

End of Year Report for DAFMs Wildlife Unit for 2021

Introduction

This is the end of year report on the activities of the Department of Agriculture, Food and the Marine's (DAFM) Wildlife Unit covers the period 1st January 2021 to 31st December 2021.

Overview and Trends in Bovine TB

The herd incidence stabilised from 4.38% in 2020 to 4.33% in 2021. The number of reactors also stabilised from 22,614 to 20,931. This followed on from a marked upward step-change in bTB levels in 2020. The Minister has restated that stakeholders must continue to work together through the TB Forum to manage the risk more effectively across all transmission routes.

Table 1 Levels of bovine TB between 2016 and 2021

Year	Incidence	Number of bovine TB reactors
2016	3.27%	16,914
2017	3.47%	17,266
2018	3.51%	17,491
2019	3.72%	17,058
2020	4.38%	22,614
2021	4.33%	20,931

The reasons for the recent increase are multifactorial and relate to a combination of national and local factors. Recent research has indicated that bTB risk is greater in large herds, herds with a larger geographical footprint, trading herds and in dairy herds^{1,2,3,4}. The proportion of reactors within dairy herds continued to increase in 2021. This has coincided with a large expansion of the national dairy herd since 2015. Wildlife is also a factor as increased prevalence of *M. bovis* will result in all susceptible species within the transmission cycle being increasingly exposed. This led to an increase in requests to remove badgers in both vaccination and non-vaccination zones. These requests were, as is always the case, on foot of epidemiological enquiries in the TB breakdown herds. Recently published papers also indicated that possible disturbances to local wildlife through road-building or forest clear-felling are also associated with an increased risk of bovine TB. In 2021 the Scientific Working Group of the TB forum completed a scientific opinion to the TB Stakeholders Forum relating to transmission of TB entitled "What is the proportional contribution of cattle-to-cattle, badger-to-cattle, and deer-to-cattle TB transmission to bovine TB in Ireland?"⁵ This is available on www.bovinetb.ie.

Each bTB breakdown is investigated by a veterinary inspector to identify the source of infection. In the case of outbreaks involving two or more standard reactors, an investigative veterinary epidemiology visit takes place. In addition to identifying the likely source and spread of disease on that farm, the herdkeeper is advised on how to eliminate infection and on what necessary measures are required to assist in reducing the risk of recurrence. Within each county, the TB programme focuses on wildlife protection through vaccination, badger removal in response to badger sourced bTB, how disease is distributed in the area, contiguous programmes, gamma interferon testing, cleansing and disinfection, testing compliance and frequency and isolation of reactors.

Attaining TB-free status remains critical from a farm family profitability and sustainability perspective and from a trade perspective at national and at international level. Every bTB restriction represents a significant emotional and financial challenge to the farm family concerned.

Whole Genome Sequencing

Whole Genome Sequencing (WGS) technology continues to advance and become more accessible, and it has given specific metrics on TB transmission. Recent WGS studies confirm the conclusions of earlier epidemiological studies of the transmission of *M. bovis* between badgers and cattle in endemic TB areas in Ireland, Britain and France^{6, 7, 8, 9, 10, 11}. Some of these studies have indicated the direction of transmission of disease between cattle and badgers. Inter-species transmission was demonstrated to occur at different rates in each of the areas examined which indicates that the density of each species, the prevalence of disease in each species and the opportunities for disease transmission are likely to be important factors in disease transmission. The DAFM TB laboratory in the Central Veterinary Research Laboratory (CVRL) has a new unit dedicated to WGS and are currently applying the technology to over 1,000 samples per annum which is like to reveal new insights into disease transmission in the coming years.

Badger Vaccination Policy

DAFMs policy regarding badger vaccination is to introduce badger vaccination in suitable candidate areas in order to protect both badgers and cattle from future outbreaks of TB caused by *Mycobacterium bovis*. Research has demonstrated the efficacy of badger vaccination. In a field trial over 755 Km² in County Kilkenny using the BCG vaccine and a blind placebo demonstrated that badger vaccination, with an efficacy of 60%, could lower the R value (reproductive ratio) of badger-to-badger TB spread from 1.22 to 0.5^{13,14,15}. Furthermore, in 2020, vaccination has been demonstrated as comparably effective and thus as an appropriate replacement for culling¹⁶. The Non-Inferiority Trial was established in 7 areas of the country over 7 years, finishing in 2017. The efficacy of BCG vaccination in reducing the spread of *Mycobacterium bovis* between badgers had been proven in the Kilkenny trial, this subsequent trial sought to examine if vaccinating badgers would keep spread to cattle suppressed. A large part of a county was subject to badger vaccination and was compared to culling badgers (in response to bTB breakdowns) in another similarly sized part of the county. While TB increased in some of the trial areas the overall result of the trial was that badger vaccination was not inferior to badger culling in terms of spread to cattle.

Suitable areas for the initial switch to vaccination are those where badger population density is relatively low^{17,18,19} and there is low prevalence of bTB in the local cattle population. With the transition to vaccination, the aim is to increase the population of BCG-vaccinated badgers in areas that previously underwent a continued removal of badgers. The previous removal was designed to maintain an equilibrium population of badgers locally at a density of circa 0.4-0.5 badgers per Km². Each sett recorded

on the Wildlife Unit information system is uniquely numbered, and the number associates the sett with the quartile (2Km X 1.5Km) in which it is located. The non-inferiority trial which demonstrated that, subsequent to a period of removal, introduction of vaccination to an area is not inferior to badger removal in terms of the prevalence of bovine TB in that area. Switching an area from removal to vaccination is based on the same criteria – the expectation that initial badger densities will be low due to pre-existent removal and low bTB prevalence in the cattle population. As the area is subject to vaccination the badger population increases over time. It is therefore critical to the success of badger vaccination that DAFM has maximised the number of setts identified within a vaccination area to ensure penetration of as large a proportion of the total badger population as is possible.

Careful consideration, in consultation with each Regional Veterinary Office, is given to the areas switched to vaccination. Since the roll-out of vaccination in 2019/2020 most areas have had low-level issues with clustering of bovine TB mediated by badgers. There have been a low number of problematic areas. In some of these areas the badgers removed under permit have had high bTB prevalence of up to 60%. This is not due to a failure of vaccine per se but rather it is as a result of high underlying prevalence at the point of introduction of vaccination or a failure to penetrate the overall local badger population due to gaps in the badger sett coverage. The latter point is the underlying precept to the ongoing campaign to engage farmers to help DAFM to map additional setts. In 2021 a new mobile app was made available to farmers on www.bovinetb.ie to allow farmers notify DAFM of badger habitats on their land. This has been very successful with over 600 notifications to date. The number of new setts added to the database in 2021 was 4,749. The majority of these were in vaccination areas.

Table 2. Number of new setts added to the database in the last 5 years (2017-2021)

Year	Number of new badger setts added
2017	824
2018	1,549
2019	1,383
2020	2,964
2021	4,749

As reported previously, the Minister, in 2018, announced that badger vaccination would roll out incrementally over time, with vaccination gradually replacing the removal of badgers as the default position in response to TB in cattle, noting that some level of badger culling in response to severe bTB episodes would still be required in places. The roll out that was reported previously was progressed to a large extent in the last few months of 2019 and early 2020 when the area of the country subject to vaccination was doubled. Currently there are 21,171 Km² subject to badger vaccination, up from 19,079 Km² at the end of 2020. A map of the area under vaccination at the end of 2020 and 2021 is shown in the appendices.

Vaccination requires both a veterinary and technical resource and, as such, it is more expensive than culling. Therefore, the areas under vaccination will be constantly under review regarding the availability of resources in each Regional Veterinary Office. Vaccination is implemented at the level of the quartile. A

quartile is a rectangular area measuring 2Km x 1.5Km (3Km²). The grid overlay used by the Wildlife Unit is based upon the Ordnance Survey Ireland (OSI) orthophotography (see appendices) contains an overall total of 24,874 individual quartiles. Of the 24,874 quartiles that overlay any part of Ireland, 7,057 (28%) quartiles have all of their 3Km² of land in the vaccine programme. It is intended to continue to increase the area under vaccination in coming years.

Wildlife Unit Research

A large multi-site and multi-annual research project involving DAFM, UCD and University of Wageningen continued throughout 2021. There have now been 4 sweeps of the study areas with 4 more planned through 2022 and 2023. This research involves TB testing all badgers captured for vaccination in 9 areas around Ireland in capture sweeps over 4 years. The purpose of the research is to monitor vaccinated badgers' potential infection status over time, estimate badger population growth in vaccination areas and vaccination population penetration and the local prevalence of TB in badgers. This will help to inform mathematical models of risk associated with spread from badgers at the local (farm) level as well as providing valuable ecological indices relating to badger population growth. Each of the sites is 20 quartiles in size. In addition to the sett-side test, further testing on blood samples will take place. Another aspect of this study which is informed by the field results involves optimising mathematical modelling of disease transmission between, and within, badgers and cattle and is being progressed in the University of Wageningen.

A collaborative study involving UCLM-CSIS (Spain), CVERA and NDCC modelling the risk associated with road building and TB risk in cattle herds was published (Barroso 2022). It found that herds within 1Km of the M17/M18 were at increased risk of bovine bTB during the construction phase of the road-build. It was hypothesised that badger social group disturbance may be the mechanism that resulted in the increase in risk.

A study led by the Laboratory of Wildlife Ecology and Behaviour, UCD completed a study modelling the risk of TB in cattle herds subsequent to local clearfelling of forest. The results showed that the interaction was dynamic, leading to an increase or decrease of the relative bovine TB risk depending on the distance from the clearfell to the farms and when the clearfell operations occurred. A cohort study was also published subsequent to peer review which demonstrated that herds had an increased risk of having a TB breakdown for up to one year after the forest clearfell period.

The New TB Strategy

In 2021 the Bovine TB Eradication Strategy was launched by the Minister. The Strategy is based on the 4 principles outlined in the National Farmed Animal Health Strategy. These are:

1. Working together to improve animal health standards,
2. The roles and responsibilities of all stakeholders must be clear,
3. The principle of 'prevention is better than cure' must be consistently applied, and
4. animal health programmes will have clear objectives, and will be sustainably and appropriately funded.

Implementation of the TB strategy is overseen by the TB Stakeholder Forum group with support from working groups on science, implementation and finance. Each group reports to TB Forum over the course of the year.

The main actions outlined in the strategy are:

Preventing spread from herds with a high risk of recurrence;

Enhanced actions to clear infection in herds in an extended breakdown;

Tailored action plans for areas of high TB incidence;

More effective and accessible communication taking account of input from behavioural scientists;

Reducing the risk posed by badgers and deer;

Supporting and empowering farmers to reduce the TB risk to their animals by making informed choices.

Most actions set out under the current TB strategy have either been implemented or are advancing well towards implementation. The current stakeholder structures are working well, particularly the Implementation Working Group and its communications sub-group.

To make substantial further progress on TB in the 2023-2025 period, additional steps to build on the current strategy will be needed and these are the subject of ongoing discussion with the stakeholders.

To date there have been 14 meetings of the Forum, 8 meetings of the Scientific Working Group, 16 of the Implementation Working Group and 11 meetings of the FWG

Stakeholder Engagement

There were many press releases and farmer interactions with the farming media during 2021. Many of these continued to focus on spread of TB from wildlife. There is also ongoing pressure from some farming stakeholders to increase badger culling and in 2021, the farm organisations sought extra funding to be dedicated to badger control in Ireland

DAFM continued the campaign to seek greater farmer involvement in biosecurity around the risk of TB spread from badgers. Farmers were texted and asked to aid in identifying and fencing off badger setts on farmland in relation to vaccination. The app mentioned above was launched and a collaboration between DAFM, Animal Health Ireland and cattle veterinary practitioners called TB TASA gave practical biosecurity advice to farmers to reduce their risk of ongoing bTB breakdowns

Wildlife Unit Software

Every badger in the vaccination area is now being recorded electronically when it is captured. A badger was captured in 2021 which was first captured, microchipped and vaccinated in 2014. This is a good indication of the health benefits of the badger vaccination programme. It is hoped that the capture/recapture data available in the database will soon be sufficient to provide insights into badger populations throughout the country.

Vaccination Data

As mentioned, population penetration is crucial in attaining herd immunity. In 2021, approximately 60% of badgers being captured in vaccination areas were new captures and had not been vaccinated previously. This is 4% less than 2020 following a 6% reduction that year on 2019. This percentage is expected to fall more over time as greater population penetration is achieved. Of the 6,586 badgers that were recorded in the vaccination area last year, 3,958 were vaccinated with BCG, 353 were removed for epidemiological reasons, 28 were either deceased at capture or were found dead on land or roads within the vaccination area, 1,483 had been previously vaccinated (termed 'goodgers'), 749 had been captured within the previous month, 4 died of complications from anaesthesia and 1 was euthanised for health reasons. See the table in the appendix for a county-by-county breakdown. The ongoing trend is for more badgers to be vaccinated and less badgers to be removed. In terms of the population penetration of vaccination in any given area, the goodger rate is a key metric. A high goodger rate is reflective of good population penetration. It is expected that once an area is recruited to vaccination for a number of years and has identified a majority of the setts that this will plateau at a high level.

Removal of Badgers

In non-vaccination areas, 5,868 badgers were captured and removed. This was an increase from 4,723 in 2020 and is reflective of the large increase in TB breakdowns that occurred up to 2020. Details of areas where all badgers removed or vaccinated during 2020 under the terms of the conditions specified in the licences issued to DAFM by the National Parks and Wildlife section of the Dept. of Arts, Heritage and the Gaeltacht are outlined in the Appendices.

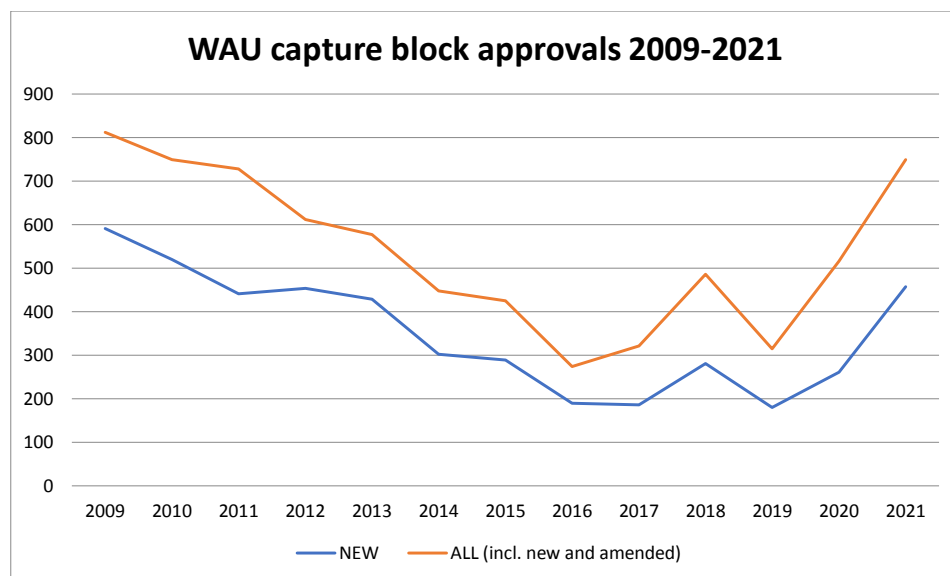
The expanded table which first appeared in the 2011 report is again included with the respective bar-charts for 2021 activities. Approvals for badger removals are actioned through the use of capture blocks which relate to a TB breakdown in a herd and the setts relevant to that herd. The approvals are sub-divided per county areas into first time approvals and approvals for setts added to areas/blocks that were approved for removal in earlier years. First time approvals represent new foci of infected herds, whereas additions to areas previously approved for capturing arise due to clustering of tuberculosis (TB) in herds adjacent to areas that had earlier instances of infected herds detected which is a characteristic of how TB spreads to other herds in local areas.

In total during 2021, the UCD Centre for Veterinary Epidemiology and Risk Analysis (CVERA) approved setts for removal in 749 areas where DAFM staff sought permissions based on agreed criteria. These criteria require that a herd must first have had a breakdown of at least 3 standard interpretation reactors or, in the opinion of the Superintending Veterinary Inspector locally, are very definitely due to *M. bovis*, and that the investigation into the source of the disease outbreak in cattle found it was not due to purchased infected animals. Of these 749 areas, 457 were new areas where capturing had not been undertaken previously since the current Wildlife program commenced in 2003. The information in Table 2 and in Figure 1 outlines trends since 2009.

Table 3 Number of new and total approved areas for removal in each year 2009-2021

	NEW	ALL
2009	591	812
2010	520	749
2011	441	728
2012	454	612
2013	429	577
2014	302	448
2015	289	425
2016	190	274
2017	186	321
2018	281	486
2019	180	315
2020	261	516
2021	457	749

New and total approved areas for removal in each year 2009-2021



The basic tenet on which the Wildlife program is based is that a majority of new herd breakdowns are due to previously uninfected cattle herds falling victim to bovine tuberculosis (bTB). This, despite removal of the infected cattle, perpetuates a cycle locally of cattle and badgers re-infecting each other and leading to chronic disease problems that become endemic in areas populated by both species. Over the years, the

reduction in the rate of herd breakdowns due to bTB since the current policy of targeted reductions in densities of badgers began can be attributed in the main to the lowered density of badgers that continued re-trapping in high incidence bTB areas results in. This in turn has led to a slowing in the rate of the addition of areas subject to removal. Expansion of vaccination has resulted in a contraction of the area subject to removal alone, while expanding the area in which vaccination is carried out. The increase seen in 2021 is reflective of the ongoing increase in TB levels over the previous years.

To recap on how removal is organised, the approach is that out of roughly 48,000 setts on DAFMs database, at least one badger has been removed at roughly 20,000 setts, and each year's re-capturing is focused on these setts/areas. Because badger social groups typically use between 4-6 setts, one of which is a main sett, the roughly 50,000 setts on the DAFM database represent perhaps 7-10,000 badger social groups.

Removal Approval Process

Following a breakdown where badgers are identified as contributing to the disease outbreak, DAFM staff may seek approval for removal of badgers at any known main sett located within 1.5Km of the affected farm or any known non-main sett located within 2Km of the affected farm. The reasoning behind this rule is to permit DAFM staff to remove badgers in social groups likely to be using lands in common with infected cattle herds. Irish research by Byrne et al.⁷ has confirmed that badgers, in the main, forage, on lands within 1.5Km of the main sett. While DAFM staff have permissions to capture badgers at setts that are within 1.5-2Kms of the farm experiencing a bTB outbreak, the capturing programs most commonly target setts that are within a 1Km radius of the affected farms. When DAFM staff survey areas, they actively seek information on badger habitats/sett locations on lands adjacent to the breakdown farms. A passive survey, in the form of a mail shot to farms on DAFMs Land Parcel Identification System (LIPS) that are within 1Km (i.e. farms in receipt of EU payments) is also used to seek information regarding other sett locations. A majority of capturing programmes focus on setts that are within the first 1Km radius of affected farms, and rarely does capturing extend to the full 2Km limit.

Activity Scoring

On an ongoing basis each year (a program which began in Feb 2011) the setts where one or more badgers have been removed are visited and rated using an activity score. Based on the activity observed during these evaluations, the subsequent capturing program targets the highest density areas. Unfortunately, our officers have reported a reduction of activity at a number of vaccination area setts. This may be caused by natural phenomena but there are anecdotal reports of an increase in illegal badger persecution throughout Ireland, especially since the coronavirus lockdowns began.

Permit to Remove in Vaccination Areas

Bovine TB breakdowns continue to occur in some areas under vaccination and can be associated with spread from the environment thus indicating badger involvement. In this scenario the Veterinary Inspector managing the TB breakdown from an epidemiological perspective completes an application where they demonstrate that infection from various means other than spillover from wildlife is very low risk. They pinpoint the fragments where introduction has most likely occurred. The Wildlife Unit (WU) Superintending Veterinary Inspector (SVI) then assesses the application and, if successful, approves a re-

survey of the area. Following a re-survey of the area the WU SVI recommends the removal of badgers from within a more restricted zone of 1Km of the affected parts of the farm. Depending on the epidemiological situation locally and the length of time under vaccination the recommendation to CVERA is at the level of a) every second unvaccinated badger which is the usual entry point, b) every unvaccinated badger, c) every badger or d) every test positive badger. The last category is continuing to be evaluated through the research project mentioned above. No category c permits have been sought or issued. CVERA assess the applications and issue an end-dated permit. In 2021, 353 badgers were removed under such permits. This is an increase from 258 in 2020 as TB levels had risen and the vaccination scheme has encroached on some areas where TB prevalence in cattle has been higher. The disease situation in badgers removed in these areas is being closely monitored. We vaccinate to protect badgers and cattle from TB and remove where there are breakdowns epidemiologically linked to TB breakdowns is a summary of the policy.

Switching removal areas to vaccination areas

The primary objective of the Wildlife Unit when it was established was to address any involvement of badgers in tuberculosis breakdowns in herds in areas where badgers were also implicated. Progress has been made in the levels of bTB in cattle herds since DAFM's Wildlife programme commenced, and it is acknowledged that the major driver of these improvements have been facilitated by DAFM's wildlife strategy and by the work done by Wildlife Unit staff assisted by operatives engaged through the Farm Relief Network.

Discussion

Bovine TB eradication has been ongoing in Ireland for more than 50 years. TB in all species, is a chronic disease and the pathogen that causes TB, *Mycobacterium bovis*, is particularly well adapted to evading detection by eliciting an unusual cell-mediated immune reaction that does not readily lend itself to common diagnostic methodologies. It is also well adapted to live in the host species for protracted periods of time causing a very slow chronic disease. Despite this, many countries, using the same eradication techniques in the cattle population as Ireland, have been successful in eradicating TB. Following studies into badger involvement in bovine TB^{20,21,22,23,24,25}, Ireland set up a badger removal programme in the early 2000s. This has helped halve Ireland's incidence of bovine TB in the last 20 years but, unfortunately, the disease has reached another state of equilibrium in terms of ongoing disease prevalence and disease levels have stagnated since 2013 and subsequently rose. A recent publication²⁸ examines why the British Isles have struggled to fully eradicate TB compared to other European countries and concludes that many ecological and environmental factors have an additive impact. In Ireland we, in broad terms, through the wildlife programme, address the spread from wildlife but the main focus of the renewed TB strategy²⁷ is in relation to other controls and stakeholder involvement. It must be noted that the TB problem in the Irish bovine herd is increasingly to be found in dairy cattle. Dairy herds comprise approximately 17% of Irish cattle herds. Over half of the breeding animals are in dairy herds.

The Wildlife Unit vaccination program ultimately aims to have high levels of BCG vaccinated badgers in "high TB risk, high animal density" areas. The areas where badgers are removed by DAFM/FRS colleagues represent the areas where herds experienced large breakdowns of tuberculosis in the past and which resulted in local populations of badgers having their sett locations searched for and recorded on DAFM's GIS systems/databases. Following on from the identification of setts where the local badger social groups colonised lands also used for grazing by herds infected with bTB, capturing programs commenced that

maintain the density of badgers locally at around 0.5 badgers per Km². These interventions have been successful in reducing the need for expansion of the Wildlife Unit program into new areas, as each year the WU removal areas only expand by circa 1% per year and these expansions are largely due to new foci of infections arising via animal movements (predominantly due to cattle, but also due to badgers and deer).

The study previously referred to¹ where an oral presentation of BCG vaccine was evaluated in badgers showed that vaccinated badgers had longer intervals to seroconversion, which is considered to be a proxy measure for infection. The study also demonstrated that TB lesions were substantially lower in vaccinated badgers as compared to unvaccinated badgers. A second study using blood samples from badgers in the same Kilkenny study by Aznar et al.¹⁴. This study estimated that BCG vaccine had an efficacy of 59%, which means vaccination is likely to protect roughly 6 out of every 10 badgers vaccinated with BCG. The authors further suggested that “these results imply that with vaccination coverage in badgers exceeding 30%, eradication of *M. bovis* in badgers in Ireland is feasible, provided that the current control measures also remain in place”. This study also demonstrated that the R_0 (a concept which has become mainstream with Covid-19) is reduced in vaccinated badgers from over 1 (whereby TB persists within the badger population) to 0.5 (whereby, on average, it takes 2 infected badgers to infect another one).

As outlined in earlier reports, DAFM commenced field testing BCG, administered intra-muscularly, in wild badger populations in Longford in 2011. Similar vaccination programs commenced in Cork, Galway, Monaghan, Tipperary and Waterford and in Louth during 2012 and 2013. The Non-Inferiority Trial¹⁶ was established in 7 areas of the country over 7 years, finishing in 2017. With the efficacy of BCG vaccination in reducing the spread of *Mycobacterium bovis* between badgers proven in the Kilkenny trial, this trial sought to examine if vaccinating badgers would keep spread to cattle suppressed. A large part of a county was subject to badger vaccination and was compared to culling badgers (in response to TB breakdowns) in another similarly sized part of the county. While TB increased in some of the trial areas the overall result of the trial was that badger vaccination was not inferior to badger culling in terms of spread to cattle.

Combining the findings of DAFM funded/supported studies undertaken to date, all similarly conclude that vaccination using BCG offers a degree of protection to badgers in the wild, and that vaccination of badgers will have an important role in the end game of finally eliminating bTB from cattle in our country and eventually also from badgers.

Conclusions

The early work estimating numbers of badger social groups by Byrne et al.²⁶ confirmed that badger populations are not in any short- or medium-term threat at the county or national level. Using modern modelling methodologies recent research suggested that badger populations in Ireland would rise from approximately 63,000 to 93,000 as we move wholly to vaccination. How badger populations recover once removal is reduced is part of the current research project mentioned above and it will continue to be the focus of DAFM in the coming years as the effectiveness of badger vaccination is measured and verified. Culling badgers will continue to be necessary in certain areas which experience ongoing or new outbreaks of bovine tuberculosis. Vaccinating badgers with BCG will protect a majority of susceptible badgers from succumbing to a future infection with *M. bovis* but will not cure a previously infected badger. In 2022 DAFM hope to launch a programme to target younger badgers which cannot be captured in restraints to ensure badgers receive protection from disease before they become infected. The success of vaccination will be improved by ensuring bTB levels in badgers is lowered in so far as that is possible prior to commencing vaccination.

The other key element is ensuring an acceptable level of population penetration through ongoing recruitment of hitherto unknown setts to the vaccination effort. The key determinant of the future levels of tuberculosis in cattle and in badgers will be the transmission rate from infected individuals to susceptible ones. The continuing cattle test and removal policy will ensure transmission between cattle and from cattle to badgers is lowered and vaccination of badgers with BCG will do the same for transmission from badger to badger and from badgers to cattle. Disease prevalence in both species will require to be monitored on an ongoing basis so that policies can continue to be relevant, effective and responsive.

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Appendix

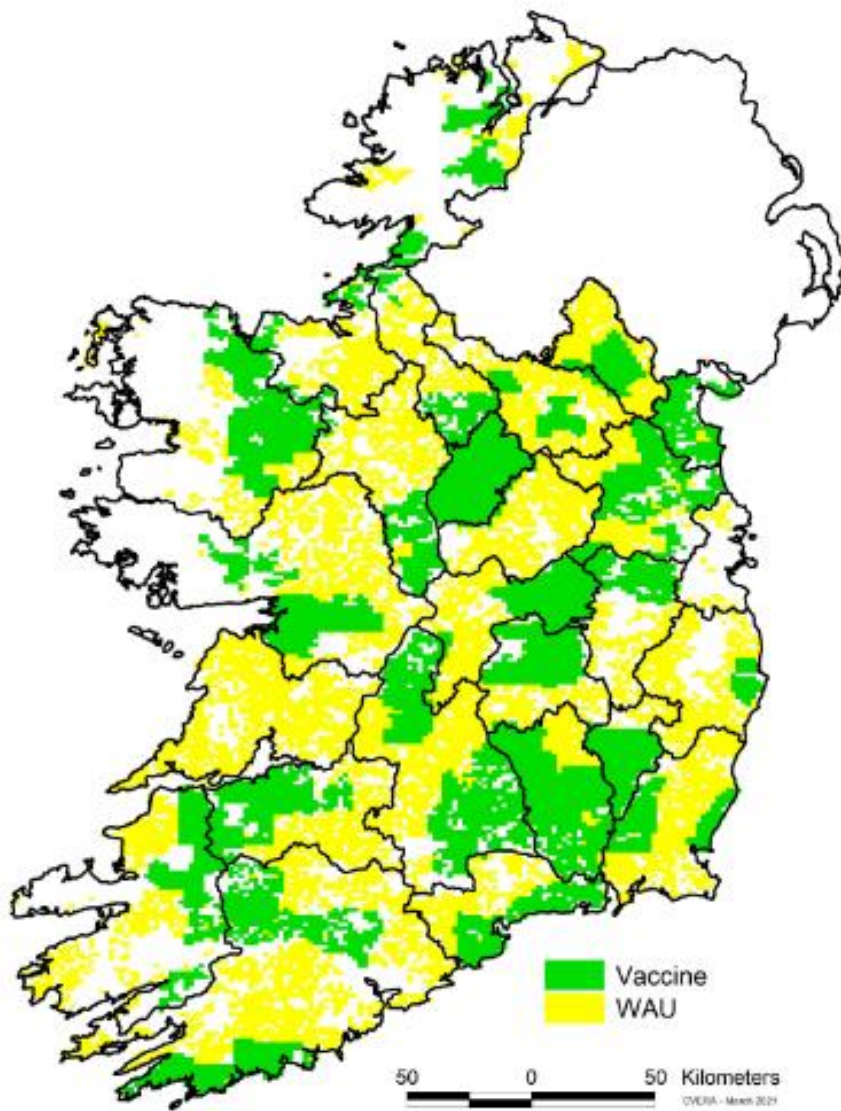
Table 4 Results of captures in Vaccination areas in 2021

	Deceased Found Dead Road Kill	Epidemiology Removed Under Permit	Goodger	Newly Vaccinated	Recapture (30 days)	Grand Total
Carlow			9	126	23	158
Cavan	1	6		2		9
Clare				23		23
Cork North	7	66	84	226	26	409
Cork South		25	33	114	13	185
Donegal	5	9	38	150	57	259
Dublin		21	62	172	40	295
Galway	2	5	24	151	23	205
Kerry	2		49	238	51	340
Kildare		19	283	369	147	818
Kilkenny	1	4	18	204	31	258
Laois		4	21	234	26	285
Leitrim	1	6	28	107	4	146
Limerick		9	175	288	17	489
Longford	6	25	128	233	35	427
Louth		26	30	216	22	294
Mayo	1	13	2	4		20
Meath	2	11	52	128	8	201
Monaghan		34	61	92	6	193
Offaly	1		23	91	11	126
Roscommon			1	23	4	28
Tipperary North	2	44	92	141	34	313
Tipperary South		26	162	244	61	493
Waterford	1		86	115	32	234
Wexford			31	222	55	308
Wicklow East			2	45	23	70
Total	32	353	1494	3958	749	6586

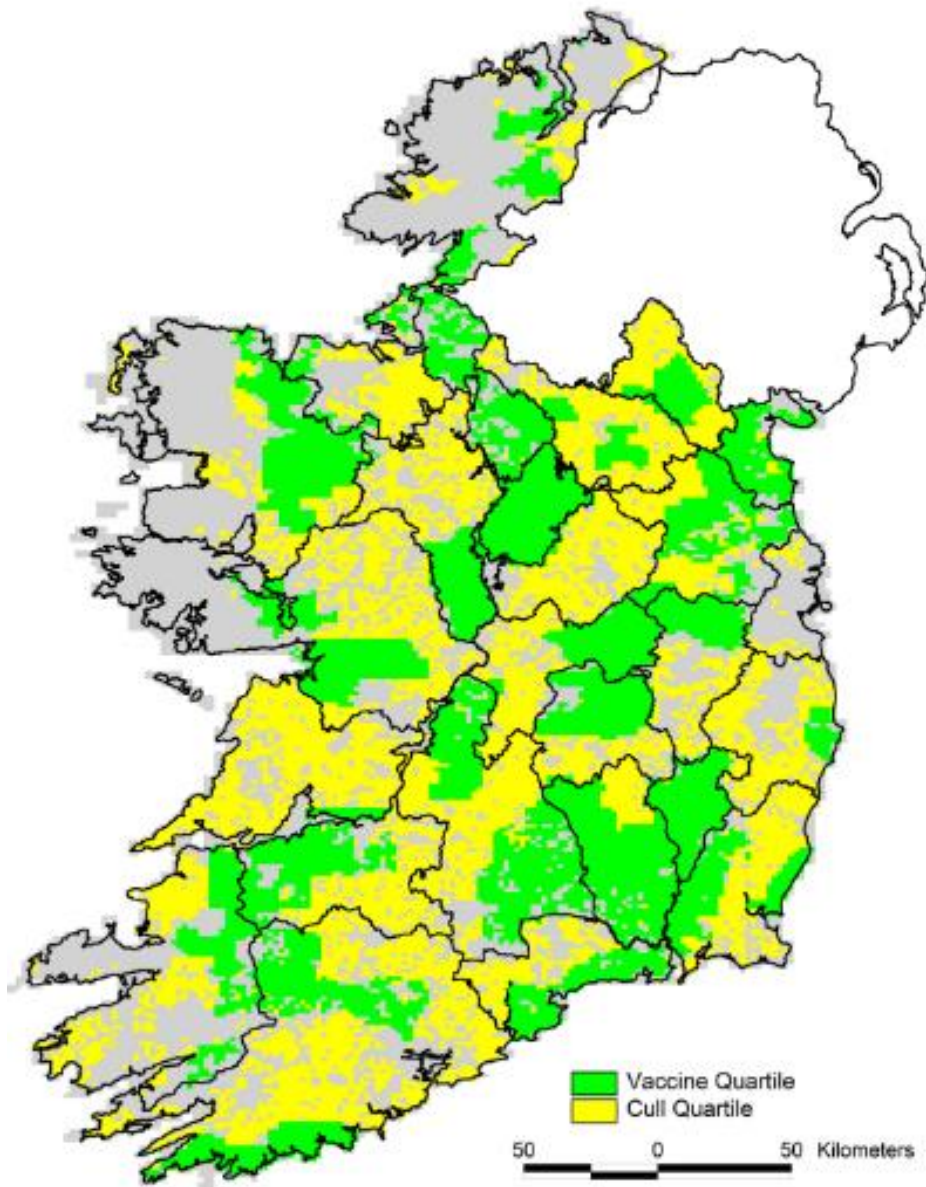
Table 5 Badgers Removal Area Removals per DVO area in 2021

<u>DVO Office</u>	<u>Total Badgers</u>
Carlow	3
Cavan	460
Clare	531
Cork North	347
Cork South	386
Donegal	159
Dublin	8
Galway	202
Kerry	329
Kildare	173
Kilkenny	42
Laois	143
Leitrim	0
Limerick	205
Longford	0
Louth	12
Mayo	146
Meath	174
Monaghan	275
Offaly	185
Roscommon	302
Sligo	286
Tipperary North	383
Tipperary South	75
Waterford	122
Westmeath	454
Wexford	242
Wicklow East	119
Wicklow West	105

Map showing National Quartile Distribution per County 2020.

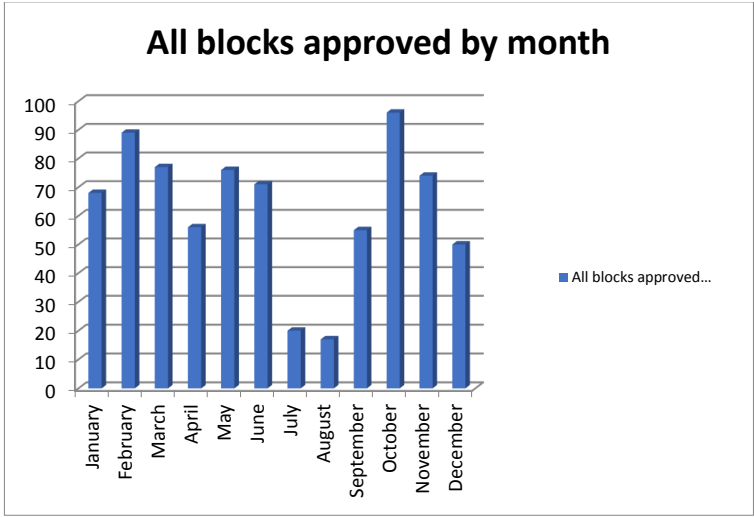


Map showing National Quartile Distribution per County 2021.

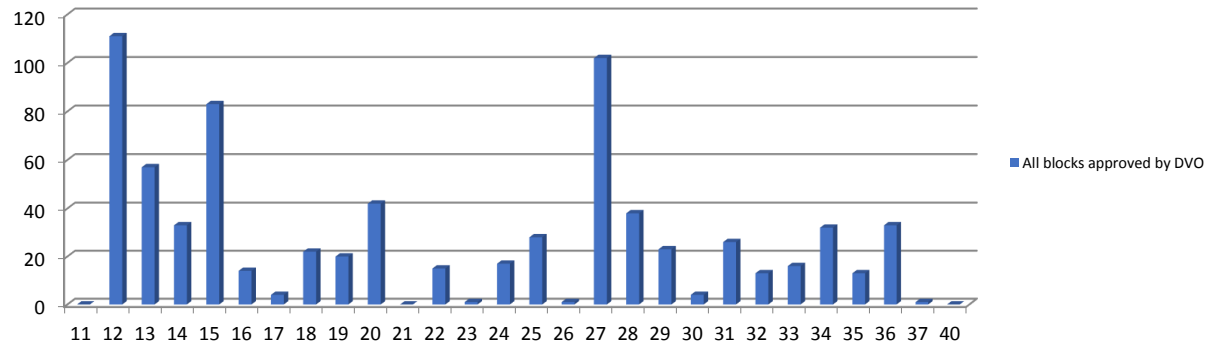


ALL APPROVALS BY MONTH (new approvals and amended)

2021	11	12	13	14	15	16	17	18	19	20/39	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	40	TOTALS
January	0	16	4	7	5	0	0	4	2	1	0	2	0	0	4	0	1	9	1	0	5	2	2	2	0	1	0	0	68
February	0	14	10	1	4	2	0	2	3	14	0	1	1	4	1	0	1	11	8	0	2	0	0	7	2	1	0	0	89
March	0	11	7	2	3	3	0	2	0	8	0	2	0	1	5	0	4	6	4	0	5	4	0	5	0	4	1	0	77
April	0	9	8	0	3	3	0	3	0	3	0	2	0	2	0	0	3	3	2	0	0	0	2	1	0	12	0	0	56
May	0	14	1	2	4	1	1	1	3	8	0	2	0	0	1	0	16	6	1	0	3	0	4	8	0	0	0	0	76
June	0	7	1	0	17	0	0	4	1	1	0	1	0	1	0	1	24	1	1	4	2	0	2	0	1	2	0	0	71
July	0	3	1	0	7	0	0	0	3	0	0	0	0	1	2	0	1	0	0	0	0	2	0	0	0	0	0	0	20
August	0	1	3	2	4	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	17
September	0	10	9	0	16	2	0	0	1	1	0	0	0	1	0	0	5	0	0	0	1	2	0	6	0	1	0	0	55
October	0	16	0	5	11	3	3	4	0	4	0	3	0	3	11	0	14	2	0	0	4	2	2	0	5	4	0	0	96
November	0	3	6	10	9	0	0	2	2	2	0	0	0	2	2	0	26	0	3	0	0	0	0	1	3	3	0	0	74
December	0	7	7	4	0	0	0	0	0	0	0	2	0	2	2	0	7	0	3	0	4	1	3	1	2	5	0	0	50
TOTALS	0	111	57	33	83	14	4	22	20	42	0	15	1	17	28	1	102	38	23	4	26	13	16	32	13	33	1	0	749

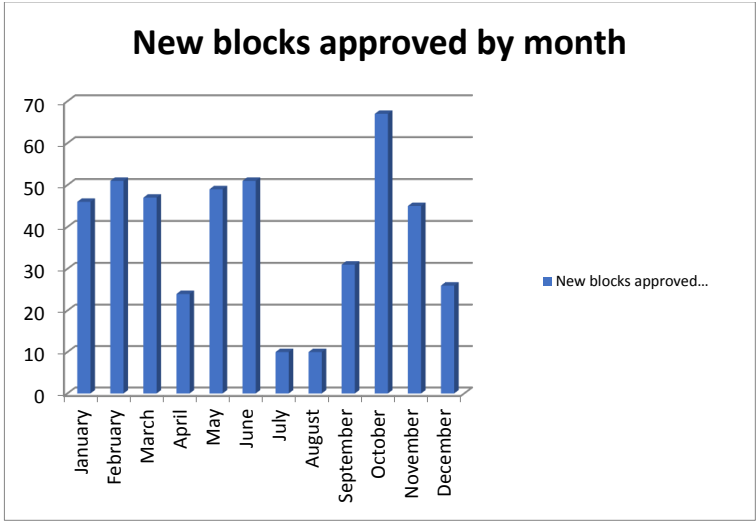


All blocks approved by DVO

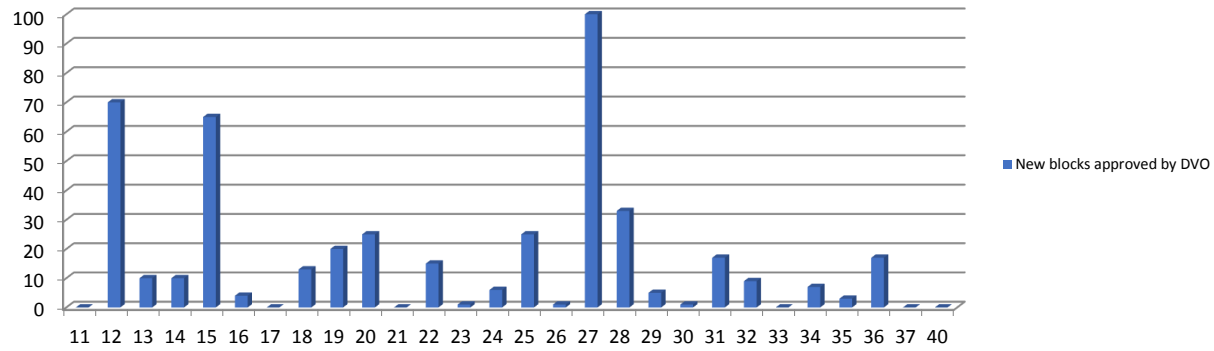


NEW APPROVALS BY MONTH

2021	11	12	13	14	15	16	17	18	19	20/39	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	40	TOTALS
January	0	15	0	0	5	0	0	2	2	0	0	2	0	0	4	0	1	8	0	0	4	2	0	1	0	0	0	0	46
February	0	4	1	0	3	2	0	2	3	11	0	1	1	3	1	0	1	11	1	0	2	0	0	3	1	0	0	0	51
March	0	8	2	0	2	2	0	1	0	6	0	2	0	0	5	0	4	5	2	0	4	1	0	2	0	1	0	0	47
April	0	9	1	0	2	0	0	2	0	3	0	2	0	0	0	0	1	2	0	0	0	0	0	0	0	2	0	0	24
May	0	10	0	0	3	0	0	0	3	4	0	2	0	0	1	0	16	6	1	0	2	0	0	1	0	0	0	0	49
June	0	3	0	0	12	0	0	2	1	0	0	1	0	0	0	1	24	1	0	1	2	0	0	0	1	2	0	0	51
July	0	0	0	0	3	0	0	0	3	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	10
August	0	1	0	0	4	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
September	0	5	2	0	13	0	0	0	1	1	0	0	0	0	0	0	5	0	0	0	1	2	0	0	0	1	0	0	31
October	0	12	0	4	11	0	0	2	0	0	0	3	0	2	11	0	14	0	0	0	2	2	0	0	0	4	0	0	67
November	0	1	0	2	7	0	0	2	2	0	0	0	0	1	0	0	26	0	1	0	0	0	0	0	1	2	0	0	45
December	0	2	4	4	0	0	0	0	0	0	0	2	0	0	1	0	7	0	0	0	0	1	0	0	0	5	0	0	26
TOTALS	0	70	10	10	65	4	0	13	20	25	0	15	1	6	25	1	100	33	5	1	17	9	0	7	3	17	0	0	457



New blocks approved by DVO



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Field Code Changed

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