BADGERS
AND BOVINE TUBERCULOSIS
IN IRELAND

by
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A Report prepared for
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Foreword

This Report was commissioned by ERAD, the Eradication of Animal Disease Board. In accordance with its terms and references (Appendix E) the Report brings together the available factual information on the present state of knowledge on the transmission of tuberculosis between badgers and cattle. In preparing the Report we have drawn extensively on the research in the UK and on the information accumulated in the District Veterinary Offices in Ireland. Also we have had extensive consultations with the wide range of agencies and interests listed in Appendix C. We have, at all times, considered the evidence objectively and have taken care to ensure that the conclusions reached have not been influenced by any of the interests consulted. Accordingly the Report should provide a basis for informed consideration of the role of badgers on the spread of tuberculosis to cattle.

February, 1989

R. O'Connor and
E. O'Malley

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(b) supplied statistics and references from the Department of Agriculture and the ERAD Board and

(c) advised us generally on technical and veterinary matters relating to the BTE schemes in the Republic, Northern Ireland and Great Britain.

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Any errors, omissions or misrepresentations are, of course, the sole responsibility of the authors.

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Introduction

Progress in the eradication of Bovine Tuberculosis has stalled at different levels in various areas of Britain and Ireland. Frequent testing can keep the disease in control in these areas but there has been little progress under current programmes in reducing it below certain critical levels (Crilly, 1987). It is thought that this failure is due to the disease having become endemic in the local wildlife, particularly in the badger. The purpose of this report is to consider the role and contribution of the badger in the spread of bovine tuberculosis and to draw conclusions on the basis of the findings. The report begins by describing briefly the nature of the disease and its control, the history of the disease in Ireland and comparisons with Great Britain and Northern Ireland. This section of the work is based on a recent ESRI paper by one of the authors (O'Connor, 1986). The second and third chapters of the report review the studies which have been carried out to determine the relationship between the badger and the spread of the disease in Britain and the Republic. The final section of the paper discusses the investigations carried out to date and draws conclusions from the results.

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* Ireland in this paper means the Republic of Ireland.

Chapter I

Bovine Tuberculosis and its Control

Bovine tuberculosis is a very difficult disease to clear up. The infective dose is very low; there is no immunity based on age or sex; there is very often no clinical evidence to alert the herd owner of the presence of the disease; transmission can occur 24 hours a day throughout the year and it is believed to be accelerated by cattle movement along roads, by contact at marts and across fences and by stress of all kinds, including poor nutrition and housing.

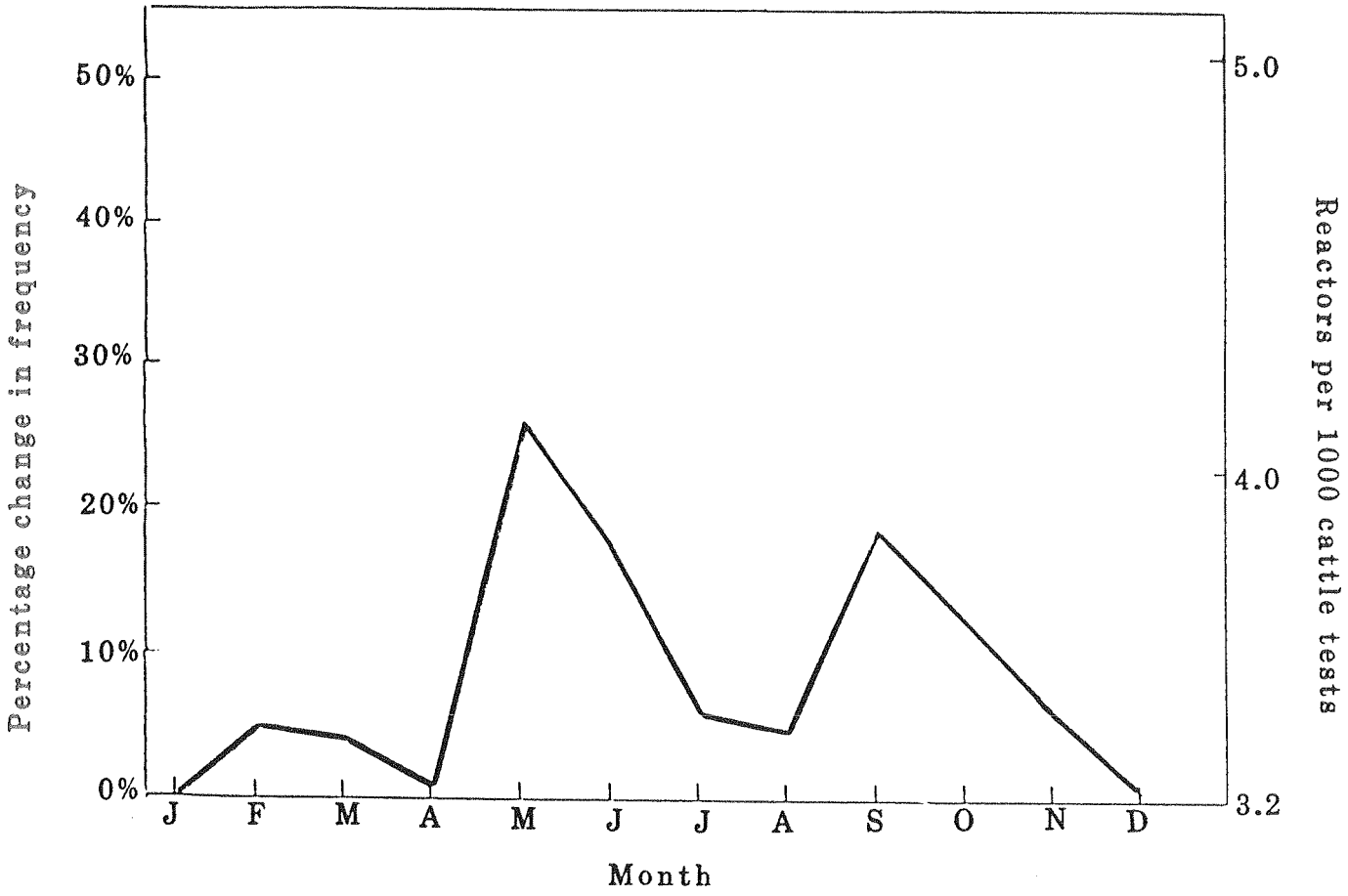
There is evidence of a strong seasonal component in reactor rates with the highest level being found in May and June (see Figure 1.1 taken from Crilly, 1986). If we assume that the period between infection and skin reactivity is 45-50 days, this seasonality pattern indicates that spread of bovine tuberculosis is greatest in the Spring months.

The germs of tuberculosis are very resistant to environmental conditions and a wide range of animals may act as reservoirs of infection including badgers, red deer, dogs, cats and goats. The disease has been eliminated or reduced to very low levels in a large number of European countries and in the USA, but there is still fairly high infection in Italy, Greece, Spain, Portugal and Ireland. Eradication, however, was not easily attained in any of the countries which are clear of the disease. In Britain it took 30 years to get the disease down to what were considered acceptable levels (less than 0.05 per cent of animals). The time taken in the USA was 50 years but like Ireland there were difficulties in that country with cattle movement in the ranching states, and with cross border movement from Mexico. In Northern Ireland the incidence was reduced to 0.04 per cent of animals in 22 years. At that time when biennial and later triennial testing were introduced the incidence rose again and annual testing had to be resumed in 1982 (see Table 1.1 for incidence levels in Great Britain and Northern Ireland since 1970). Testing commenced in New Zealand in 1958 and the disease is still not eliminated in that country. It is believed to be endemic in some areas because of infected wildlife - possums in particular (Surveillance, 1986).

Eradication Methods

A means of early diagnosis and isolation of infected animals is essential in any scheme for the eradication of bovine tuberculosis; by the time clinical signs become apparent in some animals, many others in the herd will be infected. At present there is no satisfactory blood or serum test for diagnosing the disease. The tuberculin skin test is the most reliable diagnostic method available but it is not foolproof. Animals not having the disease will often react to the test (false positives) and some of those with the disease may show no reaction (false negatives). It is therefore rather a blunt instrument, but it is the only one we have and it has succeeded in eradicating the disease in all the countries where the

FIGURE 1.1: Seasonal index for number of reactors per 1,000 cattle tests in Ireland, 1978-1985



Source: Crilly, J., 1986. Seasonal and Longterm Variation in Bovine Tuberculosis in Ireland, Department of Agriculture, Dublin

Table 1.1: *Animal Incidence of Bovine Tuberculosis in SW England, the Rest of Britain and Northern Ireland 1970-1987*

	Herd Incidence			*Animal Incidence* [a]		
Year	*SW England*	*Rest of Britain*	*Northern Ireland*	*SW England* [b]	*Rest of Britain* [b]	*Northern Ireland*
			%			
1970	2.611	0.533	0.497	0.124	0.026	0.040
1971	3.093	0.453	0.544	0.139	0.019	0.038
1972	2.756	0.410	0.808	0.118	0.016	0.068
1973	3.025	0.202	1.110	0.135	0.012	0.110
1974	2.339	0.301	1.509	0.111	0.018	0.129
1975	3.371	0.598	2.756	0.112	0.018	0.166
1976	2.409	0.616	2.435	0.073	0.007	0.191
1977	1.582	0.345	2.571	0.050	0.010	0.169
1978	1.410	0.225	1.892	0.066	0.009	0.140
1979	1.244	0.210	1.654	0.044	0.030	0.123
1980	2.002	0.310	2.407	0.065	0.010	0.175
1981	1.902	0.252	2.035	0.082	0.006	0.144
1982	1.449	0.280	1.885	0.039	0.008	0.116
1983	1.483	0.358	1.775	0.049	0.007	0.107
1984	1.297	0.522	1.610	0.049	0.009	0.089
1985	1.580	0.400	1.650	0.053	0.013	0.088
1986	na	na	1.388	0.027	0.010	0.064
1987	1.638	0.412	1.248	0.050	0.015	0.069

(a) Includes contact animals.

(b) The figures for British herds relate to herds actually tested, which tend to be those with the highest incidence.

Source: Ministry of Agriculture, Fisheries & Food, London.

disease has been eliminated.

Once herds have been declared free of the disease it is most important to control the movement of animals into the herd. These must be free of infection or they will spread the disease in the attested (disease free) herd. Contact between animals in attested herds and neighbouring farms has to be prevented also and in practice it has been found that a double fence may be necessary to achieve proper segregation. Substantial walls, hedges or banks are adequate boundaries but not single wire fences or fences over which adjoining cattle can "nose" each other (Richie 1959, p. 725).

More Recent Views on the Spread of the Disease

Experience has shown that in a region such as Ireland where the incidence of the disease is high (0.5 per cent animal prevalence) the principal means by which the disease is spread is from bovine to bovine animal. In some areas, however, it is now thought that lateral spread from cattle to cattle is not the only means of infection.

Wild animals are becoming increasingly suspect in certain areas where outbreaks continue to occur for no apparent reason and where it has proved impossible to reduce the disease incidence by frequent testing. In a letter to the *Irish Times* in October 1986, Dr Kevin Dodd of the Faculty of Veterinary Medicine in UCD (Dodd, 1986) said

> Wildlife in general but badgers in particular come under intense scrutiny as a possible source of bovine TB when a herd has a recurrent pattern of breakdown, despite the diligent application of conventional control methods such as annual testing, double fencing, disinfection of trucks and equipment and a breeding policy of home rearing stock rather than buying in replacement animals. In these circumstances, disease control methods based on the view that other cattle from "without" the herd are the source of the organism simply do not work, much to the frustration and consternation of the herd owner and his veterinary surgeon.

Other writers have been expressing similar views. See for example, Clancy (1987), Fagan (1988), McCarthy (1987), McAleer (1987) and *Irish Veterinary News* (1985). Of course there are contra views. The Wildlife Link Badger Working Group Report (1984), McDonald (1984) and many others dispute the theory of badger involvement in the spread of bovine tuberculosis. In a letter to the *Irish Times* on the 1 December 1988, Dr J.M. Barry of the Irish Wildlife Federation stated that

> "there is no evidence whatsoever to connect the badger with herd breakdowns in the Galway/Offaly/Longford area. The so called trials and research which were carried out would be laughed to scorn in any scientific assembly .... The fact that only in very isolated cases does transmission to cattle occur is

accepted by the scientific staff of the Department of Agriculture".

Commenting on the British situation Harris (1980) says that

"the mammal society agrees with Zuckerman's basic conclusion that the badger is a major reservoir of bovine tuberculosis in certain limited areas of South West England and hence is a potential danger to cattle in those areas. However we feel that the report gives a biassed interpretation of the evidence and that many of Lord Zuckerman's conclusions were not justified from the data presented in the report".

In particular "Lord Zuckerman stated that the gassing of badgers was accompanied by a decline in the number of reactor cattle in the herds concerned and that the two events were related. However the rate of decline in the incidence of TB in badgers in the South West was paralleled by a decline in the incidence of reactors in cattle herds not only in the South West but also in the rest of England. The timing and rate of decline were similar in all three samples. Lord Zuckerman offered no explanation for this".

Harris went on to say that "there are many anomalies in the data presented in the report. Clearly many issues remain unresolved ..... In order to achieve an acceptable long-term solution we believe that it is imperative that further research is undertaken to explain

(1) some of the many anomalies in the data available and
(2) understand the factors involved in the transmission of TB from badgers to cattle".

The BTE Scheme in the Republic of Ireland

The bovine TB eradication scheme commenced in Ireland in 1954 and the country was declared an attested area (virtually disease free) on the 19 October 1965. At this time the incidence of tuberculosis in herds given by the Department was 2.8 per cent compared with 80 per cent 12 years previously. This amounted to considerable progress since the scheme was initiated. Unfortunately the impetus up to that time has not been maintained in later years: the herd incidence in the 1981/82 round of testing was virtually identical with that disclosed in the 1966/67 round (see Table 1.2) and was much higher than this in most of the intervening years. Nor does there seem to have been much improvement since 1981/82. The incidence declined to 2.24 per cent on the 1983/84 round, increased to 3.59 per cent in 1986/87 and declined to 2.39 per cent in 1987/88. The validity of the official figures is discussed in Appendix A where the difference between incidence and prevalence is explained.

Table 1.2: *TB Incidence* Levels on Annual Rounds of Testing in Ireland and Total Number of Reactors Removed as a Result of all Forms of Testing* 1966/67-1987/88

Year	*Incidence of Disease* (%)*		*No. of Reactors Removed (Calendar Year)*	*Total Cattle Population (000) (June)*	*Reactors removed as % of Total Cattle Population (Animal Period Prevalence*)*
	In herds	*In animals*			
1966/67	2.80	0.28	23,278	5,590	0.42
1967/68	3.29	0.34	25,862	5,586	0.46
1968/69	3.30	0.31	22,021	5,572	0.40
1969/70	4.40	0.42	31,060	5,688	0.55
1970/71	4.49	0.40	37,104	5,956	0.53
1971/72	4.12	0.37	37,408	6,134	0.61
1972/73	4.84	0.35	31,258	6,438	0.49
1974	5.11	0.42	46,656	7,214	0.65
1975	n.a.	n.a.	21,339	7,168	0.30
1976/77	7.5	0.55	24,888	6,954	0.36
1978/79	3.95	0.25	31,238	7,124	0.44
1979/80	2.94	0.19	21,483	7,178	0.30
1980/81	2.11	0.16	26,581	6,909	0.38
1981/82	2.76	0.20	29,722	6,760	0.44
1982/83**	3.16	n.a.	26,760	6,760	0.40
1983/84	2.24	n.a.	27,691	6,859	0.40
1984/85**	3.51	n.c.	33,560	6,872	0.49
1985/86	2.43	n.c.	31,527	6,718	0.47
1986/87	3.59	n.c.	31,315	6,647	0.47
1987/88	2.39	n.c.	30,117	6,588	0.46

* For definition of incidence and prevalence see Appendix A. ** Partial round only.
n.a. - Not available due to veterinary strike.
n.c. - Not computed.
Source: Department of Agriculture and Food and ERAD.

Note: The incidence figures given in this table, based on round tests, are, for recent years in particular, considerably lower than those calculated from data for all tests.

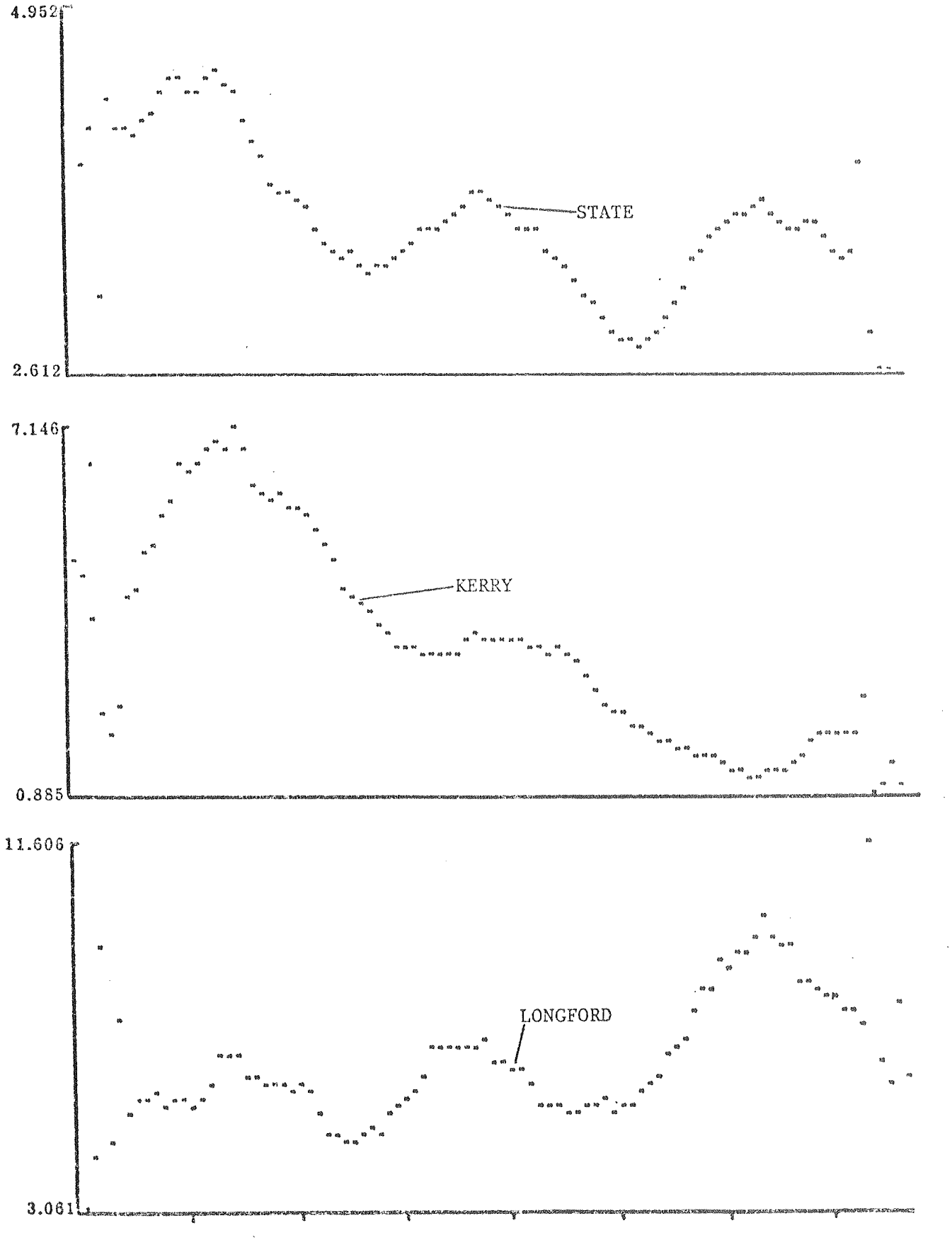
Table 1.3: *Bovine Tuberculosis Herd Incidence by County 1980-1988 as Determined by Round Tests.*

County	*Herd Incidence*								
	1980	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*
					%				
Carlow	3.03	2.08	3.47	3.49	2.39	4.29	2.15	3.09	3.94
Cavan	1.53	1.73	1.29	1.58	1.70	3.24	2.76	3.76	2.76
Clare	2.73	2.63	4.74	3.83	4.29	3.46	2.69	3.21	2.55
Cork N/E				2.68	2.67	3.16	1.87	2.20	2.75
Cork S/W	6.49	4.25	5.02	4.84	4.00	5.73	5.42	3.18	2.85
Donegal	0.76	0.59	0.93	2.67	0.56	0.82	0.39	1.74	0.53
Dublin	2.32	1.42	1.72	0.73	1.69	0.69	1.71	1.64	1.70
Galway	2.12	2.14	3.20	3.19	2.08	4.68	2.75	3.71	1.56
Kerry	3.69	2.11	2.25	3.06	1.43	1.00	1.02	2.39	2.64
Kildare	3.80	2.69	4.13	2.74	2.95	3.23	2.81	4.50	2.75
Kilkenny	4.30	2.96	3.09	2.51	3.76	5.24	3.28	3.35	4.26
Laois	2.88	2.59	4.51	2.49	3.17	5.93	4.10	3.49	2.86
Leitrim	1.12	0.43	0.90	1.86	1.31	2.51	1.87	2.64	1.10
Limerick	2.43	2.15	2.30	2.58	1.59	2.02	2.02	4.30	2.34
Longford	3.61	3.04	3.52	3.82	3.36	6.39	5.16	14.23	3.77
Louth	2.67	1.66	1.68	1.41	1.20	1.66	2.36	3.60	4.03
Mayo	0.83	0.82	0.79	-	0.75	2.71	0.99	1.45	0.93
Meath	3.53	2.60	2.34	2.17	2.60	3.43	2.71	2.76	2.77
Monaghan	3.62	2.30	2.24	2.14	2.13	2.28	1.41	2.36	1.97
Offaly	3.34	2.90	3.90	3.91	5.00	9.96	4.49	5.68	5.43
Roscommon	1.30	1.15	2.33	4.08	2.52	3.05	2.28	2.99	2.26
Sligo	0.74	0.65	0.68	0.89	0.37	1.73	0.96	2.43	1.84
Tipperary North					4.24	5.45	4.15	5.30	3.51
Tipperary South	3.79	2.40	3.24	4.32	2.59	6.40	2.62	4.76	3.20
Waterford	3.32	2.52	3.74	2.63	1.88	2.58	1.58	2.42	2.01
Westmeath	4.88	3.49	5.47	4.37	3.64	6.52	6.71	5.37	5.21
Wexford	3.32	2.11	2.53	2.76	1.77	3.32	2.55	3.50	2.78
Wicklow East				2.24	3.35	2.15	2.40	2.05	1.53
Wicklow West	3.65	2.76	3.58	2.10	4.54	4.10	3.27	3.80	4.68
Total*	2.94	2.11	2.76	3.16	2.24	3.51	2.43	3.59	2.39

* See note at foot of Table 1.2.

Source: Department of Agriculture and Disease Eradication Board.

Figure 1.2: Long-term and Cyclical Variation in Reactor Animals per 1000 Cattle Tests (APT)



Source: Crilly, J., Seasonal and Long-term Variation in Bovine Tuberculosis in Ireland 1973-85.

Because the bad areas only are tested in some years and because there are seasonal and cyclical effects in the disease incidence, the figures in Table 1.2 do not tell us whether or not the incidence is actually increasing or declining over time. In a time series analysis of 65 million tests carried out in Ireland under the BTE Scheme between 1978 and 1985 Crilly (1986) showed that for the country as a whole there was an improvement between 1978 and 1985 (see Figure 1.2). The improvement was very marked in Co. Kerry whereas in Longford the incidence has increased over the period. Figure 1.2 shows distinct cyclical effects, with a periodicity of about 30 months. In the short term these tend to mask the long-term trends.

The incidence of the disease in the different counties since 1980 based on the round tests is given in Table 1.3. This table shows that Longford has had a particularly high incidence in recent years, with 14 per cent of herds infected in 1987. Co. Offaly is a blackspot area also, with a herd incidence of over 5 per cent at the present time and almost 10 per cent in 1985. Westmeath also has a high level as well as Kilkenny and West Wicklow.

But even within some of the low incidence counties there are bad spots. For example, the incidence in parts of South West Cork has remained relatively high over the years despite intensive testing. Similarly, though the incidence in Co. Donegal is very low, there are blackspots here and there from which it is difficult to eradicate the disease.

For some reason much of the Shannon basin seems to be especially difficult to clear up. Furthermore farms and areas can remain clear for several years and then have outbreaks for no apparent reason. With this pattern of outbreaks, and the failure to reduce the disease incidence in some cases by constant testing, veterinarians and many farmers are insisting that infection is coming from badgers.

Difficulties and Defects in the BTE Scheme

Before moving on to assess the contribution of badgers to the spread of bovine TB, however, it is necessary to note the other factors which various authorities have claimed are responsible. In the 1986 ESRI report (O'Connor, 1986, op. cit., p. 4) a number of difficulties and defects in the BTE scheme were listed. The more important of these are listed and discussed below.

The difficulties and defects are:

(1) High volume of cattle movement and contact.
(2) Collection of reactors.
(3) Tag switching and illegal movement
(4) Defective testing.
(5) Failure to depopulate seriously infected herds and
(6) Stop-go funding policies.

High Volume of Cattle Movement and Contact

Because of our peculiar pastoral system of farming, and of the large number of fragmented holdings, Ireland has a very high volume of cattle movement and contact between animals from different herds at marts and along roads and lanes. Unfortunately cattle movement must continue to go on in this country. Too many people depend on it for their livelihood.

It is believed that movement, and the stress that goes with it, are important factors in the spread of the disease in Ireland. Because of these factors (movement back and forth to marts in particular) more intensive testing is needed here than in any of the other European countries. It is essential, therefore, that a movement permit system be introduced so that purchased reactors can be traced back to the herds from whence they came and to ensure that all purchased animals are presented for testing when the veterinary surgeon calls to make a test. Under the present system a purchased animal could be held back if the farmer or dealer suspected it was a reactor, and sold off before the next test was due. The movement permit should be designed to close this loophole. The tester when he calls should have an accurate up to date list of every animal in a herd.

Contact with neighbouring cattle across fences is still a factor despite exhortations to erect double fencing where there are no hedges, walls or wide boundaries. This avenue of infection, however, can now be fairly well detected since adjoining farms are tested whenever an outbreak occurs on a particular farm.

Collection of Reactors

In the past the collection of reactors by dealers and hauliers was open to considerable abuse. Though it was illegal to do so dealers often kept reactors on their farms until they had a full load for the factory. Healthy animals from the same and neighbouring farms thus became infected. National Reactor Collection system which is about to be set and which farmers must use to qualify for reactor grants, should close off this route of infection.

Tag Switching and Illegal Movement

The tags now used are difficult to switch and so illegal movement of reactor animals to marts is considerably reduced. Illegal movement could and does go on between herdowners outside the mart system In the northern counties of Cavan and Monaghan we understand that there are many problems with smuggled cattle. Authorities must therefore remain vigilant at all times on this matter.

Defective Testing

It is claimed, and with a good deal of justification, that defective testing has contributed significantly to lack of progress in eradicating

bovine tuberculosis in Ireland. An EEC report in 1981 (EEC 1981) stated that a large number of reactors were not being identified on the round tests. This conclusion was disputed by the Department of Agriculture whose officials have stated that the survey quoted by the EEC was unscientific and the results unreliable. In any case checking on the reliability of tests is a most difficult task because of the rapidity with which the disease spreads.

In recent years the problems associated with testing have received less attention than in the past. The veterinary inspectors we have interviewed have different views on the standard of testing. Some state that in all cases outbreaks are discovered in the first instance by the private practitioners and that bad testing is a very minor problem nowadays. Others feel that there is still a fair amount of bad testing going on, particularly carelessness in reading eartags and counting the number of cattle tested. We suggest that the ERAD board keep testing practice and standards under constant review. Some head office official should be appointed to make regular studies of the records of individual testers. In particular pre-movement test results should be examined closely. A high proportion of outbreaks is attributed to bought in cattle. Hence the pre-movement test does not seem to be doing what it was set up to do - prevent spread through this route.

Failure to Depopulate Seriously Infected Herds

There are still a number of seriously infected herds in the state. It is argued that depopulation of these herds would bankrupt the herdowners concerned. As the number of such chronic herds is small, we suggest that the ERAD Board institute a special scheme for them. They are a grave source of residual infection.

Stop-go Funding Policies

In the past stop-go funding was considered to be a problem in the Irish bovine TB eradication programme. It was argued that in years when testing was restricted the disease incidence built up and the gains obtained in previous years were wiped out. This is a very logical view. During the veterinary strike in 1975 the disease incidence rose substantially and it took intensive testing in subsequent years to get the incidence down to 1974 levels. Similarly, in other years when funds for testing were restricted, there is evidence that the disease incidence rose. In recent years however, particularly since farmers have been contributing to the cost of the scheme, there has been intensive testing of all the bad areas. Hence we conclude that stop-go funding is no longer the serious problem it was during the 1970s and early 1980s.

To conclude, there are still significant problems associated with the bovine TB eradication scheme in Ireland. It is necessary to bear these problems in mind when considering the contribution of the badger in spreading the disease.

Chapter 2

Badgers and Bovine Tuberculosis in Great Britain

The terms of reference for this report specified that it should include a review of international knowledge on the subject of TB in badgers and cattle, noting that work done in the UK should be particularly relevant. This chapter covers that topic.

The Eurasian badger (Meles meles) is found widely distributed throughout Europe and much of Asia (Neal, 1986, p. 3). But TB in badgers caused by M. bovis has not been identified in most countries other than the UK and Ireland, and information on the subject in other countries is very limited (Dunnet et al., 1986, p. 13). The very first identification of M. bovis in badgers, however, occurred in Switzerland in 1957 (Bouvier et al., 1962). But badger infection does not seem to have been associated with a threat to cattle there.

In the UK, on the other hand, M. bovis has been frequently identified in badgers and the relationship between bovine TB in badgers and cattle has been quite extensively researched. Two independent reports on the subject have been commissioned by government Ministers (published as Zuckerman, 1980, and Dunnet et al., 1986). Wildlife conservation groups have also taken a serious interest in the subject, joining together to produce the report of the Wildlife Link Badger Working Group (1984). Since the issue of bovine tuberculosis in badgers and cattle has arisen to a significant degree only in Britain (apart from Ireland), this chapter concentrates on the current state of knowledge on the subject in Britain.

Bovine Tuberculosis in Cattle in Great Britain

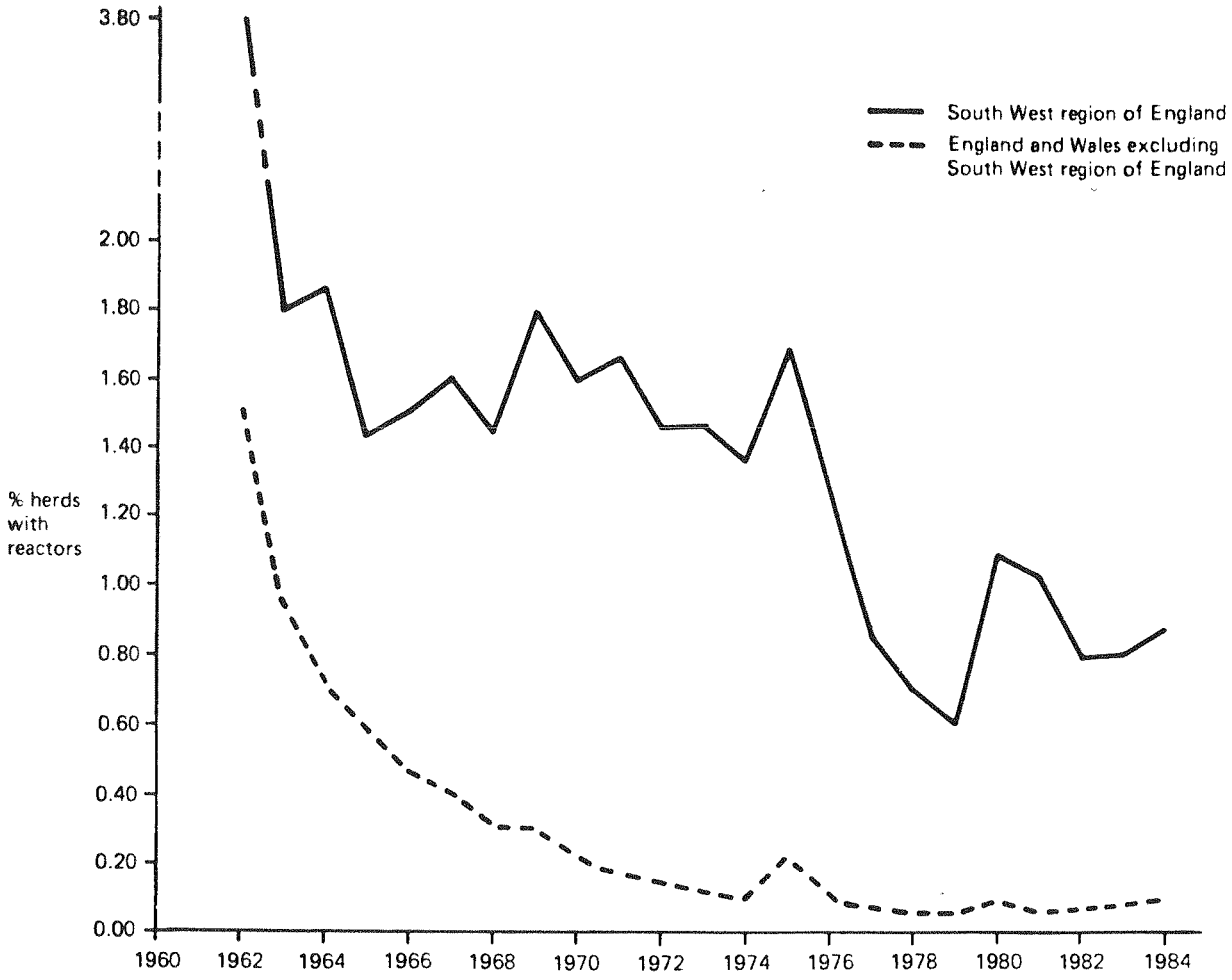
In 1950, the British government began its compulsory campaign of tuberculin testing of cattle and slaughtering of reactors, and by 1961 the proportion of cattle reacting positively to the test was down to just 0.162 per cent. This figure fell further to 0.02 per cent by 1977, and it has remained close to that level since then (Zuckerman, 1980, Table 1).

Figure 2.1 shows the annual herd incidence since the early 1960s. It will be seen that the incidence of reactor herds did not fall by nearly as much in the South West region of England as it did in the rest of England and Wales. The South West continues to be the principal bovine tuberculosis black spot in Great Britain.

British Government Policy on Badgers and Bovine Tuberculosis

In 1971, for the first time in Great Britain, M. bovis was identified in a dead badger in Gloucestershire. Investigations followed to measure the incidence of bovine TB in badgers in the area and their role as a potential reservoir of infection for cattle. The Ministry of Agriculture, Fisheries and Food (MAFF) concluded in 1973 that the badger population was such a reservoir and that action was needed to deal with

Figure 2.1: *Estimated Annual Incidence of Reactor Herds in England and Wales, 1962-1984*



Source: Dunnet *et al.*, (1986), Appendix 4.

this. In August 1975, MAFF began to gas badgers in localities where outbreaks of TB in cattle had occurred and where badgers were considered to be the source of infection.

The ensuing public criticism prompted the Minister of Agriculture, Fisheries and Food to commission Lord Zuckerman in 1979 to undertake a review of the whole problem and to advise on how it should be tackled. This review concluded that it was clear that badgers constituted a significant reservoir of bovine tuberculosis. It was also concluded that the high densities of both badgers and cattle in parts of the South West favoured transmission of the disease within the badger population and from badgers to cattle. Consequently, it was recommended that badger control operations should be resumed immediately (they had been suspended for the duration of the review).

The practice was that when herd breakdowns occurred all other possible sources of infection had to be considered and eliminated before action could be taken against badgers. If the origin of infection was not identified by these investigations, a sample of badgers in the area could be tested for infection, and if M. bovis was isolated from the sample a "badger removal operation" followed.

One of Lord Zuckerman's recommendations was that investigations should be conducted into the action of hydrogen cyanide (the poison gas used to kill badgers). This lead to some doubt as to whether the gas was a humane means of killing badgers, and gassing was abandoned in 1982. It was replaced by cage trapping followed by humane killing.

Trapping made possible the examination of the badgers post mortem to establish the incidence of infection. Subsequently badger removal operations followed a pattern of removal of all members of each social group identified as having infected members, plus contiguous social groups. If any of the contiguous social groups were found to harbour infection, the removal area was extended further. This continued until a "clean ring" of groups containing no infection was reached.

The second independent review commissioned by the government was undertaken by a group chaired by Professor Dunnet, which began work in 1984 and reported in 1986.

Dunnet's review group concluded, like Lord Zuckerman, that badgers can be infected by M. bovis, can become infectious, and are potential sources of infection of cattle. Consequently badgers must be taken into account when considering the issue of bovine TB in cattle. However, they questioned the effectiveness of the procedures involved in delineating badger social groups, sampling badgers to test for infection, and establishing a "clean ring" around infected farms. They also noted that these procedures caused considerable delays in taking action. In addition, they concluded that the costs of the policy considerably outweighed the benefits, (the benefits being measured in terms of savings of costs that would have been incurred by herd breakdowns which were averted by badger

control). They estimated the costs at £10.5 to £12.8 million for the period 1975/76 to 1983/84, and the benefits at £1.4 to £1.8 million. (It should be noted, however, that the maximum potential benefits from further reduction of the already relatively low incidence of bovine TB prevailing in Great Britain could not be very great.)

Consequently, Dunnet et al. (1986) concluded that the "clean ring" approach to badger control was not economically justifiable. They concluded, further, that complete and permanent eradication of the disease in badgers, and hence in cattle, was not attainable by available methods at an economically justifiable cost. Therefore they recommended a more limited and less expensive interim strategy. This strategy had the objective of simply limiting "the transmission of disease from badgers to cattle by dealing with identifiable and avoidable risks, quickly and effectively at a reasonable cost".

The main policy change recommended by Dunnet et al. (1986, p. 38) was that:

> the badgers using that part of the breakdown farm where it is believed that the disease was transmitted to cattle, or the whole farm if it is not possible to be more precise, should be captured, killed humanely and examined post mortem, without prior sampling or delineation of social groups, and with no question of extending the operation beyond the breakdown farm.

This approach had the advantage of eliminating prior sampling and delineation of social groups, thus avoiding delays and cutting out a costly procedure. It also reduced the scale of operations which again cut costs and helped to meet objections from conservationists. The Dunnet Report also recommended that the Ministry should work on developing a diagnostic test for M. bovis infection in living badgers, to avoid the necessity for killing all the badgers concerned when some individuals are not infected. The recommendations of the report have formed the basis of government policy since 1986.

Bovine Tuberculosis in the Badger Population

The basic evidence that wild badgers in Britain can be infected by M. bovis mainly comes from two sources - post mortem examinations of dead badgers submitted by the general public, and examinations of badgers killed in MAFF's investigations and removal operations. In the period 1972-84, 9,211 badger carcases were submitted by the general public and 451 (4.9 per cent) of these were positive for M. bovis. In the South West region 7.2 per cent of such carcases were infected. In the period 1974-84, a total of 6,629 badgers killed in Ministry operations were examined and 781 (11.8 per cent) were positive for M. bovis. In the South West 12.4 per cent of such carcases were infected (Dunnet et al., Appendices 6 and 7). It is not surprising that there was a higher level of the disease among the badgers taken by the Ministry since they were captured in the vicinity of infected farms where badgers were suspected to be the source of infection.

Badgers were probably first infected by cattle, but this would not occur often now in Britain due to the low levels of infection in cattle. Possible means of infection from cattle to badgers would have included infected cattle sputum and urine on pastures where badgers forage for earthworms, their principal food, and infected cow pats, which badgers turn over searching for dung beetles (Wildlife Link report, 1984).

Once some badgers were infected, the disease would have been relatively easily spread to others since they live in social groups of about six to ten animals sharing underground setts. Dunnet et al. (1986, p. 18) reported that in most groups found to be infected in the course of MAFF operations, about 25 to 30 per cent of the individual badgers were infected. But as many of the animals develop immunity, the disease does not wipe out whole groups or populations.

Badger social groups defend their own territories, so the groups do not mix freely, particularly in areas of high badger density. Nevertheless, cross infection between groups can occur through bite wounds and also because young animals at times leave their parental setts and attempt to establish themselves elsewhere (Neal, 1986). In areas of lower badger density, it appears that badgers roam more widely and join neighbouring social groups more frequently (Kruuk and Parish, 1987). In addition, Cheeseman and Mallinson (1981) report that tuberculous badgers, which are clinically ill and infectious, can behave abnormally, roaming into neighbouring territories. This, they say, "could be an important factor in the maintenance and spread of infection within the badger population".

It has also been found that infectious badgers can live for quite a long time while excreting M. bovis bacilli. In the laboratory, such animals have survived for up to $3\frac{1}{2}$ years (Little et al. 1982). And observing a wild population of badgers, Cheeseman et al. (1981) found that three were infectious for between one and two years. Thus there is plenty of opportunity for infection to be transmitted between badgers. As Neal (1986, p. 203) concludes:

> the result of these effects is that bovine tuberculosis appears to be stable and able to persist in high-, moderate- and low-density badger populations. The disease is probably endemic in many badger populations throughout Britain, but is particularly prevalent in areas of good badger habitat in South-West England.

The Potential for Cross Infection from Badgers to Cattle

Next we must consider the potential for cross infection from badgers to cattle. Little et al. (1982) have shown by two experiments that it is possible for badgers to infect cattle. These experiments involved placing infected badgers in a covered concrete yard together with non-infected calves. In both experiments, the calves became infected after six months. In one of the experiments, four calves which were placed in the

yard for shorter periods of between one and four weeks did not become infected.

This showed, therefore, that badgers can infect cattle, but that cattle will not necessarily be infected, even in very close proximity to infected badgers, for up to five or six months. Given the artificial nature of these experiments, questions arise as to the likelihood of transmission of infection from badgers to cattle in natural situations. The Wildlife Link reporrt (1984), for example, accepted that the experiments showed that badgers can and do infect cattle, but stated that they also showed that "the probability of cross-infection from badgers to cattle is extremely low".

Under natural conditions, there are a number of ways in which badgers could infect cattle, even though badgers tend to avoid close contact with them (Neal, 1986, p. 204). Most of these ways would involve cattle coming into contact with contaminated materials from badgers, such as badger faeces, sputum, pus from the lungs or bite wounds, discarded bedding from setts, and urine (Wildlife Link report, 1984, pp. 20, 21).

Of these, pus or sputum and particularly urine seem to be the most likely. Contaminated urine contains up to 300,000 organisms per ml. and bronchial pus contains up to 200,000 per ml. Infection from contaminated urine can persist on pasture for four weeks in winter, but only a few days in summer. Infection from pus or sputum can persist for at least as long (MAFF, 1984). And since badgers forage on pastures for earthworms which have a very high water content, they produce a large volume of urine.

If cross infections largely occur due to cattle grazing contaminated grass, the fact that most cattle infections occur in the lungs rather than the alimentary canal has to be explained. According to the Wildlife Link report (1984, pp. 21, 22),

> It is well established that in ruminants such as cattle, rumen gases are constantly shunted from the rumen to the lungs as the contractions of the rumen walls move gases along with the ingested material passing from chamber to chamber. Micro-organisms such as bacteria could thus be transported by aerosol along with gases moving from the rumen to the lungs (Mullenax, et al., 1964). If this does occur it could explain how bovine tubercle bacilli present, say, on grass could be ingested and then transported by aerosol from rumen to lungs where a focus of infection is then established. Francis (1971) reports that the dose of tubercle bacilli required to produce infection by the alimentary route is several thousand or even a million times greater than by the respiratory route. This could therefore explain why a focus of infection is rarely established in the rumen or other parts of the alimentary canal...

Another possible means of cross infection arises from the abnormal behaviour of clinically ill and infectious badgers. They have been seen abroad during daylight, sometimes in or around farm buildings. Such behaviour could bring infectious badgers into contact with cattle. Badgers are also known to eat food left out for cattle and this, too, might be a means of infection (Neal, 1986, p. 204).

While all of the above are possible means of cross infection, how likely are such occurrences in natural conditions? An experiment under natural conditions has been going on in the Woodchester Park study area in Gloucestershire for a number of years. The study area is located in one of the main disease problem areas and it covers about 9 km^2. It has a very high density of badgers at over 20 per km^2, and in 1984 had 16 cattle herds of 50-60 cattle per herd. In this area badgers are regularly cage trapped, clinically sampled and then released. While it is not possible to identify M. bovis in most infected badgers except by post mortem examination, it is possible to identify those which have progressed to the infectious stage and are excreting bacilli. Thus it is known that infection has existed in the badger population in the study area since observations began. At the same time, care was taken to ensure that other sources of infection for cattle did not arise.

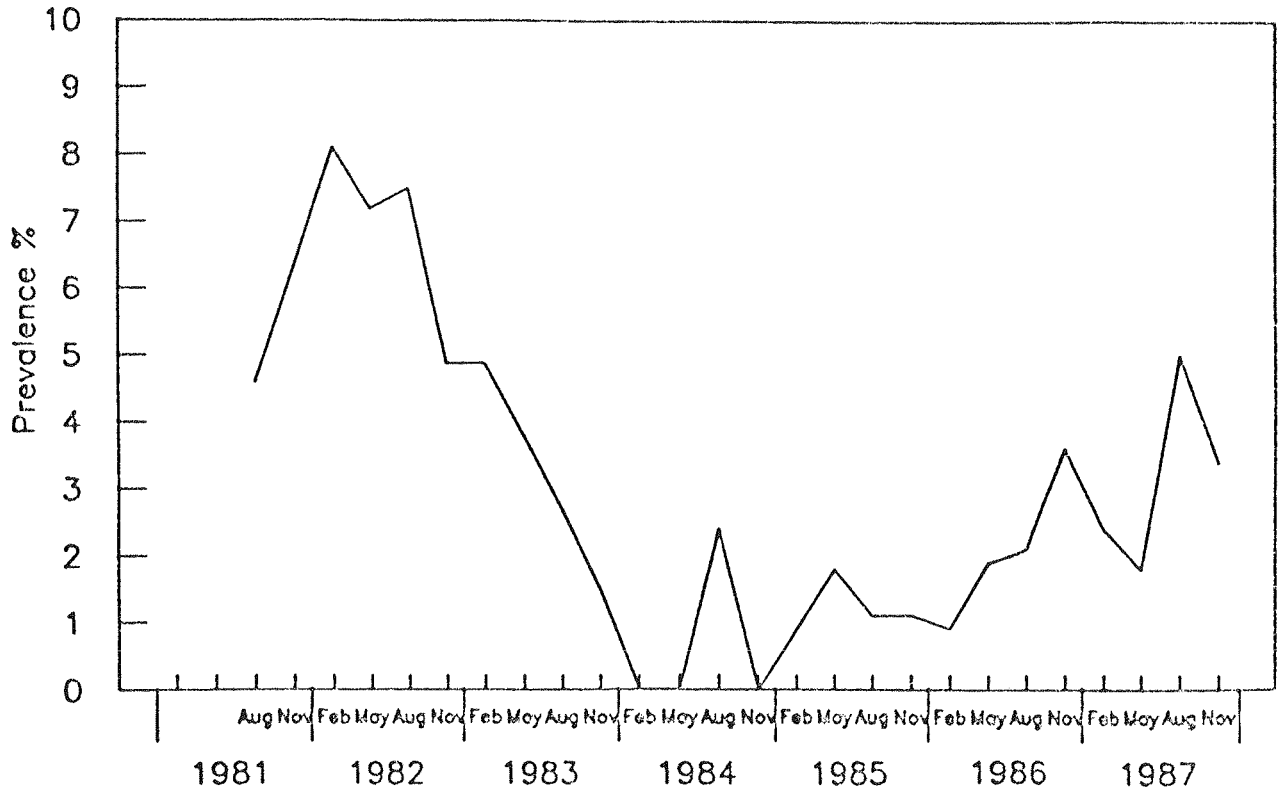
Until recently, the last cattle herd breakdown in the study area was in 1981. There were no further breakdowns until four occurred in 1987 and on one farm a total of 46 cattle were removed as reactors or dangerous contacts. A dead badger, with visible lesions and from which M. bovis was isolated, had been found in a building on this farm towards the end of 1986 (MAFF, 1988, p. 5). Thus it seems fairly clear that badgers were the original source of the cattle infection.

It is also worth noting that the level of identified infection in badgers in the study area reached a peak in late 1981/early 1982, declined for a number of years, and then increased again during 1986 and 1987 (Figure 2.2). This occurred naturally, with no intervention against the badgers in this period. The fact that the periods of high prevalence coincided quite closely with cattle herd breakdowns further supports the supposition that badgers were the source of infection in cattle.

The Woodchester Park result indicates that badgers can transmit infection to cattle under natural conditions. But it also indicates that a particularly high concentration of badgers, which are known to harbour bovine tuberculosis, can coexist with cattle for five years without doing so. One could therefore conclude that there is a risk of cross infection from badgers to cattle, but it is necessary to consider how great is this risk.

While the risk of cross infection may appear to be very low, it must be remembered that the incidence of cattle herd breakdowns is itself a rather low-risk phenomenon. In recent years, breakdowns have occurred in about 1 per cent of herds in the South West annually. In the

Figure 2.2: Prevalence of Identified Tuberculous Badgers in the Gloucestershire Study Area (per cent)



Source: Cheeseman et al., (1988).

Gloucestershire study area, with 16 herds in 1984, a breakdown rate of 1 per cent per annum would give one breakdown about every six years. The observed number of breakdowns in the six years 1982-87 (inclusive) was four. Thus assuming that cross infection from badgers accounted for these breakdowns, then this source of infection produced, in Woodchester Park, a rate of herd breakdowns considerably greater than the regional average from all sources.

It must be recognised, of course, that badger density is exceptionally high in the study area and the badger population was known to harbour infection throughout the period. Thus one would expect the risk of infection from badgers to be higher than average in this area. Nevertheless it may be concluded that, while the risk of cross infection from badgers to cattle seems rather low, it could still be high enough to account for a major proportion of the herd breakdown in South West England.

Evidence of Association Between Badgers and Bovine Tuberculosis in Cattle

Thus far it may be concluded that badgers are at least potential sources of infection in cattle in Great Britain, and it is possible that they constitute a major source of actual herd breakdowns. We now move on to consider some further indications that infection from badgers may be a major factor.

One argument on the relationship between badgers and bovine TB in cattle refers to the time trend in herd breakdowns, in the South West in particular. Referring back to Figure 2.1, it can be seen that while the incidence of reactor herds in most of England and Wales continued to fall until the early 1970s, the herd incidence remained much higher in the South West until 1975. The incidence in the South West then fell considerably after 1975, rose noticeably in 1980 and then fell somewhat.

One interpretation of these trends is, first, that the South West has a relatively high density of badgers and there is a higher than average level of bovine TB among the badgers there. Hence, it is argued, infection from badgers would explain the higher cattle herd incidence in the South West. Also after badger control began in certain areas in the South West in September 1975, the herd incidence declined. This decline continued until the gassing programme was suspended in 1979/80 while Lord Zuckerman undertook his review. The herd incidence rose noticeably while the programme was suspended, but declined again with the resumption of badger control.

McInerney (1987) has applied regression analysis to test this and other hypotheses. He found that there was indeed a statistically significant break in the trend for the South West after the badger control programme began in 1975, although it is not possible to be so precise about later changes.

The problem is, however, that while a new declining trend did become evident after 1975, another explanation has also been suggested for this. In March 1975, there was a change in the comparative tuberculin test, from the use of Weybridge human purified protein derivative (PPD) to Weybridge bovine PPD. According to McInerney's information, the new test reduced the number of "false positive" results. This would result in a decline in the recorded incidence of reactor herds. Because of this, it would not be possible to attribute the decline in herd incidence reliably to badger control, and hence the influence of badger infection could not be regarded as demonstrated. On the other hand, Wilesmith (1986) states that there is no evidence that the new tuberculin test in 1975 could have accounted for the decline in herd incidence observed in the particular local areas that had been subject to gassing. He holds the view that badger control accounted for the decline in incidence after 1975.

In view of this difference of opinion on a technical matter, it is difficult for us to reach a conclusion on this issue. The trends observed are consistent with the view that infection from badgers is a major factor in the South West. But whether the trends contribute positively to the case against the badger seems to be open to dispute.

Another type of indication of a link between badgers and bovine TB in cattle is the coincident location of cattle herd breakdowns and of badgers. The main black spot areas for herd breakdowns are also areas where badgers are relatively common, particularly parts of the South West. Some areas with a high density of badgers do not have much bovine TB in cattle, but the badgers there may not be infected or there may be a low density of cattle.

In the South West, MAFF has frequently trapped infected badgers in the locality of cattle herd breakdowns, and in many of these cases, there was no evidence of infection from other cattle. In the years 1979-84 there were 481 confirmed herd breakdowns in the South West and MAFF attributed the source of infection to badgers in 340 (or 70.7 per cent) of these cases (Dunnet et al., 1986, Appendix 5). This meant both that no other source was found and that infected badgers were discovered near the herd breakdowns concerned. There could have been some other undiscovered source in at least some of these cases, but the repeated discovery of infected badgers near otherwise unexplained breakdowns provides strong circumstantial evidence of cattle infection from badgers.

Wilesmith (1983) has examined the relationship between local densities of badger setts and numbers of herd breakdowns in Gloucestershire/Avon, Cornwall, and England and Wales excluding the South West region during the period 1972-78. In Gloucestershire/Avon and Cornwall he found that there was a positive and statistically significant relationship between badger sett density and the rate of infection of herds which had either no established source of infection or had an origin attributed to badgers. There was no such relationship between sett density and infection rates of herds whose source of infection was attributed to purchased animals.

In most of England and Wales outside the South West region, badgers were not investigated as a source of infection in the period studied. But Wilesmith (1983) found that in these areas there was a statistically significant relationship between badger sett density and the rate of infection of herds with no known origin of infection.

Local Area Case Studies

The above indications of a link between badgers and bovine TB in cattle are supplemented by a number of local area case studies. The Wildlife Link report (1984, p. 49) states that two of these, Thornbury in Avon and a large farm in Dorset, "have provided the best evidence so far that in some areas of the South-West tuberculous badgers are responsible for spreading the disease".

The Dorset case is reported in Zuckerman (1980, Appendix III) and by Wilesmith et al. (1982) and Little et al. (1982a and 1982b). On the large farm concerned, there were persistent major outbreaks of TB in cattle between 1970 and 1975, except for 1972. A total of 397 cattle were slaughtered, of which 158 had visible TB lesions. There was a high density of badgers in the area and they were found to have a high level of infection. Removal of badgers began in September 1974 and was completed by early 1976. Subsequent to this action, there were no further outbreaks in cattle from 1976 onwards.

The Thornbury case, which is also reported in Zuckerman (1980, Appendix III), involved a badger clearance programme in an area of some 10,000 hectares. There had been a history of herd breakdowns in the area in most years between 1966 and 1976, affecting 39 herds. Again, there was a large population of badgers with a high level of infection. Removal of badgers began in December 1975 and continued in 1976. In 1977, just one reactor animal was found among cattle in the area and none were found subsequently. Other local case studies linking infected badgers to cattle herd breakdowns are reported in Zuckerman (1980, Appendix III), Wilesmith et al. (1986) and Hewson and Simpson (1987).

Bovine Tuberculosis in Animals Other than Badgers and Cattle

It is clear from the above that badgers do infect cattle. But what of the role of other animals as possible sources of infection? In investigations of herd breakdowns, MAFF has examined other wild animals, and others have been examined for M. bovis after being submitted to Ministry laboratories. The results of all these examinations from 1971 to 1984 are summarised in Table 2.1.

As the table shows, M.bovis has been found in a small number of foxes, rats, moles, mink and deer. With the exception of deer, however, none of the specimens had lesions of tuberculosis and it was concluded that they were not likely to have been infectious. While visible lesions have been found in more deer since 1984, the Dunnet Report concluded that wild deer are unlikely to constitute a significant risk for cattle.

Table 2.1: *Wildlife other than Badgers Examined in Veterinary Laboratories of the Agriculture Departments in Great Britain, 1971-84*

Species Examined	*Number Examined*	*Number Positive for M. Bovis*
Bats		
Bat (Pipistrellus pipistrellus)	1	0
Insectivores		
Shrew (Sorex.spp)	135	0
Hedgehog (Erinaceus europaeus)	22	0
Mole (Talpa europaea)	165	2
Carnivores		
Cat (Felis catus)	25	0
Fox (Vulpes vulpes)	711	6
- faeces	42	0
Ferret (Mustela putorius furo)	23	0
Polecat (Mustela putorius)	8	0
Stoat (Mustela erminea)	32	0
Weasel (Mustela nivalis)	33	0
Mink (Mustela vison)	172	1
Lagomorphs		
Rabbit (Oryctolagus cuniculus)	143	0
Hare (Lepus copensis)	14	0
Rodents		
Grey Squirrel (Sciurus corolinensis)	177	0
House Mouse (Mus musculus)	58	0
Woodmouse (Apodemus sylvaticus)	744	0
Yellow Necked Mouse (Apodemus flavicollis)	73	0
Rat (Rattus norvegicus)	409	5
Harvest Mouse (Micromys minutus)	3	0
Voles (Bank and Field)	875	0
Deer		
Deer (Cervus elaphus, Capreolus capreolus, Dama dama)	123	2
- faeces	42	0

Source: Dunnet, et al., (1986, Appendix 8)

Apart from deer, therefore, there is little evidence that any other wild mammals in Great Britain can become infectious and transmit infection to cattle.

Conclusions on Badgers and Bovine Tuberculosis in Great Britain

In summary, the available evidence from Great Britain indicates that badgers are a significant source of infection of cattle there. While this conclusion is accepted, at least to some degree, by conservationist organisations and individuals, they tend to question whether infection from badgers constitutes as large a part of the problem as MAFF would claim. Thus the Wildlife Link report (1984, p.16) accepted "that badgers are susceptible to bovine tuberculosis and that they are partly responsible for the relatively high levels of the disease in cattle in certain areas of the south-west". Neal (1986, p.205) states that "the crucial question today no longer concerns whether badgers can infect cattle, but whether the control methods being used are effective in eradicating the disease or at least reducing it to an acceptable level. Unfortunately there is little evidence of success".

The Wildlife Link report's questioning of official policy also related mainly to the methods of badger control, rather than the fundamental issue of whether badgers are a source of infection in cattle. Since the publication of the Dunnet report, MAFF has given a high priority to the development of a diagnostic test for M. Bovis in living badgers. If such a test were available, badger control could be made more effective and humane.

Possums and Bovine Tuberculosis in New Zealand

Before concluding this chapter, it is worth referring to the case of bovine TB in possums in New Zealand. On the west coast of New Zealand, 4.5 per cent of cattle were reactors in 1970, compared with 0.85 per cent in other parts of the country. A search for a reservoir of infection among wildlife in the problem areas on the west coast resulted in infection being frequently discovered in possums, with an incidence level typically at around 5 per cent. Many "open" infectious cases were also found and it was concluded that possums were a source of infection in cattle (Wildlife Link report, 1984, p. 39).

In 1972 a programme of possum control was started, using poison bait dropped from aircraft, and by 1974 the incidence of cattle reactors in the area concerned was reduced to around 0.85 per cent - a level comparable to the rest of the country. Since then, the national incidence of TB in cattle has been reduced further in New Zealand, with just 0.06 per cent of cattle reacting in 1987 (*Surveillance*, Vol. 15, No. 3, 1988). But there are problem areas remaining with a higher incidence level, and nearly all of these have infection in the possum population. Tuberculosis is considered to be endemic in the possum population in such areas.

It is considered feasible to eradicate TB from the possum population in minor endemic areas. But in the major endemic areas, it is considered both practically and economically impossible to do so. At present, therefore, the government's objective is not total eradication. Rather it aims to restrict the spread of TB in possums beyond existing endemic areas and to reduce the incidence of TB in cattle in those areas by possum control. Eradication of TB in possums will be attempted in any new endemic areas, as well as existing minor endemic areas where it is considered feasible and local ratepayers are willing to contribute towards the cost (*Surveillance*, Vol. 15, No. 3, 1988).

Chapter 3

The Relationship between Badgers and Bovine Tuberculosis in Ireland

The badger was declared a preserved species under the Wildlife Act of 1976 (No.39 of 1976). Under this Act it is an offence punishable by law for any person to deliberately hunt or kill a badger otherwise than under permission on a licence granted by the Minister responsible for the Wildlife Service: (Chapter 3, Section 23). Section 42 of the Act states that the Minister may grant the permission subject to the condition that any capture pursuant to the permission is to be affected by specified means and it shall be valid only for a specified period.

This Act, which outlaws badger baiting and a number of other practices associated with habitat and snaring, seems to have resulted in a marked increase in the badger population. Other factors may also have contributed such as:

(a) increased areas of woods and plantations which are suitable habitats for badger setts;

(b) increased earthworm populations on pasture due to increased use of slurry and fertilisers. Badgers tend to expand their breeding habits in response to increased feed (mainly earthworms);

(c) reduced snaring of foxes. Thousands of foxes were snared for export of skins in the late 1970s and early 1980s and during this period a large number of badgers were also inadvertently snared. The fox skin market is no longer profitable and as a result foxes (and presumably badgers) are not now being snared to the same degree. However since no national badger count has been undertaken there is no evidence to support the view that badger numbers have in fact increased sharply in recent years.

Tuberculosis in Badgers

Until quite recently very little information was available on the distribution of tuberculosis in badgers in Ireland. In 1975 Noonan et al. reported the presence of tuberculosis in a badger in West Cork. Since then increased attention has been devoted by the Department of Agriculture to establishing the level of the disease in badgers throughout the State. Results from the Regional Veterinary Laboratories in 1984 showed that of 176 badgers examined prior to that date, 33, or 19 per cent, had TB lesions (Duffy 1987). These badgers came from different counties but are unlikely to be a random sample of the badger population. They were either road casualties or badgers found dead on farms. Nevertheless they indicated that the badger population was a reservoir of bovine TB and could be a factor in the spread of the disease in cattle. Acting on these figures and on reports from veterinary surgeons throughout

the country the Department adopted a definite policy in 1985 in relation to badgers in its bovine TB eradication scheme. This policy is outlined in Appendix B.

Badger Removal

In the four years 1985 to 1988 a total of 2,633 badgers were snared and killed in 21 counties (Table 3.1). These do not include badgers killed accidentally and subsequently examined.

Of the total number snared 434 or 16 per cent had gross tuberculosis lesions. This, of course, cannot be taken as reflecting the true incidence of the disease in badgers in the State. In the first instance, those captured were not a random sample of the badger population. The table shows that most badgers removed were from Offaly, Longford, Galway, Westmeath and S.W. Cork, counties which have very high incidences of bovine tuberculosis. Secondly the incidence is based on gross lesions. A higher incidence would be found if a bacteriological examination were made of non-lesion animals.

Projects which have been undertaken in different parts of the country to reduce the incidence of TB in cattle through badger removal are presented below.

Table 3.1: *Number of badgers caught under licence and number with gross lesions by county 1985-1988**

County	*No. Caught*					*No. with gross lesions*					
	1985	*1986*	*1987*	*1988*	*Total*	*1985*	*1986*	*1987*	*1988*	*Total*	*%*
Carlow	-	16	13	6	35	-	7	6	-	13	37.1
Cavan		22	19	74	115		3	3	15	21	18.3
Clare		9	-	33	42		-	-	3	3	7.1
Cork N.E.		6	-	18	24		-	-	2	2	8.3
Cork S.W.	63	70	26	36	195	14	13	6	6	39	20.0
Donegal	-	-	-	31	31	-	-	-	2	2	6.5
Dublin	13	-	-	-	13	3	-	-	-	3	23.1
Galway	106	67	55	98	326	32	9	8	13	62	19.0
Kerry	14	22	20	15	71	1	3	7	1	12	16.9
Kildare	1	12	35	3	51	0	1	10	-	11	21.6
Kilkenny	1	26	17	13	57	-	9	2	4	15	26.3
Leitrim	-	5	-	23	28	-	1	-	3	4	14.3
Limerick	-	36	60	33	129	-	7	4	4	15	11.6
Longford		177	113	121	411	-	26	14	9	49	11.9
Monaghan	-	-	-	22	22				3	3	13.6
Offaly	115	163	91	48	417	21	55	8	10	94	22.5
Roscommon	-	44	29	109	182	-	9	2	19	30	16.5
Sligo	-	51	-	32	83	-	2	-	2	4	4.8
Tipperary	9	27	11	107	154	2	8	2	8	20	13.0
Westmeath	7	50	68	99	224	3	15	5	6	29	12.9
Wexford		5		-	5	-	-	-	-	-	-
Wicklow	18	-	-	-	18	3	-	-	-	3	16.7
Total	347	808	557	921	2633	79 (23)	168 (21)	77 (14)	110 (12)	434 (16)	

Note: Figures in brackets are percentages. * January-October figures for 1988.
Source: Eradication of Animal Disease Board (ERAD)

Offaly

Co. Offaly has an area of 771 sq. miles in 87 District Electoral Divisions (DEDs). The cattle population is about 200,000 in 4,200 herds. Average herd size is 46 animals. The bovine tuberculosis situation in the county in the years 1978 to 1987 is given in Table 3.2. This table shows that

Table 3.2: *Co. Offaly Bovine TB History*

Year	*No. of reactor herds*	*Number of reactor animals*	*% of herds with reactors*	*Reactor animals as % of total animals*
1978	289	532	6.8	0.27
1979	214	525	5.0	0.27
1980	261	603	6.2	0.30
1981	326	865	7.7	0.43
1982	478	1495	11.3	0.75
1983	440	1432	10.4	0.72
1984	370	1210	8.8	0.61
1985	360	1030	8.5	0.52
1986	329	987	7.8	0.49
1987	325	991	7.7	0.50

Source: Offaly DVO.

the percentage of herds with reactors rose from 5-7 per cent between 1978 and 1980 to over 10-11 per cent in 1982 and 1983 and subsequently declined to 7-8 per cent. The number of reactor animals reached a peak of 1,495 in 1982 amounting to 0.75 per cent of the cattle in the county. This is a very high level by national standards (see Table 1.2)

A report prepared by the Offaly DVO in November 1988 notes that most of the TB outbreaks in the 1980s are concentrated in clusters of herds located in particular geographic areas. In the majority of breakdowns the reactors identified were from groups of cattle which were on a particular area of land at a particular time. When some of these reactors were later mixed with other cattle from the same herd no further reactors were identified. Lateral spread from animal to animal seemed to be less than might be expected.

The report concluded by saying that the majority of the breakdowns were linked to the TB status of the local badger population and were often associated with the presence of a severely TB infected dead or dying badger.

To test this conclusion a number of case studies were undertaken. The results from some of these are summarised below:

Joint Department of Agriculture/Department of Wildlife Study

Investigations were undertaken in two areas of Co. Offaly. They were selected because of high and prevailing levels of TB in the cattle in these areas and the presence of badgers which were thought to be infected with TB. The herds were tested according to the procedures adopted for the county as a whole. Contiguous herds to each breakdown were tested and retesting of all the herds in the local area was undertaken where a large number of herds had gone reactor.

The badgers were caught in specially made stoppered snares and were euthanised with pentobarbitone injections. No official snaring of badgers had taken place in either of these areas previous to this study. The first official snaring began in November 1986 and ended on the 31 January 1987. Snaring was resumed in May 1987 and has continued at intervals since then.

Rahan Area - 4,500 Acres

This area is bounded on the northern side by a river which turns southwards and comes quite close to the Grand Canal at the western end. The canal forms the southern boundary. The eastern boundary is a public road. There were 65 herds in the area in 1980. This has subsequently increased to 71 herds. Herd sizes vary from just a few cattle to 300. Total cattle numbers varied from 2,758 in 1985 to 4,154 in 1983.

Twenty badger setts were identified of which 6 were active. Density was estimated at 5 badgers per sq.km. Between November 1986 and May 1988 27 badgers were snared, of which 8 showed TB lesions (30 per cent).

Table 3.3 shows that the prevalence of the disease in herds (infected herds as a per cent of total) rose from 7.6 per cent in 1980 to 41.8 per cent in 1984, and remained at about that level until the end of 1986 when the badger programme commenced. TB levels dropped to 16.2 per cent in 1987 but rose somewhat to 18.3 per cent in 1988.

Some of the increase in reactors between 1980 and 1986 is no doubt due to the increased level of testing and the more severe interpretation of the test applied. Nevertheless the number of reactors was so high in the period 1984-1986 that there must have been a real increase in the disease levels in those years. In fact the increased amount of testing was due to the large numbers of reactors being identified. For example in 1983 one herd of 130 cattle with a very good previous record had 12 reactors. Eight of these showed TB lesions on slaughter. In 1984 one herd of 35 animals which had been clear since 1980 had 25 reactors, 8 of which showed lesions.

Table 3.3: *Rahan Co. Offaly, Bovine TB History 1980-88*

Year	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*
					No		Badger Removal		
Herds	65	65	65	67	67	68	68	68	71
Animals	3340	3651	3846	4154	3587	2757	3779	3173	3068
Reactors									
Herds	5	13	10	12	28	27	23	11	13
Animals	12	26	12	26	80	61	87	14	21
Period Prevalence*									
Herds	7.6	13.8	15.4	18.5	41.8	39.7	33.8	16.2	18.3
Animals	0.36	0.71	0.31	0.50	2.33	2.21	2.30	0.44	0.68

* For definition of period, prevalence see Appendix A.
Source: Offaly DVO.

While the current disease levels are higher than in 1980 nevertheless the results given in Table 3.3 indicate that the badger control programme was instrumental in reducing the TB levels in all cattle herds by about 50 per cent. The Offaly report says that the area is too small to demonstrate the full impact of badger control on prevailing disease levels. It is impossible to prevent re-colonisation of setts. Setts that had badgers removed from them and had subsequently become quiescent showed signs of activity again after a number of months.

Killeigh Area - 2500 Acres

The second study area, Killeigh, is about five miles south of Tullamore. It is bounded on the south by bogland, on the west by a river, on the north by a marsh and on the east by farmland in Co. Laois. The area has 33 herds of cattle ranging in size from one animal to 350. Total cattle numbers varied from 1,747 in 1980 to 2,580 in 1985.

The number of badger setts within the area at the start of the investigation was nine and positive badgers were snared at six of these during the period December 1986 to January 1987. Further snaring was undertaken on five subsequent occasions and is continuing at the present time due to re-colonisation of setts.

Table 3.4 shows that there had been a huge build up of cattle infection in the area between 1980 and 1984 when 58 reactors were removed from 7 of the 32 herds. Following commencement of the badger removal programme in 1986 the number of reactor cattle declined to 39 in 1985 and to 41 in 1986. The level dropped to 2 in Spring 1987.

All herds were clear in Autumn 1987 but during 1988, 8 herds became infected. Six of these had single reactors, one had 2 reactors and one had 3 reactors.

As in Rahan the area is too small to be kept entirely free of badgers. However the disease level in cattle in this area must continue to be monitored over the coming years.

Table 3.4: *Killeigh, Co. Offaly TB Bovine History 1980-1988*

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988
		No					Badger removal		
No of Herds	27	29	30	32	31	32	32	29	27
Reactors									
Herds	1	3	4	7	7	13	10	1	8
Animals	1	8	10	32	58	39	41	2	11
Period Prevalence					%				
Herds	3.7	10.3	13.3	21.9	22.6	40.6	31.3	3.4	29.6
Animals*	0.04	0.33	0.41	1.30	2.36	1.59	1.67	0.08	0.45

* Prevalence based on an average of 2458 cattle
Source: Offaly DVO.

Croghan DED

Between 1980 and 1988 this DED had an average of 1715 cattle in 36 herds. Because of a serious build up in reactor herds in the area which could not be controlled by testing a licence to snare badgers in the district was obtained in 1985. Twenty badgers were removed in 1985/86 of which 5 were TB positive. In 1987, 17 were removed of which 3 were positive. Following these removals the level of bovine TB dropped markedly. Table 3.5 shows that the number reactors removed dropped from 71 in 1986 to 8 in 1987 but rose to 11 in 1988 when 6 were removed from one farm on which a dead badger had been found.

Because of the necessity to trap badgers by snaring it has not been possible to achieve complete removal. Nevertheless the limited removal exercise undertaken seems to have been attended by a reduction in the TB level in the area. Whether the improvement will be maintained in future years is uncertain.

Table 3.5 *Croghan DED Co. Offaly Bovine TB History 1980-1988*

Year	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*
				No		Badger Removal			
Reactor Herds	12	6	6	5	11	11	13	5	4
Reactor Animals	24	14	16	11	57	57	71	8	11
*Period Prevalence**				%					
Herds	33.3	16.7	16.7	13.9	30.6	30.6	36.1	13.9	11.1
Animals	1.40	0.82	0.93	0.64	3.32	3.32	4.14	0.4	0.64

* Prevalence based on an average of 1715 cattle in 36 herds

Other Offaly Areas

In the Ballymooney area three neighbouring farms with a total of about 250 cattle had severe outbreaks of bovine TB in 1985. The area has had a very good TB history and these three farms had only one reactor between them from 1980 to 1985. The three herds had clear tests in the summer of 1985 but a severe breakdown occurred on one of the farms in the Autumn of that year even though no cattle were reported to have been bought in since the summer test. The reactors were detected through a pre-movement test. In the two years 1985 and 1986 a total of 67 animals were removed from the three herds.

Initial investigation on these herds for bought-in cattle, lateral spread and residual infection, failed to produce a satisfactory explanation for the breakdown. However, a badger which was found dead on one of the farms in December 1985 had generalised TB lesions.

Arising from this a licence was obtained to remove badgers from two setts on these farms. Of five badgers snared from one sett, 1 had TB lesions. Four badgers removed from the other sett were clear.

Since the badgers were removed in the Spring of 1986 all the cattle have remained clear on these farms except for 1 inconclusive reactor in 1987.

Knockearl, Brickanagh and Emmil Townlands are situated on the county boundary between Offaly and Tipperary. Apart from a minor outbreak in 1983 the area was clear of bovine TB from 1980 to 1985. In 1986/87 a major outbreak occurred involving 9 herds which between them had 749 cattle.

Eighty eight reactors were removed from these lands in the period June 1986 to June 1987. In addition two herds in Co. Tipperary which were contiguous to these herds were restricted at this time also.

Two decomposed badgers were found in this area at the time. Arising from this, allied to the severity of the outbreak a licence to snare badgers was obtained at the end of 1986. Of 15 badgers removed from 9 setts in early 1987, 3 showed gross lesions of TB.

All of the herds except two have been clear since the end of 1987. One reactor was found on each of two herds in June 1988 but these herds have gone clear since then.

Summary of Offaly Test Areas

The results from the different Offaly investigations described above are summarised in Table 3.6.

Table 3.6: *Overall Impact of Badger removal on Bovine TB levels in Co. Offaly*

Year	*Rahan*		*Killeigh*		*Croghan*		*Ballymooney*		*Knockearl Brickanagh Emmil*	
	Herds (67)	Animals (3483)	Herds (32)	Animals (2458)	Herds (36)	Animals (1915)	Herds (3)	Animals 244	Herds (9)	Animals (749)
					No of Reactors					
1980	5	12	1	1	12	24	-	-	-	-
1981	13	26	3	8	6	14	-	-	-	-
1982	10	12	4	10	6	16	1	1	-	-
1983	12	26	7	12	5	11	-	-	3	6
1984	28	80	7	58	11	57	-	-	-	-
1985	27	61	13	39	11	37	1	26	-	-
1986	28	87	10	41	16	7	3	42	5	48
1987	11	14	1	2	5	18	1	1	6	40
1988	13	21	8	11	4	11	-	-	2	2

Note: The cross lines in the table indicate the time when the badger removal programmes commenced in each area. The figures in brackets at the head of the columns are the average number of herds/animals in this area.

This table shows that in all the areas the number of reactor herds and animals declined following badger removal programmes.

However, overall the disease level is no lower now than in 1980. This could be due to the fact:

(a) that all the badgers have not been removed in these areas and

(b) that there is still a good deal of residual infection which can only be controlled by intensive testing.

South West Cork

Even though there is little cattle movement into the region, South West Cork has had a poor bovine tuberculosis record over the years (see Table 1.3). As in most other counties some areas in the region are particularly bad, notably the Castlehaven district which is an area of 15 sq. miles comprising two DEDs. Despite an intensive testing programme in 1984/85 the level of TB in cattle remained relatively high in the district. Because of this, allied to the relatively large badger population a badger control programme was undertaken in 1986, when 50 badgers were removed, 10 of which had visual lesions of TB. In 1987, a further 27 badgers were snared, of which 10 had lesions. In 1988, four badgers were snared, all of which had TB lesions. In addition 13 killed by road traffic were examined and 6 had lesions.

As shown in Table 3.7 the herd prevalence dropped from roughly 30 to 20 per cent in 1985 following the intensive cattle testing programme. With the introduction of the badger removal programme in 1986 the herd prevalence was reduced to 14 per cent in 1986 and 1987 and to 7.6 per cent in 1988. It has not been possible to remove all the badgers by snaring. There is still a very high concentration of badgers in the area judging by the activity round the setts.

Table 3.7: *Bovine TB history in the Castlehaven Area of West Cork 1980-1988*

	1980	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*
							Badger Removal		
Reactor herds No.	18	34	29	29	34	24	17	16	9
Reactors No.	38	136	122	118	111	67	51	38	30
					%				
*Period Prevalence**									
Herd	15.3	28.8	24.6	24.6	28.8	20.3	14.4	13.6	7.6
Animal	0.79	2.81	2.52	2.44	2.29	1.38	1.05	0.79	0.62

* Prevalence based on an average of 4840 animals in 118 herds.
Source: S.W. Cork DVO

One farm in the area has been restricted for almost 8 years (1980-88) apart for one six-month interval. The farm carries about 80 cattle, none of which is reported to be brought-in. Between May and December 1987 nine badgers were trapped in the vicinity of this farm of which four were TB positive. Following these removals, the herd has been clear since January 1988.

Every attempt is being made to prevent re-colonisation of the setts concerned and to prevent badgers from outside areas coming onto the land.

Galway

The Ballycrissane/Derryhiney area of East Galway covers 708 hectares (1749 acres) approximately 5 km. north of Portumna. The area is divided by the main Portumna/Ballinasloe road and is bounded by woods and bogland on the west and by the Shannon river on the east.

Of the 49 herds in the area 35 had a chronic TB problem between 1980 and 1985 (Table 3.8). In 6 of the problem herds, bought-in stock were considered to be the likely source of the disease. In the remaining 29 herds (2,000 cattle) the source could not be identified. Intensive testing programmes in addition to other standard TB eradication procedures failed to improve the situation over the three-year period from 1982 to 1985. The finding of a dead badger with generalised tuberculosis late in 1984, and further infected badgers on a subsequent survey resulted in a badger eradication programme being initiated in 1985.

Following mapping of the badger setts (17) in the Spring of 1985 snaring was commenced in June 1985 and continued until October of that year. Thereafter snares were set only where there were persistent signs of badger activity or where

Table 3.8: *History of Bovine TB in Ballycrissane Co. Galway 1980-1988*

Year	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*
			No			Badger Removal			
Reactor Herds	1	4	21	11	20	20	2	2	0
Reactor Animals	1	27	87	22	130	72	5	2	0
Period Prevalence*			%						
Herd	3.4	13.8	72.4	37.9	69.0	69.0	6.8	6.0	0.0
Animal	0.05	1.35	4.35	1.10	6.50	3.60	0.25	0.10	0.0

* Prevalence based on an average of 2000 cattle in 29 herds
Source: Source EP Duffy (1987) and Galway DVO.

repopulation of setts had taken place. A total of 54 badgers were removed. Fourteen (29%) of the 48 badgers subjected to post mortem examinations had visible lesions.

The disease profile for the cattle herds in the area given in Table 3.8 shows that a total of 87 reactors was removed in 1982. While this dropped to 22 in 1983 the outbreak flared up again in 1984 when 20 herds were infected and 130 reactors were removed. The following year 20 herds had 72 reactors despite nearly 3 tests per herd on average in 1984. Following badger removal in 1985 only 2 herds had infection in 1986 and 1987, and all herds have remained clear in 1988.

The Glann, Oughterard area of Co. Galway, which has 14 cattle herds, is virtually isolated from the rest of the county. The farms are bounded on one side by Lough Corrib and on the others by high hills and state forests. There is a long history of herd breakdowns in the area.

In 1983: 6 herds had 17 reactors. In 1984: 10 reactors were detected in 5 herds and in 1985: 9 herds had 21 reactors removed.

Following the receipt of a licence in June 1985 30 badgers were removed in the late Autumn of 1985 and early January 1986. Nearly half had tuberculosis. In the following year (1986) one herd had 2 reactors and in 1987 2 herds had just one reactor each. In 1988 all herds in the area were clear.

In certain other areas in Co. Galway where badgers have not been officially removed the disease levels have remained high despite intensive testing. For comparative purposes these areas may be taken as controls for the Ballycrissane and the Glann regions where badger control programmes have been followed by a marked reduction in disease levels.

The bovine TB profile in two DEDs (Doonbally and Addergoole) in the Tuam area from which badgers were not officially removed is given in Table 3.9.

Table 3.9: *Bovine TB History in Doonbally and Addergoole Co. Galway 1979-1988*

	1979	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*
						No.				
Reactor herds	7	8	11	27	14	17	47	32	36	34
Reactor Animals	9	13	18	57	21	43	150	109	56	64
Period Prevalence*						%				
Herd	3.32	3.79	5.21	12.80	6.64	8.06	22.27	15.17	17.06	16.11
Animal	0.15	0.22	0.31	0.98	0.36	0.74	2.59	1.88	0.97	1.10

* Prevalence based on an average of 5,860 animals in 211 herds
Source: Galway DVO

This table shows that the number of reactor herds rose from 7 in 1979 to 47 in 1985 and declined erratically to 34 in 1988. Over the same period reactor animals rose from 9 in 1979 to 150 in 1985 and declined to around 60 in 1987 and 1988. Hence, the disease level in these DEDs has been reduced by conventional eradication methods. However the extent of the improvement is much less than that achieved in the Ballycrissane and Glann areas where badgers were officially removed.

Co. Longford

Over the period 1980 to 1987 Co. Longford has had the highest incidence of bovine tuberculosis in Ireland. During that time approximately 7 out of every 1,000 animals tested were positive and one herd in every three was restricted at some time during the period. As shown in Figure 3.1 the disease level in Co. Longford was relatively high between 1964 and 1977 with up to 50 reactors being removed per month over the period. In 1977, however, the levels increased dramatically and in 1983 when 170 reactors were removed in one month the disease level had reached epidemic proportions. Since then, despite intensive testing, the level of the disease has remained very high. No doubt some of the marked increase in reactors in recent years is a consequence of a more intensive testing programme coupled to more severe interpretation of the tests. Nevertheless the actual level of the disease is unacceptably high.

Kenagh Area

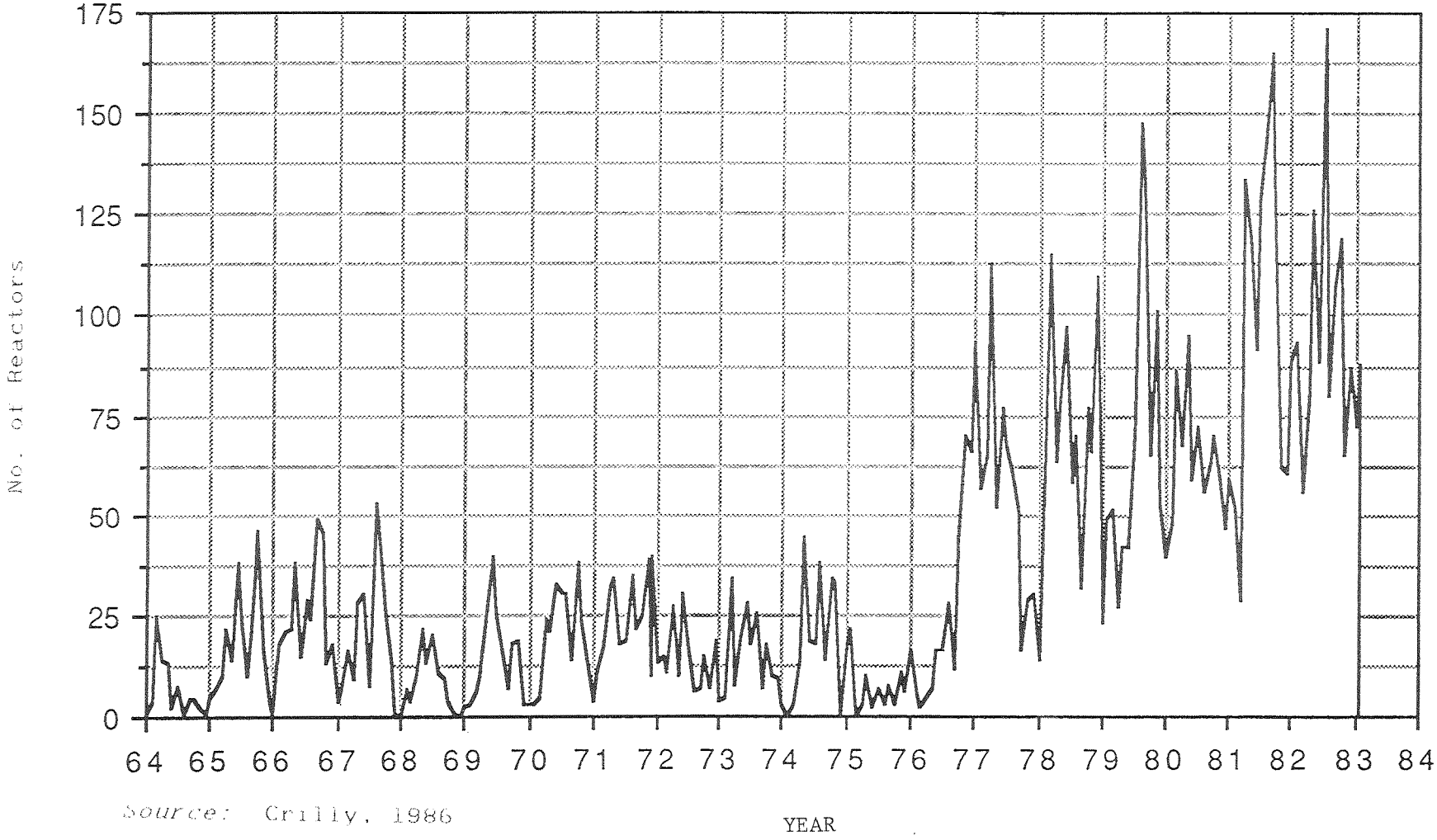
The area between Kenagh, Killashee and Longford town has had an extremely high level of the disease. Up to 80 per cent of the herds in the area have been restricted at some time during the last 7 years. The area had a major outbreak of bovine TB in 1981 when one-sixth of the herds had reactors (see Table 3.10). Despite intensive efforts to control the disease the TB level continued to escalate reaching an unprecedented animal period prevalence level of 5.8 per cent

Table 3.10: *Bovine TB History in Kenagh Co. Longford 1980-1988*

Year	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*
				No	Badger Removal				
Reactor Herds	7	13	19	31	26	29	14	14	10
Reactor Animals	13	119	74	248	206	149	77	55	30
*Period Prevalence**				%					
Herd	9.0	16.7	24.4	39.7	33.3	37.2	17.9	17.9	12.8
Animal	0.32	0.42	1.80	5.80	4.58	3.52	1.91	1.38	0.75

* Prevalence based on actual no of cattle and herds in area each year i.e approximately 4100 cattle in 78 herds.
Source: Longford DVO

Figure 3.1: Number of Reactors by Month in Longford 1964-1983



Source: Crilly, 1986

in 1983, when every animal in the region was tested about three times. Despite this amount of testing disease prevalence continued almost unabated in 1984. In August of that year a licence was obtained to examine the possible involvement of the badger in spreading the disease. Ten badgers were trapped in snares and three of these were found to have TB lesions. In 1985 a further 50 badgers were trapped and thirty per cent of these had TB lesions.

From August 1984 to January 1987 a total of 79 badgers were removed from the area and its surrounding 2 km. buffer zone. Gross lesions of TB were found in 23 (31 per cent) of the 74 badgers subjected to laboratory examination. Between January 1987 and January 1988 a further 27 badgers were trapped, of which 5 (18.5 per cent) had lesions.

Following the initial removal of the badgers in 1984 and 1985 the bovine TB level declined sharply in 1986. However the level remained very high with 18 per cent of herds and almost 2 per cent of animals infected.

Intensive testing of the cattle population continued in 1987 when 13,266 animal tests were carried out and 55 reactor animals were identified. Twenty-seven of these were on one farm which has a chronic disease problem not necessarily associated with badgers. In 1988 the number of reactors detected was reduced to 30, of which 11 were on the chronic farm.

The removal of badgers has been attended by a marked reduction in disease levels in the area. Failure to reduce the TB levels further may indicate that all of the badgers have not been removed by snaring. However, after the very heavy levels of infection in the recent past, there must still be a considerable amount of residual infection in the area which can only be reduced by intensive testing and possibly by depopulation of chronic herds. As with the other test areas described, it is essential to monitor disease levels and badger density in the area over the coming years.

Granard Area

The area (4 DEDs - 36 sq. miles) surrounding Granard town, experienced a major outbreak of bovine TB in 1985/86 (Table 3.11). However in contrast to Kenagh (above) badgers had not been officially removed from the area until very recently (mid 1988).

Despite intensive testing TB levels continued to escalate in the area. Every bovine animal in the district has been tested three to four times annually over the last two years. Table 3.11 shows that the number of tests in the area rose from 13,697 in 1982/83 to 30,026 in 1987/88 with a reduction to 7,476 tests in 1984/85, due to shortage of funding.

Table 3.11: *Bovine TB History in Granard Area, 1982/83 - 1988/89*

Year	*1982/83*	*1983/84*	*1984/85*	*1985/86*	*1986/87*	*1987/88*	*1988/89*
Number of animal tests	13,697	11,623	7,476*	15,590	22,346	30,026	17,835
Number of reactors removed	24	50	57	130	189	307	66
Animal period prevalence** %	0.30	0.66	0.75	1.71	2.50	4.04	0.87

* Reduced funding
**Based on 7,400 cattle each year in 233 herds.
Source: Longford DVO.

The number of reactors in the area rose from 24 in 1982/83 to 307 in 1987/88. Over the period the animal prevalence rose 13 fold, from 0.3 per cent in 1982/83 to 4.04 per cent in 1987/88,

As a result of the massive testing campaign in 1987/88, when every animal in the areas was tested an average of 4 times, the number of reactors removed was reduced to 66 in 1988.

In the Spring of 1987 when it was seen that the disease level in the Granard area seemed to be getting out of control the possibility of wild life as a source of infection was investigated. The badger population in the area was found to be considerable.

Following the granting of licences in March 1988 snaring of badgers commenced in May 1988. Full results of the badger removal programme are not yet available.

While the intensive testing programme has reduced the disease levels in Granard the costs involved have been very high. The direct cost (testing fees plus reactor compensation for the area in the 1987/88 programme) exceeded £90,000. This is three times the cost of typical area of the same size with an average level of disease.

Three Castles Area, Co. Kilkenny

Three Castles located some six miles to the northwest of Kilkenny comprises one DED with 53 herds of cattle. Twenty-three of the herds had a TB problem during 1986 and 1987 (Clancy 1987). The maximum number of reactor herds in the area each year from 1976 to 1985 was 7 and the number of reactor cattle removed varied from zero in 1982 to 19 in 1977. However, in 1986 23 herds were infected and 130 reactors were removed.

Two farms, which between them had 43 reactors, had fields adjacent to a dump which contained a badger sett. The cattle on these fields contracted bovine TB, while cattle on parts of the farms remote from the dump remained clear even though they were mixed at times with cattle from the fields around the dump.

A licence was obtained to investigate the badger setts in the area and by June 1987 a total of 23 badgers had been trapped on this site. Nine (32 per cent) had tuberculosis. Since the removal of the badgers the two herds have gone clear.

Badgers do not appear to have been the primary factors responsible for the TB outbreaks on the other infected farms in the area. Other factors, such as cattle movement, residual infection, bad fences etc., seem to have been the main contributory factors.

Other Investigations

In Co. Dublin an offal factory was diagnosed as being responsible for a major disease outbreak even though infected badgers were found in the area and were at first thought to have been responsible. The infected herds went clear at the end of 1985 after some badgers were removed and the offal factory closed down. The herds in the area have remained clear since then even though there are still infected badgers in the locality.

In Co. Wicklow a large outbreak occurred on a farm where dairy cows in a field were seen surrounding a dying badger which had generalised TB. Sixteen cattle became infected and a licence was obtained to remove the badgers in the area. The herd went clear following this exercise. Subsequently, however, it was shown that a cow on the farm, which was deemed inconclusive on two tests, had generalised TB when slaughtered. While the infected cow rather the badger now seems to have caused the outbreak it is not possible to definitively distinguish between both sources.

Summary of Overall results

Results are summarised in Table 3.12 of major badger removal operations in Offaly, Longford, Galway and SW Cork together with results from two areas from which badgers were not officially removed prior to 1988. Results from the smaller areas and from individual farms are not included in this table as prevalence figures from such areas would be misleading.

Looking first at the areas from which badgers were not officially removed it can be seen that in the Granard area, the animal disease prevalence rose from 0.30 per cent in 1982 to 4.04 per cent in 1987 and declined to 0.87 per cent in 1988. In the Doonbally/Addergoole areas the animal prevalence rose from 0.22 per cent in 1980 to 2.59 per cent in 1985 and declined to 1.10 per cent in 1988. In both these areas the disease

Table 3.12: *Impact of Badger Removal on Bovine TB Levels in a number of areas 1980-1988*

	1980	1981	1982	1983	1984	1985	1986	1987	1988
	Animal Period Prevalence%								
Areas from which badgers removed									
Rahan Offaly	0.36	0.71	0.31	0.50	2.23	2.21	2.30	0.44	0.68
Killeigh "	0.04	0.33	0.41	1.30	2.36	1.59	1.67	0.08	0.45
Croghan "	1.40	0.82	0.93	0.64	3.32	2.16	4.14	0.47	0.64
Castlehaven Cork	0.79	2.81	2.52	2.44	2.29	1.38	1.05	0.79	0.64
Ballycrissane Galway	0.05	1.35	4.35	1.10	6.50	3.60	0.25	0.10	0.00
Glann Glann Galway	na	na	na	6.25	3.68	7.72	0.75	0.75	0.00
Kenagh Longford	0.32	0.42	1.80	5.80	4.58	3.52	1.91	1.38	0.75
Areas from which badgers were not officially removed									
Granard Longford	na	na	0.30	0.66	0.75	1.71	2.59	4.04	0.87
Doonbally/ Addergoole Galway	0.22	0.31	0.98	0.36	0.74	2.59	1.88	0.97	1.10

na = not available.

Note: Lines over figures indicate badger removal programmes.

level has been reduced considerably by intensive testing but it is still unacceptably high.

The most striking impact of badger removal programmes have been obtained in the two Galway areas of Ballycrissane and Glann. In both these districts the animal prevalence has dropped from around 7 per cent in 1984/85 to zero in 1988 following badger removal. The level of the disease in the other areas summarised in Table 3.12 has also declined sharply following badger removal. However there is still a high level of residual infection in these areas.

While it is realised that there is a cyclical pattern in bovine TB outbreaks, (See Figure 1.2) which could have caused a decline in disease levels in recent years, nevertheless it is felt that the steep drops which have occurred in the areas from which badgers were officially removed are not entirely due to this effect. It seems too much of a coincidence that the decline in each case would have followed badger removal if these animals were not responsible to some extent for the outbreaks. Badger removals combined with intensive testing seem to have played important roles in the disease reduction in these areas but of course further time

to see how results progress and a more thorough removal of badgers from some of the areas would lead to firmer conclusions. For that reason every effort should be made to keep these areas clear of badgers over the coming years and at the same time monitor the TB levels in the cattle.

Chapter 4

Discussion and Conclusions

It is difficult to determine experimentally the relative contribution of the badger to the spread of bovine tuberculosis. First, it is not easy to quantify the risk of transmission of the disease from badgers to cattle particularly under farm conditions. Secondly there are problems with setting up investigations to determine the impact on prevailing disease levels of removing infected badgers.

In the concrete yard experiments in England, described in Chapter 2, it took six months exposure to infected badgers for calves to become infected with TB. In the Woodchester Park experiment in Gloucestershire, where 16 herds of cattle were in contact with infected badgers under more natural conditions, it took six years for a herd breakdown to occur. However when the infection took place it was quite dramatic, affecting four farms from one of which 46 cattle had to be removed.

Commenting on the results of the concrete yard experiments, Little et al (1982) concluded that "in the field the relative risk of cattle acquiring infection from badgers is low". This conclusion appears to be supported by the Woodchester Park experiment since the time taken for badgers to infect cattle there was relatively long. On the other hand, a recent experiment in Abbotstown (see O'Reilly and Costello, 1988), though not concerned with badgers, would tend to cast some doubt on the usefulness of trials carried out under such conditions in assessing the risk of TB transmission. In this experiment, healthy cattle in contact with infected cattle for 4 to 9 months did not catch the disease. Yet it is well known that TB does spread rapidly from animal to animal (and indeed from person to person) given the right conditions.

What conclusion can be drawn from the British trials? The concrete yard experiments prove that badgers can transmit the disease to cattle. The Woodchester Park experiment shows the same result but it also shows that when infection does take place under field conditions a large number of animals can go down. The question which then remains to be answered is what is the risk of such infection.

To answer this question, it is necessary to remove badgers from an area where there is a high incidence of bovine tuberculosis in cattle and monitor the impact of such removal. This was done in the Dorset and Thornbury experiments in England from whence the bovine disease seems to have been eliminated. As already described, similar type investigations are being carried out in many areas in Ireland at present. However, the conditions which must be adhered to in undertaking these investigations present some difficulties.

In the absence of gassing it is not possible to remove all the badgers from the test areas and hence the impact cannot be fully assessed. Control areas should be selected and treated in the same way as the test areas except for badger removal. However, in the resent climate of opinion, it would be difficult to ensure the security of the control areas. Some farmers in these areas whose cattle are infected may remove badgers illegally and thus invalidate the exercise.

But even if the badgers are not removed from the control areas, the incidence in an area may decline through cyclical effects and in the short term, at any rate, the comparison with the test area will not be valid.

A third problem is associated with the level of residual infection in the country. Even if badgers are responsible, their removal will not immediately reduce the level of the disease in cattle. False negative animals will continue to spread infection for some time after badger removal.

Hence it is difficult to demonstrate conclusively that badgers play a significant role in the spread of bovine tuberculosis in Ireland. The best that can be done is to assemble and evaluate all the available information. Absolute proof is impossible and indeed seldom is such proof available in any area of enquiry, especially from field experiments. At the end of the day decisions very often have to be taken on the basis of the balance of available information.

Assessment of the Case against the Badger

As was pointed out in Chapter 1, various weaknesses exist in the operation of the bovine TB eradication programme in Ireland. These deficiencies have contributed to the failure to eradicate the disease. Nevertheless the alarming increase in the number of reactors in Offaly and Longford and in other counties can hardly be explained on the basis of these defects.

The data from Longford (Figure 3.1) show that the level of the disease in the county was fairly well controlled from 1964 to 1976 despite complaints about bad testing, stop-go funding, tag switching, illegal movement etc. Yet in 1977, when concerted efforts were being made to remedy these defects, the level of the disease rose dramatically and it has gone on increasing despite intensive testing. Some of the increases in reactor numbers in recent years are due to the more intensive testing programmes, allied to the use of more severe interpretation in testing. However, the magnitude of the increase indicates that the actual level of the disease itself has, in fact, increased substantially in Longford in recent years.

While test results going back to 1964 are not available for Offaly, the data in Table 3.2 show that the level of the disease in that county increased to very high levels in the 1980s.

In view of these figures, together with the corresponding data compiled for other smaller areas of the country, it seems that there is some external vector involved in the spread of the disease particularly in the Shannon basin. More intensive testing on its own does not arrest these outbreaks whereas when combined with badger removal in certain areas there has been a marked decline in disease levels.

Based on the investigations outlined in Chapter 3, a substantial body of evidence has been accumulated indicating that infected badgers make a significant contribution to bovine TB outbreaks in some areas of the country. However, it should be stressed that the badger is not the sole or indeed the primary cause of bovine TB in all areas. With the high residual levels of infection in the cattle population, allied to the high level of cattle movements in the country, the most serious risk of cattle infection in most areas is likely to be from infected cattle.

With a view to quantifying the relative contribution of badgers to the prevailing level of TB in the cattle population, ERAD and the Wildlife Service have recently agreed to undertake a large scale project in East Offaly (see Appendix D). Plans are well advanced to remove badgers from a 240 sq. mile area by snaring and to monitor the resulting impact on the prevailing disease level in cattle. The (direct) cost of the badger removal operation is estimated at £200,000. This district which embraces part of the Killeigh and Rahan areas already investigated (see Chapter 3) has about 60,000 cattle in 1,364 herds and is fairly self contained, being bounded by canals, rivers and roads. A survey of the area indicates a density of about 4 badgers per sq. km. The area also has a history of bovine TB in cattle. In the period from 1978 to 1988 approximately half of the herds in the district had reactors and a total of about 3,000 reactors were removed. About half of these herds had a serious problem with multiple reactors.

Apart from the East Offaly project, a number of other research projects in relation to badgers and bovine TB are also being funded by ERAD. These include:

(a) A study of the dynamics of the disease in a badger population in South West Cork.

(b) An assessment of the efficacy of an oral vaccine for badgers, M.Vaccae, in limiting the spread of infection from badgers to cattle, also in West Cork.

(c) A study of the biology of the badger in the Midlands, in conjunction with the East Offaly badger removal project.

(d) A study of the distribution and density of badgers in Ireland.

In addition, the Central Veterinary Laboratory in England is developing a blood test for diagnosing TB in living badgers. A field test of this kind could prove very useful for controlling TB in badger

populations.

Pending the outcome of these research projects, it could be argued that further badger removal exercises should be suspended. Unfortunately the weight of evidence already available against the badger both in Britain and Ireland is too substantial to permit such a course. Removal of badgers cannot be suspended as long as major outbreaks of bovine TB are occurring which cannot be attributed to other causes. The losses for herdowners in such situations are too serious.

Summary of Conclusions.

1. In addition to very high cattle movement in the state, the various weaknesses in the operation of the bovine TB scheme during the past decades have contributed to the failure to eradicate bovine TB in Ireland.

2. It is also true that the dramatic flare-ups of bovine TB to unprecedented levels in some areas of the country cannot be explained on this basis.

3. These episodes, which seem to have become more common since the late 1970s, cannot be permanently controlled by the normal testing procedure and even saturation testing is not always effective.

4. Many of the areas concerned have a badger population in which over 10 per cent of the animals have gross TB lesions.

5. Removal of the badgers together with intensive testing has, in most of such cases, been attended by a marked decrease in bovine TB.

6. It should be stressed, however, that the badger is not the sole or, indeed, primary source of bovine TB in many areas of the country.

7. With the high residual level of TB in the cattle population, the most serious risk of cattle infection in most areas is from direct or indirect contact with infected cattle.

8. Thus eradication of the badger population would not eradicate bovine TB in the country.

9. It is also true that in many areas of the country it may not be possible to control bovine TB without controlling the badger population.

REFERENCES

BARRY, J.M., 1988. "Badgers and Bovine TB", letter to The Irish Times, 1 December.

BOUVIER, G., H. BURGISSER and P.A. SCHNEIDER, 1962. "Observations sur les maladies du gibier, des oiseaux et des poissons", Schweizer Arch. Tierheilk, 104, 440-450.

CHEESEMAN, C.L., G.W. JONES, J. GALLAGHER and P. MALLINSON, 1981. "The Population Structure, Density and Prevalence of Tuberculosis (Mycobacterium Bovis) in Badgers (Meles Meles) from Four Areas in South-West England", Journal of Applied Ecology, 18, 795-804.

CHEESEMAN, C.L. AND P.J. MALLINSON, 1981. "Behaviour of Badgers (Meles Meles) infected with Bovine Tuberculosis", Journal of Zoology, 194, 284-289.

CHEESEMAN, C.L., J.W. WILESMITH and FIONA A. STUART, 1988. "Tuberculosis: The Disease and Its Epidemiology in the Badger, a Review", mimeo.

CLANCY, MICHAEL F., 1987. "Tuberculosis in Cattle, Is the Badger Involved?" Paper delivered to the Annual Congress of the Irish Veterinary Association at Kilkenny, October.

COMMISSION OF THE EUROPEAN COMMUNITIES, 1981. Commission Report to the Council on the Application of Plans to Accelerate and Intensify the Eradication of Brucellosis, Tuberculosis and Leukosis in Cattle, Comm. 81/611 Final.

CRILLY, J., 1986. "Seasonal and Long-term Variation in Bovine Tuberculosis in Ireland 1978-1985". Mimeo

CRILLY, J., 1987. "The Bovine Tuberculosis Scheme - Building on Reality". Paper delivered to the Agricultural Economics Society of Ireland, 23 February.

DODD, K., 1986. "Badgers and TB", Letter to The Irish Times, 22 October.

DUFFY, E.P., 1987. Tuberculosis in Cattle and Badgers in East Galway, Internal Report to Department of Agriculture.

DUNNET, G.M., D.M. JONES and J.P. McINERNEY, 1986. Badgers and Bovine Tuberculosis, Report to the Rt. Hon. M. Jopling, M.P. and the Rt. Hon. N. Edwards, M.P., London: HMSO.

FAGAN, JOHN, 1988. Badger Control and Bovine TB in Kenagh, Co. Longford, Internal Report to Department of Agriculture and Food.

FRANCIS, G., 1958. Tuberculosis in Animals and Man, London: Cassel and Company Ltd.

FRANCIS, J., 1971. "Susceptibility to Tuberculosis and the Route of Infection", Australian Veterinary Journal, 47, 414.

GALLAGHER, J., R.H. MUIRHEAD and K.J. BURN, 1976. "Tuberculosis in Wild Badgers in Gloucestershire: Pathology", The Veterinary Record, 98, 9-14.

HARRIS, STEPHEN, 1980. "Badgers and TB", Correspondence, Nature, Vol. 288, 11 December.

HEWSON, P.I. and W.J. SIMPSON, 1987. "Tuberculosis Infection in Cattle and Badgers in an Area of Staffordshire, The Veterinary Record, March 14.

IRISH VETERINARY NEWS, 1985. "Badgers and TB - the UK Experience", report of meeting of Connaught Clinical Society, December.

KRUUK, H.H. and T. PARISH, 1987. "Changes in the Size of Groups and Ranges of the European Badger (Meles Meles L.) in an Area of Scotland", Journal of Animal Ecology, 56, 351-364.

LITTLE, T.W.A., P.F. NAYLOR and J.W. WILESMITH, 1982. "Laboratory Studies of Microbacterium bovis Infection in Badgers and Cattle", Veterinary Record, 111, 550-557.

LITTLE, T.W.A., C. SWAN, H.V. THOMPSON and J.W. WILESMITH, 1982a. "Bovine Tuberculosis in Domestic and Wild Mammals in an Area of Dorset. II. The Badger Population, Its Ecology and Tuberculosis Status", Journal of Hygiene (Cambridge), 89, 211-224.

LITTLE, T.W.A., C. SWAN, H.V. THOMPSON and J.W. WILESMITH, 1982b. "Bovine Tuberculosis in Domestic and Wild Mammals in an Area of Dorset. III. The Prevalence of Tuberculosis in Mammals Other than Badgers and Cattle", Journal of Hygiene (Cambridge), 89, 225-234.

McALEER, P.D., 1987. "The Relationship Between badger Density and Bovine Tuberculosis in Cattle in County Galway", Paper read to Irish Veterinary Association Congress. Kilkenny, October.

McCARTHY, JOHN, 1987. Bovine Tuberculosis Trends, Relevant Data Evaluation in a Geographical Area and the Involvement of Badgers. Internal Memorandum to Department of Agriculture and Food, April.

MacDONALD, DAVID, 1984. "Badgers and Bovine Tuberculosis, Case Not Proven", New Scientist, 25 October.

McINERNEY, J.P., 1987. "Assessing the Policy of Badger Control and its Effects on the Incidence of Bovine Tuberculosis", Society for Veterinary Epidemiology and Preventive Medicine - Proceedings, Solihull, April.

MAFF, 1984. Unpublished background document for Dunnet Review Group.

MAHMOOD, K.H., C.A.W. ROOK, J.L. STANFORD, FIONA A. STUART, D.G. PRITCHARD and JACKY I. BREVER, 1987. "The Immune Response in Two Populations of Wild Badgers Naturally Infected with Bovine Tubercule Bacilli, Tubercule, 68, 119-125.

MALLENBY, KENNETH, 1981. Farming and Wild Life, London: Collins, St. James Place.

MUIRHEAD, R.H., J. GALLAGHER and K.J. BURNS, 1974. "Tuberculosis in Wild badgers in Gloucestershire: Epidemiology", The Veterinary Record, 95, 552-555.

MULLENAX, C., M.J. ALLISON and J.R. SANGER, 1964. "Transport of Aerosolised Micro-organisms from the Rumen to the Respiratory System During Eructation", American Journal of Veterinary Research, 25, 1583-1593.

NEAL, ERNEST, 1986. The Natural History of Badgers, London and Sydney: Croom Helm.

NOONAN, N.L., W.D. SHEANE, W.R. HARPER and P.J. RYAN, 1975. "Wildlife as a Possible Reservoir of Bovine Tuberculosis", Irish Veterinary Journal, Vol. 29, p. 1.

O'CONNOR, R., 1986. A Study of the Bovine Tuberculosis Eradication Scheme, Dublin: The Economic and Social Research Institute, Paper No. 133, December.

O'REILLY, L.M. and R. COSTELLO, 1988. "Bovine Tuberculosis with Special Reference to the Epidemiological Significance of Pulmonary Lesions", Irish Veterinary News, September.

RICHIE, J.N., 1959. "Eradication of Bovine Tuberculosis", in A.W. Stableforth and I.O. Galloway (eds.), Infectious Illnesses of Animals: Illnesses of Animals due to Bacteria, Vol. 2, London: Butterworth, pp. 713-736.

SURVEILLANCE, 1986. "Cattle Tuberculosis", Ministry of Agriculture and Fisheries, New Zealand, Vol. 13, No. 3.

SURVEILLANCE, 1988. "Bovine Tuberculosis Control Scheme", Ministry of Agriculture and Fisheries, New Zealand, Vol. 15, No. 3.

WILDLIFE LINK BADGER WORKING GROUP, 1984. Badgers, Cattle and Bovine Tuberculosis, Report to Minister for Agriculture's Bovine Tuberculosis Review Group.

WILESMITH, J.W., 1983. "Epidemiological Features of Bovine Tuberculosis in Cattle Herds in Great Britain", Journal of Hygiene (Cambridge), 90, 159-176.

WILESMITH, J.W., 1986. "Analyses to Examine the Effects of Badger Control by Gassing (1975-1982) on the Incidence of Tuberculosis in Cattle Herds", Appendix 12 in Dunnet et al., (1986).

WILESMITH, J.W., T.W.A. LITTLE, H.V. THOMPSON and C. SWAN, 1982. "Bovine Tuberculosis in Domestic and Wild Mammals in an Area of Dorset. I. Tuberculosis in Cattle", Journal of Hygiene (Cambridge, 89, 195-210.

WILESMITH, J.W., P.E. SAYERS, R. BODE, D.G. PRITCHARD, F.A. STUART, J.I. BREWER AND G.D.B. HILLMAN, 1986. "Tuberculosis in East Sussex. II. Aspects of Badger Ecology and Surveillance for Tuberculosis in Badger Populations (1976-1984)", Journal of Hygiene (Cambridge), 97, 11-26.

ZUCKERMAN, LORD, 1980. Badgers, Cattle and Tuberculosis, Report to the Rt. Hon. Peter Walker, MBE, MP, London: HMSO.

Appendix A

Measuring the Disease Level

Three measures of TB infection are currently used, namely (A) Incidence, (B) Animals per Thousand (APT) and (C) Prevalence.

A. Incidence is a measure of the total number of new cases identified during a specified testing period expressed as a percentage of the total number of tests carried out in the period - often a year.

(1) Animal Incidence is defined as the number of reactors detected in a specified testing period expressed as a percentage of the total number of tests carried out in the period - often a year. It is not the number of reactors detected as a percentage of the number of individual animals tested.

(2) Herd Incidence is defined as the number of reactor herds detected in a specified time expressed as a percentage of the total number of tests carried out on full herds in the period - often a year. It is not the number of reactor herds detected in a specified time expressed as a percentage of the total number of individual herds tested.

B. Animals per Thousand (APT) is defined as the number of reactors detected in a specified period per 1,000 tests carried out in the period - often a year. It is not the number of reactors detected in a specified period per 1,000 animals tested. Animal incidence and APT are identical measures apart from the fact that the former expresses reactors per 100 tests while the latter expresses reactors per 1,000 tests carried out.

C. Prevalence is a measure of the total number of reactor herds existing at any specified point in time (Point Prevalence) or during any specified testing period of time (Period Prevalence) expressed as a percentage of the total number of herds in the area.

(1) Animal point prevalence is defined as the total number of reactors existing at a specified point in time expressed as a percentage of the total number of animals in the area.

(2) Animal period prevalence is defined as the total number of reactors detected during a specified time interval expressed as a percentage of the total number of herds in an area.

Interpretation of the Tuberculis test

A comparative tuberculin test with avian and bovine tuberculins is now used in routine tuberculosis testing of cattle in Ireland. In general the tuberculins are injected into the skin of the neck and the degree of resulting inflammation and swelling is established by palpation and measurement of the double thickness of the skin 72 hours after inoculation.

The EEC standard interpretation classifies animals as positive when the bovine reaction exceeds the avian reaction by more than 4 mm and classifies animals as inconclusive when the bovine response exceeds 2 mm and the bovine excess (over the avian) is 1-4 mm. The Department of Agriculture instruction advises the removal as reactors of all animals positive or inconclusive on the test when the veterinary surgeon carrying out the test is of the opinion that there is bovine infection present in a herd. This is known as the Severe Interpretation. In herds where no animals are found positive to the test as defined above inconclusives are not removed but their cards are taken up and they are not allowed to be moved out of the herd until they are retested after an interval of 60 days. Twice inconclusive animals must be deemed positive and removed.

Appendix B

1985 Badger Control Policy

Where after a thorough investigation of a herd breakdown due to bovine tuberculosis and no explanation is found, or where a tuberculosis problem in a herd or group of herds fails to respond to conventional eradication procedures (prompt isolation, removal of reactors, movement control and disinfection of premises) the veterinary inspector may apply for a badger investigation. If his/her senior officer agrees that such an investigation is required, the application is sent to head office which makes a formal application to the Wildlife Service.

On the basis of this application the Wildlife Service may issue a licence to the Minister for Agriculture and Food and his nominees stipulating:

(a) valid period of the licence

(b) the area to which the licence applies. This is usually the focal farm and an area 2 km. deep around this farm.

(c) the manner in which the investigation is to be carried out. Traps and snares to approved specifications are the methods allowed for capturing badgers, followed by shooting.

(d) that all trapping sites be visited by trappers at least once every 24 hours to ensure that snared badgers are disposed of as speedily and humanely as possible.

On receipt of a licence a sample of badgers is removed from the designated area. The sample is not less than five badgers per licence and should one of these prove positive for tuberculosis on post mortem examination the entire badger colony is declared infected and an attempt is made to have all members of the colony removed using the approved methods.

Removal Operations

These are divided into two parts:-
(1) Preliminary badger investigation
(2) Badger removal operation

Preliminary badger investigation

(a) Informing owners of the land and neighbouring lands of intention to remove badgers.

(b) Getting their permission to carry out the operation.

(c) Advising on danger to domestic animals and household pets.

(d) Mapping the setts on the focal farm and on neighbouring farms. In some cases owners have a good knowledge of sett locations but very often it is necessary to walk most of the field boundaries to locate the setts.

2. *Badger removal operations*

Snares are the only method of badger capture used to date. The snares used are of free running multistrand high tensile wire with a stopper placed 13 inches from the end of the snare. This prevents the snare closing completely. The snares are placed around the sett entrance and along the runs used by the badgers. A large noose is used so that animals are caught round the thorax.

Caught badgers are dispatched using a 0.22 rifle which causes very little damage to the carcase and allows thorough post mortems to be carried out. The location is visited as early as possible every morning and all snares inspected.

An operation continues until signs of activity round the sett cease. This may be because all badgers present have been caught or because those remaining have moved to a new location. Surveillance of each site is maintained over a period and on any signs of recolonisation further snaring takes place. All badgers killed are tagged and their location recorded. They are sent to the nearest regional veterinary laboratory for post mortem examination.

Appendix C

Individuals interviewed in connection with this study.

Mr J. Noonan, Mr E.P. Duffy, Eradication of Animal Disease Board.

Ms N. O'Keefe, Mr P. Warner, Mr E. Grennan, Wildlife Service.

Professor J. Quinn, Professor J.D. Collins and Dr K. Dodd, Faculty of Veterinary Medicine, UCD.

Dr J. Rochford, Dept. of Zoology, Trinity College, Dublin;
Chairman, Irish Wildlife Federation.

Dr T. Hayden, Dr I. Whelan, Dept. of Zoology, UCD.

Mr F. McRory, President, Mr C. O'Brien-Lynch, Irish Veterinary Association.

Mr Peter Meagher, General Veterinary Practitioner.

Mr Peter Dargan, General Secretary, Irish Veterinary Union.

Mr P. Morgan, President, Mr David Tantrum, Irish Veterinary Officers Association.

Mr D. Bray, SVI, and staff, DVO, Tullamore.

Dr D. Byrne, SVI, and staff, DVO, Longford.

Mr H. Cummins, SVI, and staff, DVO, Galway.

Mr T. Richardson, SVI, and staff, DVO, SW Cork.

Mr D. Daly, SVI, Dublin/Wicklow.

Mr S. Griffin, SVI, and staff, DVO, Cavan.

Mr D. O'Reilly, Deputy Director, Mr L.M. O'Reilly, Superintending Senior Veterinary Officer, and Mr P.F. O'Reilly, Senior Research Officer, Veterinary Research Laboratory, Abbotstown.

Mr J. Crilly, Teagasc.

Mr Peter Lynch, Irish Farmers Association.

Mr David Kyle, Assistant Chief Veterinary Officer and Mr Peter Philip, Senior Veterinary Officer, Ministry of Agriculture, Fisheries and Food, Tolworth, Surrey.

Mr J. Harkness, Head, Bacteriological Department; Mr J. Wilesmith, Head, Epidemiology Department; Ms Fiona Stuart, Research Officer, Bacteriology Department; Dr Peter Roeder, Head, Immunology Research team; Dr Anne Nolan, Research Immunologist; Central Veterinary Laboratory, Weybridge, England.

Professor John McInerney, Agricultural Economics Department, Exeter University, England.

Mr Ivor Davies, Regional Veterinary Officer for South West England.

Dr Christopher Cheeseman, Research Ecologist at Woodchester Park Research Centre, Gloucestershire.

Appendix D

Agreed position between the Office of Public Works (Wildlife Service) and the Department of Agriculture (ERAD) in relation to the Badger and Bovine TB and in particular the proposed East-Offaly Study

1. *General*

The impact of badger removal on the prevailing TB levels in cattle needs to be scientifically researched as the Wildlife Service feels that the significance of the badger as a factor in the spread of bovine TB has yet to be determined. Without prejudicing the Wildlife Act, 1976, both parties agree that until such time as the results of the various research programmes into this matter are available licences for the taking of badgers will only be sought in the context of research and every effort will be made to stamp out illegal action against this protected species.
Applications for individual licences for other areas will continue to be considered on their merits as heretofore on the understanding that all other factors relating to the spread of bovine TB will have been examined first.

2. *Research*

(a) The research programme currently under way will be actively pursued.

(b) The Wildlife Service will co-operate with Professor R. O'Connor and Dr E. O'Malley (ESRI) in their review of the role of the badger in Bovine TB.

(c) Joint funding by ERAD and the Wildlife Service of a project aimed at establishing a national badger census will be examined.

(d) Additional areas will be selected for testing the oral vaccine for badgers now being developed subject to the outcome of the meeting with Professor Standford of the UK.

3. *Data*

Returns on badger licences issued to date in 1988 will be made available to the Wildlife Service before 1 December, 1988. Returns on future licences will be made at monthly intervals.

4. *Extension of licensing*

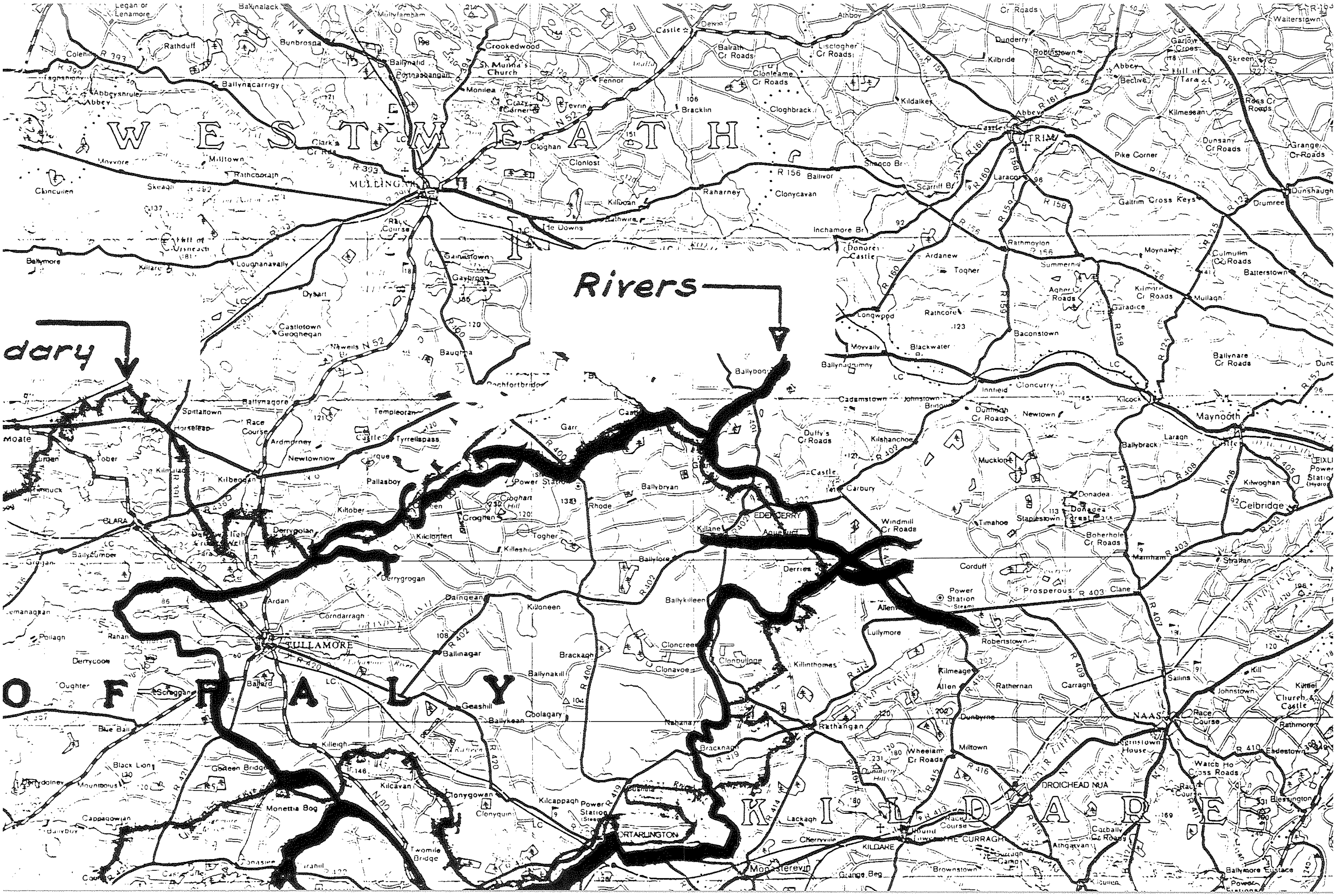
As part of the research programme at 2(a) above licences will be granted for the taking of badgers in the area outlined on the attached map.

5. *Publicity*

Both parties agree that positive publicity for the approach now being adopted will be pursued.

6. *Future Action*

As the results of the various studies become available there will be consultation between both parties. The Wildlife Service note that ERAD may wish to propose a longer term Wildlife Strategy on the outcome of any particular study.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Maynooth
Celbridge
Monasterevin
Rathangan
Clonbullogue
Rhode
Carbury
Kilcock
Daingean
Clara
Moate
Geashill
Killeigh
Clonygowan
Prosperous
Clane
Robertstown
Allenwood
Lullymore
Ballybryan
Ballycommon
Tyrrellspass
Kilbeggan
Rochfortbridge
Castletown Geoghegan
Milltown
Raharney
Clonycavan
Kinnegad
Johnstown Bridge
Enfield
Cloncurry
Ballynadrumny
Timahoe
Donadea
Staplestown
Sallins
Kill
Johnstown
Blessington
Ballymore Eustace
Brownstown
Kilcullen
Grange Beg
Cherryville
Lackagh
Monettia Bog
Twomile Bridge
Ballinagar
Cloonagh
Walterstown
Dunshaughlin
Dunsany
Summerhill
Ballivor
Bracklin
Cloghbrack
Crookedwood
St. Munna's Church
Bunbrosna
Ballynacarrigy
Rathduff
Abbeyshrule
Coolcullen

Appendix E

Terms of Reference

"It is increasingly recognised that badgers can contract tuberculosis and can transmit the disease to cattle. This study should examine the significance of this for the bovine tuberculosis scheme in Ireland and should be divided into three sections.

1. Review of the international knowledge on the subject. Work carried out in the United Kingdom should be particularly relevant.

2. Review of investigations carried out in Ireland and other information accumulated at District Veterinary Offices.

3. Discussion and conclusions."