evidence

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Courcier et al. (2018)	RTA surveillance demonstrates widespread *M. bovis* infection in NI badgers and supports use of road-killed badgers for surveillance.	The study analysed badgers killed by vehicles between 1998 and 2011 and provides important evidence of badger infection and geographical relationships with cattle disease in NI.	**Supported with qualification**	The **current approximately 20% prevalence figure is not derived from Courcier et al. (2018) alone**; DAERA combines the historic published work with more recent RTA surveillance/unpublished data. [662] RTA badgers are also a convenience sample rather than a spatially representative population survey.

[662] DAERA (2024), *Chief Veterinary Officer Review of Bovine Tuberculosis in Northern Ireland*, p. 29; DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, para. 2.14.3, p. 15. The CVO Review gives an approximately 20% RTA prevalence estimate using Courcier et al. (2018) together with DAERA unpublished data, while Annex IX similarly states that the current RTA survey suggests prevalence of approximately 20%.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Reid et al. (2012)	Provides the principal published NI badger population estimate and contributes to intervention population assumptions.	The 2007/08 survey estimated approximately **34,100 badgers**, around **7,600 social groups**, and an average NI density of approximately **2.5 badgers/km²**.	**Supported for the historic national estimate**	The data are now nearly two decades old and conceal substantial spatial variation. DAERA's economic appraisal uses **423 badgers per 100 km² (4.23/km²)**, described as deriving from "QUB / Reid model outputs". The 4.23/km² figure is therefore **not simply the national density reported by Reid et al. (2012)** and the additional modelling/source chain should be made clear. [663]

[663] DAERA (2026), *Badger Intervention Analyses – Calculation Assumptions*, Annex IX, paras. 2.14.1–2.14.2, pp. 14–15; Reid, N. et al. (2012), 'Monitoring and population estimation of the European badger *Meles meles* in Northern Ireland', *Wildlife Biology*, 18(1), 46–57. Annex IX assumes 423 badgers within an indicative 100 km² intervention area and attributes the figure to 'QUB / Reid model outputs'. This should be distinguished from the Northern Ireland-wide mean density of approximately 2.5 badgers/km² reported from the 2007–08 survey.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Byrne et al. (2012)	Supports assumptions concerning badger trappability using stopped restraints.	The study provides empirical estimates of per-session trappability and demonstrates the value of repeated capture sessions.	**Supported with qualification**	A per-session capture probability is not automatically equivalent to the **proportion of the total population reached**. Repeat captures, age/size effects, trap response and uncertainty in the true population denominator matter when converting trappability into intervention coverage. DAERA uses approximately 34–35% per session and 56–58% annual capture in its proposed restraint options. [664]

[664] DAERA (2026), *Consultation on Potential Wildlife Intervention Options*, section 7b, 'TVR Using Stopped Restraints', pp. 58–59; Byrne, A.W. et al. (2012), 'Population estimation and trappability of the European badger (*Meles meles*): implications for tuberculosis management', *PLoS ONE*, 7(12), e50807. DAERA applies a mean trappability estimate of 34–35% for each trapping cycle and an estimated overall annual capture rate of 56–58%.

Paper	Proposition for which it is relevant in DAERA material	Paper-level verification	Verification assessment	Important qualification / implication
Bright Ross et al. (2022)	Minimum Number Alive and raw capture measures should be used cautiously as measures of badger population size.	The study identifies biases arising from age structure and trap-happy/trap-shy behaviour and cautions against treating MNA as a reliable stand-alone population estimator outside suitable longitudinal datasets.	**Supported**	Reinforces AgriSearch's recommendation that **activity totals and raw captures should not be treated as actual population coverage without a defensible population denominator**. Annex VI itself makes this point clearly. [665]

[665] DAERA (2025a), Annex VI, 'Badger ecology', discussion of population estimation and Minimum Number Alive; Bright Ross, J.G. et al. (2022). DAERA notes the potential for capture behaviour and age structure to bias MNA estimates and cautions against treating MNA as a reliable population estimate without regard to trapping efficiency and study design.

A3.7 Overall source-verification assessment

The paper-level source-verification exercise does **not** indicate that DAERA's supporting scientific material is characterised by widespread factual misrepresentation. In many cases the Annotated Bibliography and Scientific Opinion accurately identify both the principal findings and important limitations of the literature.

The more material issue arises as those findings are carried forward into intervention comparison, modelling and option ranking. Several recurring points emerge from the source-verification exercise:

Direct outcomes and modelled outcomes need to remain distinguishable. The field evidence for cattle outcomes is materially different between interventions. A model can legitimately project cattle benefits from TVR or vaccination, but that does not make the modelled result equivalent to an observed cattle outcome.

Contextual qualifications matter. The NI TVR trial was undertaken in one area without replicated intervention and untreated control areas. Although cattle herd bTB breakdowns were monitored, the study design was not sufficient to establish a causal cattle-incidence effect. The most important Irish direct cattle-outcome vaccination evidence arose in populations already subjected to previous badger removal. WGS transmission proportions vary markedly between study sites.

Absence of evidence should not become evidence of absence. Failure to demonstrate a cattle-incidence benefit during the NI TVR project is not the same as demonstrating that TVR has no cattle effect. Likewise, absence of detected sustained perturbation under the selective-removal intensity studied does not establish that perturbation could not arise under materially different conditions.

Population and coverage assumptions require particular care. The historic Reid population survey remains important, but the population figure used in DAERA's current intervention calculations is not simply the national density reported in that paper. Similarly, capture rates should not be equated automatically with true population coverage.

Overall, this source-verification supports the central conclusion of AgriSearch's assessment: **DAERA's scientific source material is substantial and generally relevant, but the level of qualification and evidential emphasis does not always remain consistent as evidence of different types is translated into comparative intervention outcomes.**

Appendix 4 – Interim findings from the Queen's University Belfast Badger Population Assessment Project

The following interim research outcomes were supplied in writing by Professor Jaimie Dick, Queen's University Belfast, to AgriSearch on 4 September 2026. [666] The research is ongoing and has not yet been published as a complete project report. The statements are reproduced substantially as supplied by the research team in order to make transparent the Northern Ireland-specific evidence considered in this response.

AgriSearch is a co-funder of the project alongside the Ulster Farmers' Union and BH Estates.

A separate series of "Discussion Points" was supplied by Professor Dick alongside these research outcomes. Those points were provided to stimulate discussion rather than as research findings and are therefore not reproduced here as project results.

- Badger population densities in Northern Ireland have never before been directly assessed by live recording of undisturbed, free-roaming badgers
- QUB researchers deployed thermal imaging binoculars and drones at night over 64 1km2 areas across N. Ireland land-class groups in 2023-2026
- Badgers were widespread and abundant across all land-class types, including mountain habitats, which were previously thought unsuitable
- Several areas of N. Ireland previously assessed as badger free (Reid et al 2007/8 survey) were found by thermal to have badgers present in 2026
- Badger densities assessed by thermal ranged from 0-18 badgers per 1km2
- Badger density hotspots were 3-5 times higher than previous estimates that had used indirect survey methods
- In 4 known badger hotspots, density range was 12-18 (mean 14.25) badgers per 1km2
- Across 50 random 1km2 areas assessed in winter/spring (before cubs born) with thermal drones, badger density range was 0-12 per 1km2, with mean (where badgers were present) of 3 per 1km2
- Badger density coldspots (zero badgers detected) had suitable badger habitat, suggesting anthropogenic reasons for badger absence
- Indirect badger counting methods returned consistently lower badger density estimates than concurrent direct thermal survey techniques

[666] Dick, J.T.A. (Queen's University Belfast) (2026), interim research outcomes from *Badger populations in Northern Ireland: a re-assessment with thermal technology*, written communication to AgriSearch and other project funders, 4 September 2026.

- Badger densities were significantly higher in locations with anecdotal reports of high badger activity compared with random similar habitat
- QUB has developed a phage-based PCR technique to detect live bacteria of both bTB and MAP (Johne's) from any sample
- Live bacteria of bTB and MAP, alone and in combination, were found in badger faeces
- Badgers were observed urinating and defecating across landscapes as well as using latrines
- Current thermal surveys are underway to assess badger densities in the same locations as above now that cubs have been born and raised

Additional field observation – mid-Down, September 2026

Following the earlier interim findings provided by Professor Jaimie Dick, a further field observation was reported by the Queen's University Belfast research team from a 1 km^2 survey area at mid-Down in September 2026. During that survey, 36 individual badgers were observed, with care taken to avoid double-counting animals. This represents a site-specific minimum observation and should not be interpreted as a revised Northern Ireland-wide population estimate.

During the same mid-Down survey, badgers were observed using foraging space also used by cattle. This is a site-specific field observation and does not establish the frequency or epidemiological significance of such shared space, but it illustrates the value of locally resolved behavioural as well as population information when characterising potential intervention areas. [667]

Note on interpretation

The QUB team cautioned against interpreting differences between the current thermal surveys and the 2007–08 Northern Ireland badger survey as a direct measure of population change over time because the methodologies are substantially different. The thermal surveys directly record free-ranging animals and provide a minimum number observed within the area surveyed, whereas the earlier national estimate relied principally on indirect sett-based methods and assumptions concerning social-group size. [668] The interim findings should therefore be interpreted primarily as evidence of

[667] Childs, C. (Queen's University Belfast) (2026), field observation update from the mid-Down survey site, written communication to AgriSearch and project partners, 22 September 2026. The observation is an interim, site-specific direct count and does not constitute a revised Northern Ireland-wide population estimate.

[668] Dick, J.T.A. and QUB research team (2026), methodological clarification provided at Badger Population Assessments Project meeting, 8 September 2026. The research team emphasised that the contemporary

contemporary badger distribution, local density and spatial heterogeneity rather than as a new Northern Ireland-wide population estimate.

thermal surveys and the 2007–08 sett-based survey use substantially different methodologies and should not be treated as a direct population time series; thermal observations provide a direct minimum number observed within the survey area.

Appendix 5 – Independent Economic Review: Stage 1

AgriSearch commissioned The Andersons Centre, under written Terms of Reference established by AgriSearch, to undertake an independent review of the economic assumptions and analysis underpinning DAERA's appraisal of the wildlife intervention options. The review considered whether the economic assessments and assumptions were clearly stated, justified, robust, transparent, internally consistent, appropriately tested and relevant to Northern Ireland conditions. The material below reproduces the introductory scope and Executive Summary of the Andersons' independent economic review. Additional findings from the Stage 1 report concerning sensitivity to assumed intervention effectiveness and the weighting of DAERA's assessment are then summarised by AgriSearch. [669] The full Stage 1 independent review will be published separately.

Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB
The Andersons Centre
Richard King, Michael Haverty and Caroline Ingamells
September 2026

This Report

This report has been commissioned by AgriSearch, Northern Ireland's farmer-funded research and innovation body. It is an independent review of the economic assumptions set out in the 'Consultation on Potential Wildlife Intervention Options as part of the Bovine Tuberculosis in Northern Ireland: Blueprint for Eradication1' as published by DAERA on 3rd July 2026.

The purpose of the project is to assess whether the economic assessments and assumptions used to compare the control options in the Consultation are clearly stated, justified, robust, transparent, internally consistent, appropriately tested, and relevant to Northern Ireland conditions.

This report, prepared by The Andersons Centre ('Andersons'), is a summary of the assessment. As part of this project, DAERA was asked to provide additional background workings. Additional data were supplied to Andersons on 11th September 2026, after the analysis for this Stage 1 review had substantially been completed. Given the timing and volume of the material, it has not been possible to assess it within this report. This

[669] The Andersons Centre (2026), Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB, prepared for AgriSearch, September 2026.

Stage 1 review therefore assesses the economic appraisal on the basis of the information published as part of the Consultation. Subject to agreement with AgriSearch, the additional data may be examined in a subsequent Stage 2 analysis.

Both AgriSearch and Andersons have no preference for any of the wildlife interventions outlined in the Consultation. This project aims to provide independent scrutiny of the economic appraisal so that AgriSearch, farmers, industry organisations and wider stakeholders can better understand the strengths, limitations and implications of the analysis underpinning the Consultation.

The Andersons Centre previously undertook a study of the indirect costs of bovine tuberculosis (bTB) borne by Northern Ireland farmers, commissioned by the Ulster Farmers' Union, Livestock and Meat Commission and Dairy Council for Northern Ireland and published in March 2026. That work was separate from this review.

Project Approach and Report Structure

The analysis has been conducted as a desk-based exercise. It is based on the DAERA consultation plus other relevant published data. No wider industry opinions have been sought. Therefore, the views expressed in this report are those of Andersons. *We are happy to receive feedback and comments on the analysis provided.*

Executive Summary

The Andersons Centre has been contracted by AgriSearch to undertake an analysis of the economic calculations underpinning DAERA's consultation on Wildlife Intervention Options for Bovine TB.

It is recognised that producing estimates of potential costs and benefits is difficult and involves numerous assumptions and simplifications. The analysis contained within this short report is not designed as a criticism of DAERA. Instead it aims to highlight areas where there may be issues.

Overall, an analysis of the economic assumptions is severely hampered by a lack of detail in many areas. This information was requested. *DAERA provided further data on the 11th September 2026 after this analysis had substantially been completed. The material has therefore not been assessed in this report which is based on the information available in the public Consultation.*

The costs set out for the various Options in the consultation are single figures (not ranges) and are expressed to the nearest £1,000. There is little acknowledgement in the

analysis of the inherent uncertainty in producing such figures. Overall, this gives the impression of greater certainty and accuracy in the figures than is probably warranted.

The Options that involve Cage trapping of badgers are costed based on data derived from DAERA's own test at Banbridge in 2014-2018. These should be relatively robust, but there are concerns over the age of this data, and whether costs from a trial are directly applicable to a general roll-out.

Cost estimates for Restraint trapping and Shooting come from the culls in the Republic of Ireland (DAFM) and England (Defra) respectively. This data appears to be only at a high-level. For example, the DAFM data only at a 'cost per badger removed'. The lack of granularity in the comparable evidence calls into question the accuracy of the costing of these Options.

All Options are costed over the same area and for the same timescales. Whilst this is valid for making meaningful comparisons, factors arising from differences between the methods should also be considered – for example, whether some interventions could be effective over a shorter period or produce benefits over a longer period. Similarly, a single unit of analysis of 100km^2 has been used across the Options. This makes sense for comparative purposes, although the actual intervention areas are likely to be larger in practice.

The length of the interventions under all Options is five years. Given experience elsewhere, this could be too long. For some interventions, particularly culling by shooting, a four-year programme may be sufficient. Longer intervention pushes up costs and makes the Options less attractive in terms of costs versus benefits. The benefits are estimated to last five years after the intervention ends. This seems broadly fair although a longer effect could be argued. This is modelled in one of the sensitivity analyses.

The cost of intervention depends on the number of badgers present in any area. Research from Queen's University shows that badger densities are highly variable, with local hotspots several times higher than previous estimates. [670] If this were the case, this would require much more intensive levels of intervention to meet targets and thus result in higher costs. The cost implications of higher badger densities are also likely to differ between intervention methods because their capture, treatment and removal requirements differ. This has not been examined in DAERA's sensitivity analysis.

The largest element of cost under any Option is likely to be labour. Ideally, this element would be built up from hours per activity multiplied by a relevant wage rate. These would

[670] AgriSearch notes that the emerging QUB work does not yet establish a revised Northern Ireland-wide badger population estimate or a directly comparable national population trend. Its present relevance to the economic appraisal is principally that it demonstrates substantial local variation in observed density and therefore supports sensitivity testing of population assumptions. See Section 3.4 and Appendix 4.

then be published so that they could be 'sense tested', and the efficiency of operations and allocation of resources be questioned. This is not provided in the Consultation or its supporting Annexes. It is thus almost impossible to judge whether the Option costs are robust.

In general, the Consultation seems to lean towards a private-sector delivery model mainly due to lower labour costs involved.

As with labour, equipment and other costs are not broken down in detail so it is difficult to make any judgements on whether the costings are robust.

Whilst the two economic Annexes set out costs for each Option, they are silent on who would be expected to pay these costs – specifically reserving it for later consideration. Interestingly however, the main Consultation document has a question (number 9) on this issue.

The cost of each Option is set against the benefits it produces – this is measured in terms of herd breakdowns prevented. Therefore, the cost of each herd breakdown is a key variable in the analysis. The costs to Government (public costs) should be well-known to DAERA. The costs borne by the farming industry (private costs) are more uncertain. Based on earlier work undertaken by The Andersons Centre, it is believed that these costs are underestimated in the DAERA analysis. Consequently, the benefit of preventing these costs will be underplayed.

The benefits are calculated based on modelled estimates of the effectiveness of the interventions in preventing herd breakdowns. There is uncertainty around these figures which is not made explicit in the analysis, especially around the TVR options where direct cattle-outcome evidence is lacking.

In the sensitivity analysis one of scenarios modelled is that the benefits of the intervention are seen outside of the immediate 100km^2 area. The wider area increases the value of the intervention. It is unclear how certain these effects are. However, it is an interesting economic benefit which is not really highlighted in the main Consultation document.

The various Options are given rankings. On a purely economic basis, Option 5 comes highest – cull via controlled Shooting. [671] This is due to its relatively low cost of implementation.

However, rankings are also provided for both non-monetary factors and (operational) risks. The three sets of rankings are combined to produce an overall score. Under this,

[671] This statement relates to DAERA's principal or base no-perturbation economic analysis. DAERA's separate sensitivity scenario applying perturbation to the non-selective culling options changes the economic ranking, with restraint-based TVR (Option 8) ranking highest on illustrative NPV. See DAERA (2026), Badger Intervention Options Analysis Paper, Annex VIII, and Section 8.9 of this response.

Option 8 (Test, Vaccinate, Remove using Restraints) is the highest-ranked. It should be noted that each criterion is given equal weighting in generating the composite rankings. There could be an argument that some criteria (e.g. the economic benefit) should be weighted higher than others (e.g. the perceived risks; which are qualitative).

The cost of Option 8, TVR undertaken by the private sector using restraints, is estimated at £0.865m for a five-year operation over 100 km^2. Actual programme costs will depend on the number, size and characteristics of the areas ultimately selected for intervention. DAERA states that the total area under wildlife intervention would not at any one time exceed 30% of Northern Ireland's agricultural land in order to remain consistent with the Bern Convention. Intervention is therefore likely to be targeted towards areas where wildlife is judged to be contributing materially to persistent cattle bTB. This limits overall expenditure but also places greater importance on careful area selection, effective delivery and achieving the required population coverage so that the greatest possible disease-control benefit is obtained from the resources deployed.

Additional sensitivity findings from the Stage 1 report

The final Andersons report includes additional illustrative analysis of the sensitivity of the economic results to the assumed number of cattle herd breakdowns prevented. Applying a ±15% variation in assumed effectiveness across all intervention types demonstrates that relatively modest changes in realised cattle benefit can materially alter the economic results. Andersons additionally applies a ±30% range to the TVR options, not as a prediction of greater variability, but to illustrate the greater uncertainty where the cattle-level effect remains modelled rather than directly demonstrated. Under DAERA's baseline assumptions, Options 3, 4, 5 and 8 have a positive illustrative net present value. Option 8 remains positive when assumed TVR effectiveness is reduced by 30%, while Option 3 becomes negative when assumed effectiveness is reduced by 15%. [672]

Andersons also tests the sensitivity of DAERA's composite ranking to the weighting assigned to economic, non-monetary and operational-risk considerations. Giving the economic criterion twice the weight of each of the other two categories leaves Option 8 highest-ranked, but narrows the difference with Option 5. If economics is given 3.5 times the weight of each of the other categories, Options 5 and 8 have the same overall score. This illustrates that the composite ranking depends materially on the weighting

[672] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, section 5.6 and Figure 3. The sensitivity analysis applies ±15% to assumed effectiveness across intervention types and, for illustrative purposes, ±30% to the TVR options. Andersons expressly cautions that the latter does not imply that TVR effectiveness will vary by 30%, but illustrates the greater uncertainty surrounding a cattle-level effect that remains modelled rather than directly demonstrated.

applied and is therefore a multi-criteria policy judgement rather than an economic conclusion alone. [673]

Andersons further notes that three of the five criteria within DAERA's non-monetary assessment — cattle killed prematurely, GHG-related inefficiency and human welfare — are all derived from the same underlying APHA-modelled number of herd breakdowns avoided. Although these represent distinct consequences of disease, they are not analytically independent. The APHA model therefore influences 60% of the score within the non-monetary category. [674]

NI Farmer bTB Costs

An important qualification applies to the Andersons breakdown-cost estimate shown below. The March 2026 study was designed to estimate total indirect costs borne by farmers rather than to divide those costs precisely between breakdown and non-breakdown activity. The £46.8 million attributed below to farms experiencing breakdowns is therefore an approximation and is likely to be a slight overestimate of strictly breakdown-specific costs because some routine non-breakdown activity, including routine testing, is also incurred on those farms. [675]

Table 20. Comparison of DAERA and Andersons estimates of bTB costs in Northern Ireland

Costs - £m	DAERA Consultation			Andersons March 2026 Study		
	Non-Breakdown	Break-down	Total	Non-Breakdown	Break-down	Total
Labour	10.6	9.5	20.2			
'Other Costs'	-	12.8	12.8			
Total	**10.6**	**22.4**	**33.0**	**49.4**	**46.8**	**96.1**
Government Costs	11.7	66.1	77.8			
Grand Total		**88.5**				
Breakdowns		*3,216*				
Cost per B'down		£27,500				

Note: Component figures are rounded and may not sum exactly to the published total. The March 2026 Andersons study reports a central estimate of £96.1 million for total indirect farmer costs.

Andersons also notes that some herd breakdowns are substantially more costly than others, particularly where they are prolonged or recurrent. As wildlife intervention is likely to be targeted towards areas where epidemiological evidence indicates significant

[673] The Andersons Centre (2026), section 5.7. With economics weighted twice as heavily as each of the other two categories, Option 8 has a weighted score of 2.5 and Option 5 a score of 3.3. With economics weighted 3.5 times as heavily, Options 5 and 8 both score 2.6.
[674] The Andersons Centre (2026), section 5.7.
[675] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, section 5.4 and Figure 2; The Andersons Centre (2026), *Review of the Indirect Costs Borne by Farmers as a Result of Bovine TB*, March 2026.

wildlife involvement, those areas may contain a higher proportion of such costly breakdowns. Andersons considers the Northern Ireland-wide average breakdown cost appropriate for the present appraisal, given current uncertainty around targeting and wildlife attribution, but identifies this as an area where further sensitivity analysis would be useful. [676]

[676] The Andersons Centre (2026), *Economic Review of the DAERA Consultation on Potential Wildlife Intervention Options for Bovine TB*, section 5.5.

Appendix 6 – Indicative assessment of the DAERA Easy Read Summary against recognised Easy Read guidance

This assessment is intended as a structured comparison against recognised UK Government guidance on Easy Read communication. [677] The RAG ratings are an AgriSearch analytical aid and do not represent a formal government accessibility assessment or accreditation. Where information is unavailable, for example, whether the document was developed or tested with people with learning disabilities, this is recorded as "not evidenced" rather than treated as non-compliance. The assessment is concerned with accessibility and the consistency of evidential presentation; it is not a legal compliance assessment and does not assess the lawfulness of the consultation process.

A. Easy Read accessibility and presentation

Table 21. Easy Read accessibility and presentation: assessment criteria

Assessment criterion	What we are assessing
Simple, concise and jargon-free language	Short sentences, straightforward vocabulary and avoidance/explanation of technical terminology
Layout, typography and visual structure	Readable text size, white space, headings and manageable amounts of information per page
Images support the meaning of the text	Whether pictures actually explain or reinforce the accompanying information rather than merely decorate the page
Difficult words explained when introduced	Whether terms such as surveillance, disease trends or public confidence are made understandable
Length and cognitive load	Whether the 34-page document is sufficiently concise for an Easy Read audience
Important consultation information is prominent and current	Closing date, purpose of consultation and how to respond
Availability of alternative formats	Whether alternative versions, such as paper copy, large print, Braille or other-language formats, are available or can be requested.
Accessible means of participating in the consultation	Whether the response process and questions themselves are accessible, not merely the background information

[677] Cabinet Office and Disability Unit (2026), *Accessible communication formats*, section 5.1 'Easy Read'; Department of Health and Office for Disability Issues (2010), *Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce Easy Read information*, revised edition, particularly pp. 14–15, 20–23 and Annex A, pp. 26–30; Cabinet Office (2018), *Consultation Principles*, particularly principles 1, 3, 6 and 7. See also Government Digital Service (2018), 'Accessibility advice when creating a UK government consultation'.

Development and testing with the intended audience	Whether involvement or testing with people with learning disabilities is evidenced

Table 22. Easy Read accessibility and presentation: RAG assessment

Assessment criterion	Relevant guidance / benchmark	RAG	Basis for assessment
Simple, concise and jargon-free language	Cabinet Office/Disability Unit (2026); DH/ODI (2010); Cabinet Office Consultation Principles	**Amber**	Much of the Summary uses short sentences and relatively straightforward language. However, terms such as “surveillance data”, “disease trends”, “public confidence”, “regulation” and “compliance” introduce concepts that may not be readily understood and are not all explained when first used.
Layout, typography and visual structure	Cabinet Office/Disability Unit (2026); DH/ODI (2010)	**Green**	The document generally uses large, legible text, clear headings, substantial white space and relatively limited amounts of text on each page. Its overall visual structure is easy to navigate.
Images support the meaning of the text	Cabinet Office/Disability Unit (2026); DH/ODI (2010)	**Amber**	Some images clearly support the subject matter, for example vaccination and cage trapping. Others appear principally illustrative or decorative rather than explanatory. The principal non-selective culling page, for example, contains a photograph of cattle rather than an image helping to explain the intervention, and the accompanying text does not itself explain culling.

Assessment criterion	Relevant guidance / benchmark	RAG	Basis for assessment
Difficult words and concepts explained	Cabinet Office/Disability Unit (2026); DH/ODI (2010)	**Amber**	The two-page glossary is a positive feature and explains many key terms. However, some potentially difficult concepts are not included, and explanation often occurs in the glossary rather than at the point where the term is first encountered.
Length and cognitive load	DH/ODI (2010); Cabinet Office Consultation Principles	**Amber**	At 34 pages, the Summary is relatively long. Detailed government guidance recommends keeping Easy Read documents as short as practicable and indicates that documents exceeding around 20 pages may become difficult for the intended audience. [678] The relatively uncluttered page design partly mitigates this concern.

[678] Department of Health and Office for Disability Issues (2010), *Making written information easier to understand for people with learning disabilities*, section 4 and Annex A, particularly pp. 21–23 and 26–30. The guidance recommends keeping Easy Read material as short as possible and notes that documents of more than around 20 pages may be too long for many intended readers.

Assessment criterion	Relevant guidance / benchmark	RAG	Basis for assessment
Important consultation information is prominent and current	DH/ODI (2010); Cabinet Office Consultation Principles	**Red**	Information on how to respond and the closing date does not appear until pp. 29–30. More importantly, the Summary still states that the consultation closes on 25 September 2026, whereas DAERA announced on 3 September that the closing date had been extended to 9 October 2026. [679] [680] This is principally an updating issue rather than a defect in the document as originally published.
Accessible means of participating in the consultation	GDS consultation accessibility good practice; Cabinet Office Consultation Principles	**Amber**	The document clearly provides online, email and postal response routes. However, it does not contain an adapted Easy Read set of consultation questions or an equivalent Easy Read response mechanism. Government good-practice examples have provided Easy Read versions of the consultation information **and questions**.
Availability of alternative formats	Cabinet Office/Disability Unit (2026)	**Green**	Page 3 prominently explains that paper copy, large print, Braille and other-language versions can be requested and provides a contact address.

[679] DAERA (2026), *Bovine Tuberculosis (bTB) Consultation on Wildlife Intervention Options – Easy Read Summary*, p. 29; DAERA (2026), 'Consultation on wildlife intervention options to tackle bTB in Northern Ireland extended', News Release, 3 September 2026. The Easy Read Summary gives a closing date of 25 September 2026, while the subsequent DAERA announcement extended the consultation to 9 October 2026.

[680] See also Department of Health and Office for Disability Issues (2010), particularly the consultation case studies at pp. 14–15 and 18–19 and Annex A, p. 26; Government Digital Service (2018), 'Accessibility advice when creating a UK government consultation'. These provide examples of consultation information and questions being adapted into Easy Read formats.

Assessment criterion	Relevant guidance / benchmark	RAG	Basis for assessment
Development and testing with the intended audience	Cabinet Office/Disability Unit (2026); DH/ODI (2010); GDS good practice	**Not evidenced**	The Summary does not state whether people with learning disabilities were involved in its development, co-production or user testing. This should not be interpreted as evidence that such involvement did not occur.

B. Accuracy and consistency of evidential presentation

Table 23. Accuracy and consistency of evidential presentation: assessment criteria

Assessment criterion	What we are assessing
Accurate description of each intervention	Whether culling, TVR and vaccination-only are actually explained accurately and comparably
Preservation of important scientific qualifications	Whether simplification omits caveats that materially change the meaning of the underlying evidence
Direct cattle-outcome evidence presented consistently	Whether demonstrated cattle evidence for culling and the absence of demonstrated cattle benefit from NI TVR are conveyed proportionately
Diagnostic uncertainty represented accurately	In particular whether describing DPP-negative badgers as "healthy" overstates what the test establishes
Observed, modelled and inferred outcomes distinguished	Whether readers can tell what has actually been demonstrated versus predicted or inferred
Uncertainty and limitations treated consistently across options	Whether one option's limitations receive greater prominence while comparable limitations of another are omitted
Speed of effect presented consistently	Whether the slower expected effect of vaccination and the differing evidence concerning culling and TVR are consistently represented
Consistency of presentation across the three options	Whether each receives broadly equivalent treatment in explaining benefits, limitations and evidential strength

Table 24. Accuracy and consistency of evidential presentation: RAG assessment

Assessment criterion	Benchmark	RAG	Basis for assessment
Accurate description of each intervention	DAERA full consultation and supporting scientific evidence	**Amber**	TVR and vaccination-only are described reasonably clearly on their principal option pages. By contrast, the principal non-selective culling page repeats the preceding generic text on duration, review and monitoring rather than explaining what the intervention involves. A definition is provided later in the glossary, but the three options are not introduced equivalently.
Preservation of important scientific qualifications	DAERA Scientific Opinion and Annex VIII	**Red**	Important qualifications are presented unevenly. Vaccination-only explicitly notes that vaccination does not treat already infected badgers and that disease reduction may take a long time. Equivalent qualifications concerning the TVR evidence, including its single intervention area, absence of replicate untreated controls and lack of demonstrated cattle-incidence effect, are not communicated. [681]
Direct cattle-outcome evidence presented consistently	DAERA Scientific Opinion; replicated culling trials; NI TVR evidence	**Red**	The Summary does not explain that proactive culling has direct replicated field evidence of reductions in cattle bTB herd incidence. Conversely, it does not tell readers that the NI TVR study did not demonstrate an impact on cattle herd incidence. This removes an important distinction between the evidential bases of the options. [682]

[681] DAERA (2026), *Bovine Tuberculosis (bTB) Consultation on Wildlife Intervention Options – Easy Read Summary*, pp. 15–18; DAERA (2025b), *DAERA scientific opinion on the peer reviewed evidence on badger intervention in relation to the control of bovine tuberculosis*, Annex VII, TVR section and Scientific Opinion Conclusion 6. DAERA's Scientific Opinion identifies the lack of replicate and control areas in the Northern Ireland TVR study and concludes that it was not of sufficient scale or design to demonstrate a statistically significant impact on cattle bTB. The Easy Read Summary does not communicate these study-design qualifications, while its vaccination-only section explicitly notes that vaccination does not treat already infected badgers and that disease reduction may take a long time.

[682] DAERA (2025b), *Scientific Opinion*, Annex VII, Proactive Culling section, Scientific Opinion Conclusion 5, and TVR section, Scientific Opinion Conclusion 6. The Scientific Opinion identifies direct field evidence that sustained proactive culling can reduce cattle bTB, while recognising that the Northern Ireland TVR

Assessment criterion	Benchmark	RAG	Basis for assessment
Diagnostic uncertainty represented accurately	NI TVR/DPP evidence; DAERA Scientific Opinion and Annex VIII	**Red**	Page 15 correctly refers to badgers that "test negative". Page 16 then describes those animals as "Healthy badgers". A negative DPP result does not establish that a badger is uninfected because test sensitivity is imperfect. The wording therefore gives greater certainty than the diagnostic evidence supports. [683]
Observed, modelled and inferred outcomes distinguished	DAERA Scientific Opinion and Annex VIII	**Red**	The Summary does not consistently tell readers whether statements about intervention benefits arise from direct field evidence, modelling or inference. In particular, it states that TVR can "help to reduce disease levels in the badger population over time", but does not distinguish that badger-level statement from the separate and materially greater uncertainty concerning cattle-level outcomes, nor consistently identify where projected benefits derive from field evidence, modelling or inference.
Uncertainty and limitations treated consistently across options	DAERA Scientific Opinion and Annex VIII	**Red**	Vaccination-only receives clear qualifications concerning infected badgers remaining in the population and the potentially long time to reduce disease. The TVR section does not provide comparably important qualifications concerning diagnostic performance, study design or cattle outcomes; the culling section gives greater prominence to welfare, removal without testing, delivery and public-confidence issues than to the strength and limitations of its efficacy evidence.

study did not demonstrate an equivalent cattle-level effect. See also Donnelly et al. (2006) and Griffin et al. (2005).

[683] Arnold, M.E. et al. (2021), 'A Bayesian analysis of a Test and Vaccinate or Remove study to control bovine tuberculosis in badgers (*Meles meles*)', *PLoS ONE*, 16, e0246141; DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII, TVR section. Arnold et al. estimated whole-blood DPP sensitivity at 69% (95% CrI 48–88%) and specificity at 98% (95% CrI 96–99%). A negative DPP result therefore does not establish that a badger is uninfected.

Assessment criterion	Benchmark	RAG	Basis for assessment
Speed of effect presented consistently	DAERA Scientific Opinion and Annex VIII	**Amber**	The Summary appropriately says culling may reduce disease pressure more quickly than vaccination-only and that vaccination may take a long time. However, it does not explain the greater uncertainty surrounding the timing of any cattle-level benefit from TVR, so readers cannot make a fully like-for-like comparison of expected speed. [684]
Consistency of presentation across the three options	DAERA underlying evidence suite; consistent evidential presentation	**Red**	The three options are not presented using a common structure covering what the intervention involves, what has been demonstrated, what is modelled or inferred, major uncertainties and expected speed. This creates material differences in the amount and type of qualification communicated to Easy Read users.

[684] DAERA (2025b), *Scientific Opinion*, Annex VII, TVR section and Summary on TVR; DAERA (2026b), *Badger Intervention Options Analysis Paper*, Annex VIII, paras. 6.1.3–6.1.6 and Table 28; Budgey, R. and Smith, G.C. (2019), *A simulation model to assess the relative performance of wildlife intervention options on bTB in wildlife and cattle in Northern Ireland*. DAERA's Scientific Opinion notes that the imperfect DPP test and BCG efficacy may mean that TVR takes longer to achieve an equivalent endpoint to proactive culling, although the modelling is equivocal, while direct cattle-level timing has not been demonstrated for TVR. Vaccination-only is expected to act more gradually.

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