Detailed epidemiological analyses of the impact of TB pre-movement testing in England during the first 4-5 months of implementation

1 Epidemiological impact of pre-movement testing

1.1 Assessing spread by calculating the number of confirmed new bTB incidents in 1,2,3 and 4 yearly tested parishes.

1.1.1 Table 1 describes the distribution of numbers of herds by testing interval during the first 127 days of pre-movement testing in England (bold text) and compares it with the matching period one year earlier. The intervening period (and a matching period one year earlier) are also shown.

1.1.2 The measure of interest is the relative number of confirmed new incidents (CNI) in 3 or 4 yearly tested parishes and number of CNI in more frequently tested parishes. This has been expressed as a ratio in the Tables, allowing the measures to be compared between periods.

1.1.3 The effect of restricting the analysis to parishes that have not had relatively recent CNI is shown in Tables 3 and 4. These Tables show CNI in parishes that have been free of CNI in the previous four or eight years. Shorter intervals of freedom have been omitted because many herds (e.g. those in four-yearly testing parishes) would not have received a routine tuberculin test.

Table 1 – Numbers of confirmed[1] new incidents (CNI) over the period when pre-movement testing was employed (bold) and in comparison periods, by parish testing interval in Great Britain

Dates	*Duration, days*	Parish testing interval (PTI, years)				The ratio, [CNI in 3 and 4 year PTI] / [CNI in 1 and 2 year PTI]	
		1	2	3	4		
1 August 2004 to 26 March 2005	*238*	1013	182	8	65	0.061	Chi-square = 7.96; 3 degrees of freedom (d.f.); *P* = 0.047
27 March to 31 July 2005	*127*	389	87	6	31	0.078	
1 August 2005 to 26 March 2006	*238*	982	100	2	67	0.064	
27 March to 31 July 2006 [2]	***127***	**337**	**71**	**2**	**40**	**0.103**	

[1] Confirmation of bTB in *herds* (rather than individual animals) requires the finding, after slaughter, of visible lesions in one or more reactors and/or *Mycobacterium bovis* on culture in samples from one or more animals.

[2] Pre-movement testing was employed in England in this period.

1.1.4 There was a tendency for the total number of herds disclosed with confirmed bTB in 3 and 4-year tested parishes to fluctuate with time in comparison with herds in 1 or 2-yearly tested parishes ($P < 0.05$), with a suggestion of a seasonal pattern. During the pre-movement testing period the ratio was 0.103, in comparison with 0.078 one year before ($P = 0.046$ by one-tailed Fisher's exact test). This increase occurred in spite of the reduction in

number of three- and four-yearly tested parishes in the autumns of 2004 and 2005. **It may take a number of months before any reduction of infection introduced into a herd is detectable, and herds in 3 & 4 yearly tested parishes may not be tested for up to four years.**

1.1.5 The proportion of CNI disclosed by slaughterhouse cases was slightly reduced when pre-movement testing (VE-PrMT) was in force than during the period 12 months earlier, but the reduction was similar in both 1 & 2 and 3 & 4 yearly tested parishes (Table 2). Tracing tests disclosed a smaller proportion of CNI in 3 & 4 yearly tested parishes in the VE-PrMT period than 12 months earlier, despite the proportion being *larger* in 1 & 2 yearly tested parishes ($P \approx 0.05$).

Table 2 Proportion of confirmed new incidents that were disclosed by various test types in 1 & 2- yearly & 3 and 4 yearly testing parishes, when pre-movement testing was in force and 12 months earlier (Great Britain)

Disclosing test type	Period	1 and 2-year tested parishes	3 and 4-year tested parishes
Slaughter-house case(s)	27th March – 31st July 2005	8.6% (83/969)	21.3% (23/108)
	27th March – 31st July 2006	7.2% (68/938)	18.4% (19/104)
Tracing tests	27th March – 31st July 2005	1.3% (13/969)	15.7% (17/108)
	27th March – 31st July 2006	2.1% (20/938)	12.5% (13/104)

Table 3 Confirmed new incidents (CNI) in parishes in which the last CNI was at least four years ago (Great Britain)

Dates	***Duration, days***	**Parish testing interval (years)**				**The ratio, (CNI in 3 and 4 year PTI) / (CNI in 1 and 2 year PTI)**	
		1	**2**	**3**	**4**		
1 August 2004 to 26 March 2005	*238*	51	83	4	50	0.40	
27 March to 31 July 2005	*127*	22	34	3	27	0.54	Chi-square = 5.74;
1 August 2005 to 26 March 2006	*238*	28	61	2	60	0.70	(3 d.f.); $P = 0.12$
27 March to 31 July 2006	***127***	**23**	**39**	**2**	**33**	**0.56**	

1.1.6 In parishes with a favourable history of bTB (Tables 3 and 4) the numbers of CNI were greatly reduced, and although there was a suggestion that the number of such incidents in 3 and 4 year tested parishes had been increasing faster than in other parishes, the increase did not continue after the start of pre-movement testing. It is unlikely that this change was statistically significant, however. Herds in parishes that had been free from confirmed bTB for eight years (Table 4) – a subset of herds in parishes that were free for four years – showed a similar pattern.

Table 4 Confirmed new incidents (CNI) in parishes in which the last CNI was at least 8 years ago (Great Britain)

Dates	*Duration, days*	Parish testing interval (years)				The ratio, (CNI in 3 and 4 year PTI) / (CNI in 1 and 2 year PTI)	
		1	2	3	4		
1 August 2004 to 26 March 2005	*238*	28	68	4	50	0.56	
27 March to 31 July 2005	*127*	13	29	2	26	0.67	Chi-square = 2.37;
1 August 2005 to 26 March 2006	*238*	22	54	1	60	0.80	(3 d.f.); *P* = 0.50
27 March to 31 July 2006	***127***	**11**	**33**	**1**	**32**	**0.75**	

1.2 Relative risk of TB breakdowns in 3 or 4 yearly tested herds associated with the movement of cattle from 1 or 2 yearly tested herds

1.2.1 This task awaits a sufficient period of time for infection to develop and be detected in infrequently tested herds. The analysis would compare the fate of herds receiving batches of pre-movement tested animals with herds receiving batches that were not tested in this manner (for example because of their age or the date when movement occurred). Cattle movement data will be essential, to distinguish between possible effects of pre-movement testing: *deterrence* of unnecessary animal movements, reduced *movements of infected animals* as a result of testing, and possible fraudulent misreporting of movements. Evidence that infected animals have been prevented from movement is so far encouraging (Table 8).

1.3 Number of herds with reactors found at a PrMT that disclosed more reactors/inconclusive reactors at the herd check test.

Table 5 Figures below include all reactors found at a PrMT reported to the SVS by the 22-09-06

	No of herds that did not identify any other R or IRs at subsequent testing	Number of herds that identified other R or IRs at subsequent testing	Number of herds awaiting subsequent testing
England	30	34	23

1.4 Number of inconclusive reactors identified by pre-movement testing that became classed as reactors following further check tests

Table 6

Number of disclosures as IR before testing clear of TB				
IR x 1	**IR x 2**	**Awaiting testing**	**Reactors**	**Total**
190	17	97	10 from 9 herds	314 IRs from 213 herds

1.5 Ratio of IRs to reactors with pre-movement testing compared to routine surveillance testing (broken down into type eg RHT, WHT, check test etc)

Table 7 Ratio of number of inconclusive reactors (IR) to number of reactors with pre-movement testing, compared with types of routine surveillance testing, for tests on unrestricted herds (Great Britain)

Type of test	Yearly testing interval				Two-yearly testing interval			
	Thous-ands of tests	Number of IRs per 1000 tests	No. of reactors per 1000 tests	IR:R ratio	Thous-ands of tests	Number of IRs per 1000 tests	No. of reactors per 1000 tests	IR:R ratio
Tests to check the herd of origin of cases (VE-CT)	18.6	8.8	10.6	0.82	9.2	10.2	5.3	1.9
Forward tracing tests (VE-TR)	2.7	6.3	5.6	1.1	1.7	6.0	10.7	0.56
Pre-movement tests	***60.3***	***3.1***	***1.4***	***2.2***	***34.2***	***2.9***	***1.3***	***2.2***
Contiguous herd tests (all)	87.4	5.4	2.2	2.5	49.3	3.6	0.85	4.2
Whole herd tests (VE-WHT or VE-WHT2)	246.5	5.8	2.3	2.5	46.7	4.9	0.86	5.7
Retests of inconclusive reactors (VE-IR)	4.1	133	45	2.9	1.2	162	51	3.2
6 & 12-month post-breakdown tests (VE-6M or VE-12M)	195.7	7.6	2.4	3.1	34.1	7.6	1.0	7.7
Routine herd tests (VE-RHT)	n.d.	n.d.	n.d.	n.d.	45.0	6.0	3.1[2]	1.9

[1] It is unusual to perform routine herd tests in yearly-tested herds.

[2] This figure (and possibly that for IRs) was unusually high, as explained under Table 8.

1.5.1 The ratio of IRs to reactors was not unusual with pre-movement tests, ranking third out of seven test types in yearly tested herds and fourth out of eight in two-yearly tested herds. The ratio was a little less than the ratio for whole herd tests in yearly tested parishes and was intermediate between the ratios for routine and whole herd tests in two-yearly tested parishes.

1.6 The rate of reactors (and IRs) per 1,000 pre-movement tests compared with routine surveillance tests (VE-RHTs, VE-WHTs, VE-WHT2s) and other (non-routine) tests carried out in 1 and 2 yearly testing herds.

1.6.1 The "rate of detecting bovine TB" is construed as the proportion of tested animals that are reactors to the tuberculin test. This proportion is shown in Table 8 for types of test and parish testing intervals for a 127-day period since the start of pre-movement testing.

Table 8 Tuberculin test reactors per 1,000 animals tested in the period 27th March to 31st July 2006, by test type and parish testing interval (Great Britain)

Test type	Recorded parish testing interval at the time of the test				Number of herds tested	Number of animals tested (thousands)
	1	2	3	4		
	Reactors per 1000 animals tested [1]					
Pre-movement tests	***1.43***	***1.29***	***n.d.*** [2]	***n.d.***	***8,700***	***94.5***
Retests of inconclusive reactors	45.1	51.3	0.00	27.0	3,071	6.2
Forward tracing tests	5.57	10.72	0.00	3.66	3,031	8.8
Tests to check the herd of origin of cases (VE-CT)	10.64	5.33	0.00	3.10	1,392	39.4
Short interval tests	5.35	0.68	0.00	1.71	3,630	27.9
6-month and 12-month post-breakdown tests	2.45	1.00	3.01	0.40	1,866	248.2
Contiguous herd tests (all)	2.15	0.85	0.00	0.31	1,489	150.3
Whole herd tests	2.27	0.86	n.d.	n.d.	4,391	293.2
Routine herd tests	*n.d.*	3.2 [1] (or 1.12)	1.02	0.34	3,281	162.9

n.d. The type of test was not intended for the given parish testing interval.

[1] The larger figure represents 141 reactors in 43,509 animals tested and includes a 501-animal Devon dairy herd with 93 reactors. If this herd is excluded, confirmed bTB in routine herd tests in 2-yearly tested herds becomes 1.1 per 1,000.

Table 9 - Animals with confirmed bovine TB per 1,000 animals tested in the period 27th March to 31st July 2006, by test type and parish testing interval (Great Britain)

Test type	Recorded parish testing interval at the time of the test				Number of herds tested	Number of animals tested (thousands)
	1	2	3	4		
	Reactors per 1000 animals tested [1]					
Pre-movement tests	***0.78***	***0.41***	***n.d.*** [2]	***n.d.***	***8,752***	***96.8***
Retests of inconclusive reactors	24.4	26.8	0	9.4	3,081	7.6
Forward tracing tests	4.6	5.3	0	3.2	3,050	9.0
Tests to check the herd of origin of cases (VE-CT)	4.7	2.4	0	1.3	1,414	66.9
Short interval tests	2.0	1.5	0.82	0.63	3,634	599.2
6-month and 12-month post-breakdown tests	1.13	0.42	4.4	0.06	1,878	255.2
Contiguous herd tests (all)	1.01	0.36	0	0.26	1,497	151.1
Whole herd tests	1.30	0.28	n.d.	n.d.	4,404	304.8
Routine herd tests	n.d.	1.3 [3] (or 0.33)	0	0.02	3,295	166.8

[1] Confirmed bTB denotes finding visible lesions in reactors at post-mortem and/or finding *Mycobacterium bovis* in cultured samples (except where culture showed the lesions were probably due to an organism other than *M. bovis*).

[2] *n.d.* The type of test was not intended for the given parish testing interval.

[3] The larger figure represents 57 animals with confirmed bTB in 43,506 animals tested and includes a 501-animal Devon dairy herd with 44 confirmed animals. If this herd is excluded, confirmed bTB in routine herd tests in 2-yearly tested herds becomes 0.33 per 1,000.

1.6.2 Normally in analyses such as these, the proportion of tests of a given type that reveals reactors or infected animals tends to fall as parish testing interval increases. There are a number of test types shown in Tables 8 and 9 where this is not so; this can be explained by the irregular distribution of

heavily infected herds in the testing intervals. Footnotes to the Tables illustrate the effect of excluding a single severely infected herd detected by a routine herd test in a two-yearly tested parish in Devon.

1.6.3 Notwithstanding these imprecisions, Table 9 puts the ability of the pre-movement test (VE-PrMT) to detect infected reactors in yearly tested parishes as better than half of the ability of whole herd tests. This was expected, since the interval between the previous whole herd test (VE-WHT) and the pre-movement test was less than the interval between successive VE-WHTs. (The interval for VE-PrMT in yearly tested herds could have been anything between 61 days after the previous whole herd test and shortly before the next whole herd test. In round figures, that is 17-100% of the normal testing interval in yearly tested parishes and 8-100% of the interval in two-yearly tested parishes).

1.6.4 The proportion of pre-movement tests that revealed reactors or revealed IRs (Table 7) was almost identical in yearly and two-yearly tested herds despite the difference in bTB prevalence. Future results are likely to show whether this was an effect of random fluctuations.

1.7 Are more animals tested in a RHT since the introduction of PrMT?

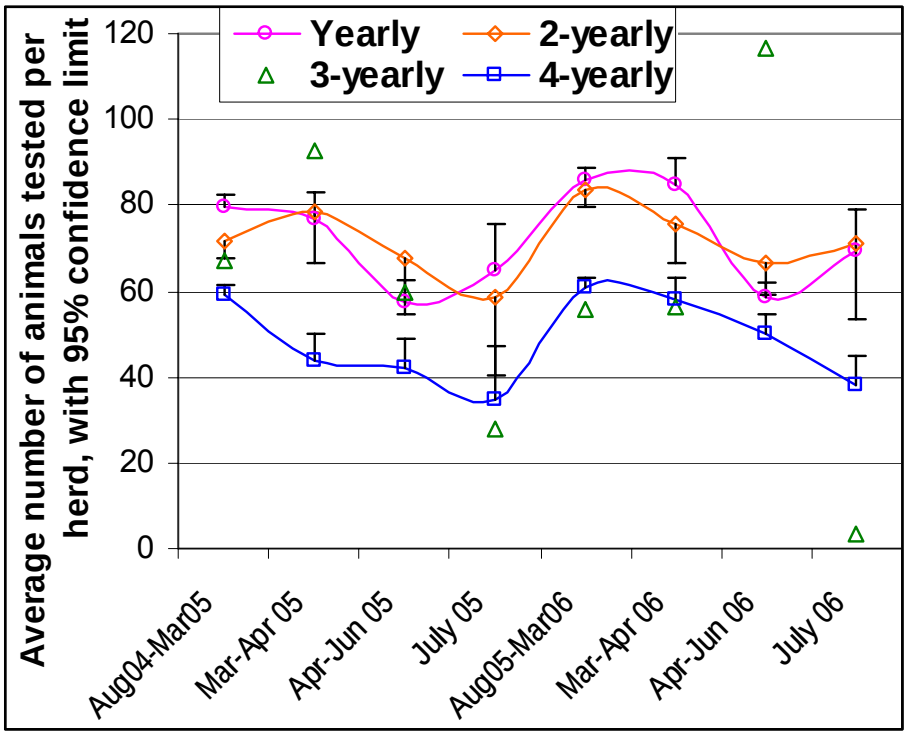

Figure 1 – Average numbers of animals tested per herd in routine herd tests (VE-RHT, VE-WHT and VE-WHT2) for each period by parish testing interval (Great Britain): lines and 95% confidence limits are given for all testing intervals except 3-yearly testing (sample sizes too small)

1.7.1 The seasonal pattern of numbers of animals tested is repeated in each of the two years covered (Figure 1-note the periods are not of equal length**).** No change in the pattern is apparent since the introduction of pre-movement testing (represented by the last three points, covering 27th March to 31st July 2006).

2 Changes in farmer behaviour

2.1 Movement patterns following routine surveillance testing after the introduction of PrMT compared with historic data to determine if farmers are actively choosing to use Government funded routine surveillance testing to ensure cattle have been tested prior to movement.

2.1.1 There would seem to be two possible ways in which farmers could take advantage of routine surveillance testing to exempt cattle movements from the requirement of PrMT. Firstly, they may seek to move their surveillance testing to coincide with planned movements or conversely they may alter their movement patterns to coincide with their surveillance testing. If the first hypothesis were true you would expect to see a change in the distribution of Surveillance tests. If the second were true you would expect to see a change in the movement pattern of animals. The net effect of either or both strategies would be that a greater percentage of movements would be seen within 60 days of a surveillance test.

2.1.2 Figure 2 & 3 show that there has been no major change in the pattern of VE-WHT and VE-RHT testing since January 2004. The increase in the number of herds tested over time (Figure 3) is a reflection of the increasing number of herds in yearly tested parishes.

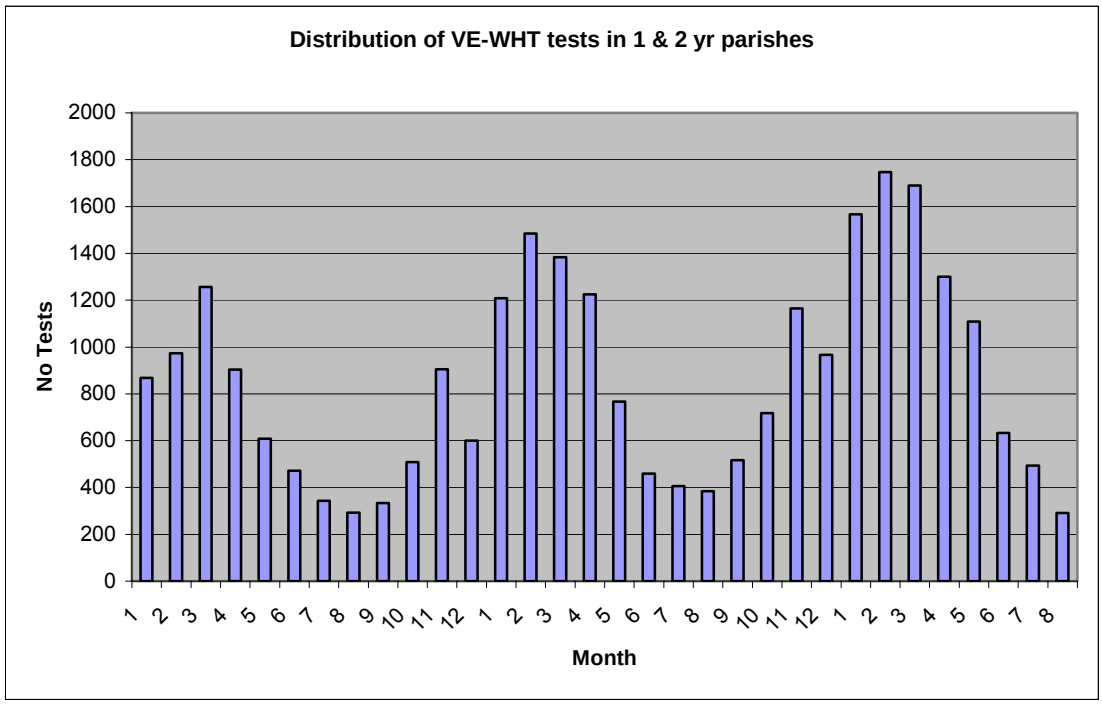

Figure 2 – Distribution of VE-WHT in 1 and 2 year parishes

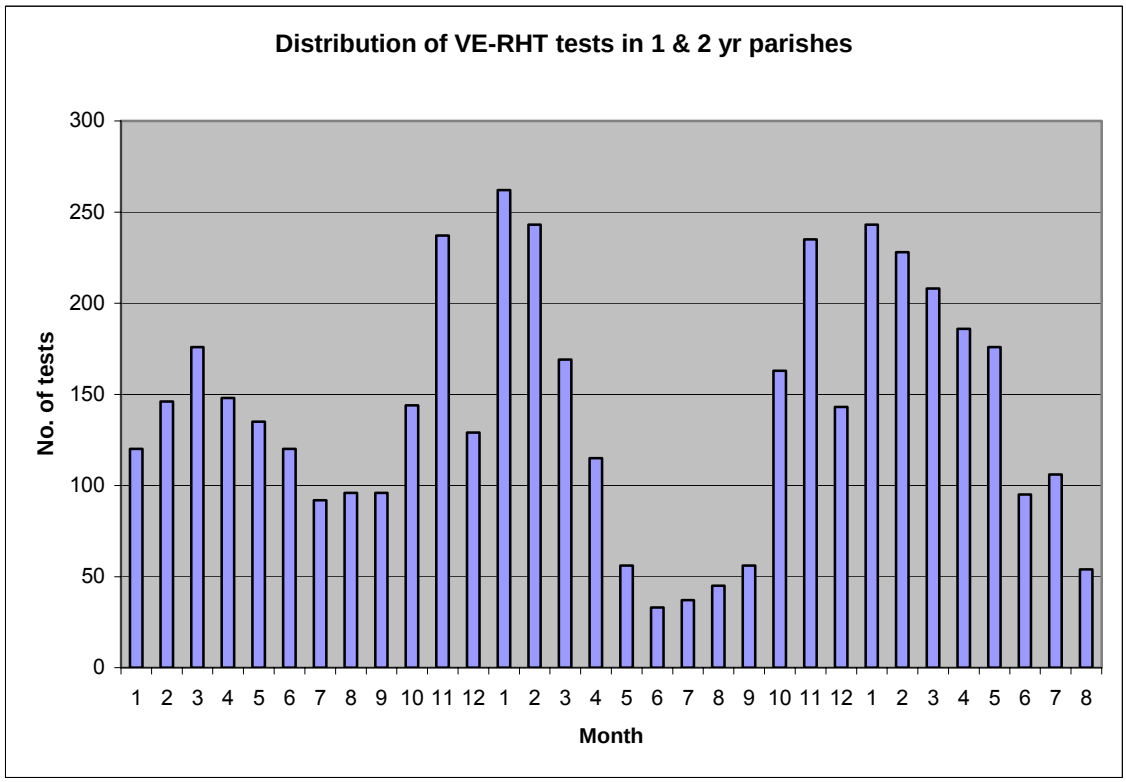

Figure 3-Distribution of VE-RHT in 1 and 2 year parishes

2.2 Number of overdue routine surveillance tests following the implementation of PrMT compared to pre-PrMT.

Table 10

	2002	2003	2004	2005	2006
Jan	25,778	6,720	4,705	2,358	2,398
Feb	26,936	6,139	3,973	1,915	2,417
Mar	25,285	4,511	3,932	2,827	2,994
Apr	22,546	3,831	4,085	2,331	3,442
May	20,030	4,077	3,526	1,750	2,924
Jun	18,037	3,068	2,545	1,844	2,912
Jul	16,960	3,332	2,794	1,939	2,887
Aug	15,576	3,134	2,845	1,593	3,226
Sep	14,921	3,308	3,288	2,049	3,437
Oct	12,177	3,949	2,924	2,355	
Nov	9,852	4,035	3,855	2,104	
Dec	6,283	3,623	2,739	2,595	

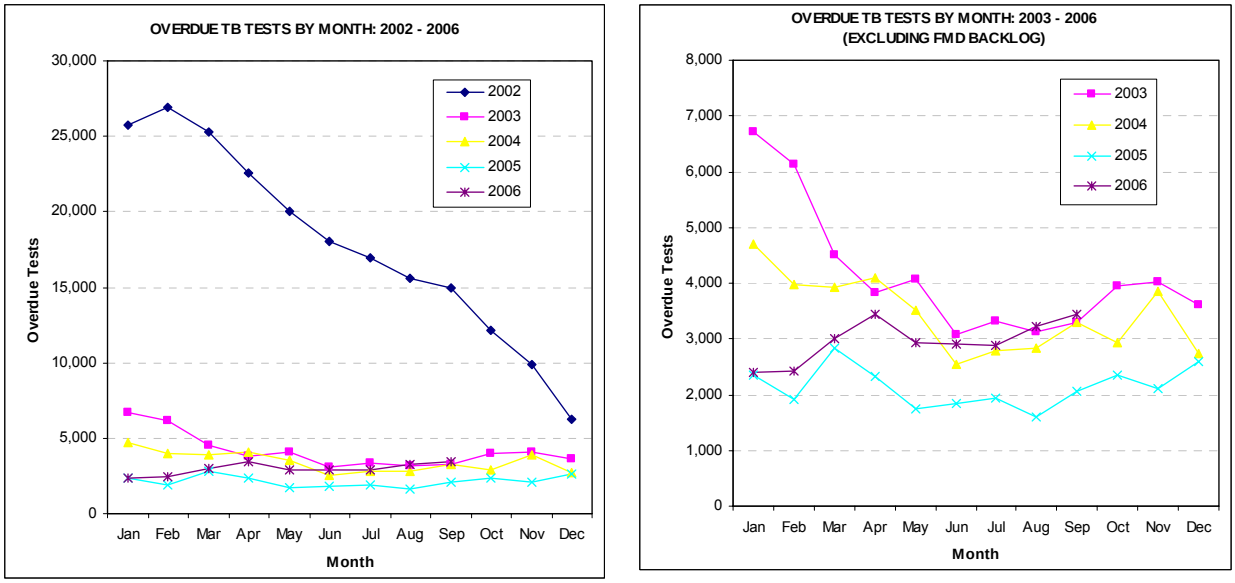

Figure 4 – Overdue tests by month

2.2.1 Calculated monthly numbers of overdue tests since January 2002 are listed in Table 10 and shown graphically in Figure 4. The right-hand graph excludes data for 2002 and has an expanded y-axis. The way Vetnet calculates overdue tests means each data point is a snapshot of the total number of **GB** herds overdue at the end of the reporting month that were still overdue at the time the report was run. Therefore, all data is subject to variability depending on when the monthly report was run (usually in the first week of the subsequent month, but occasionally later).

3 Pre-movement testing batch size and destination of PrMT tested cattle

3.1 Pre-movement testing batch size range

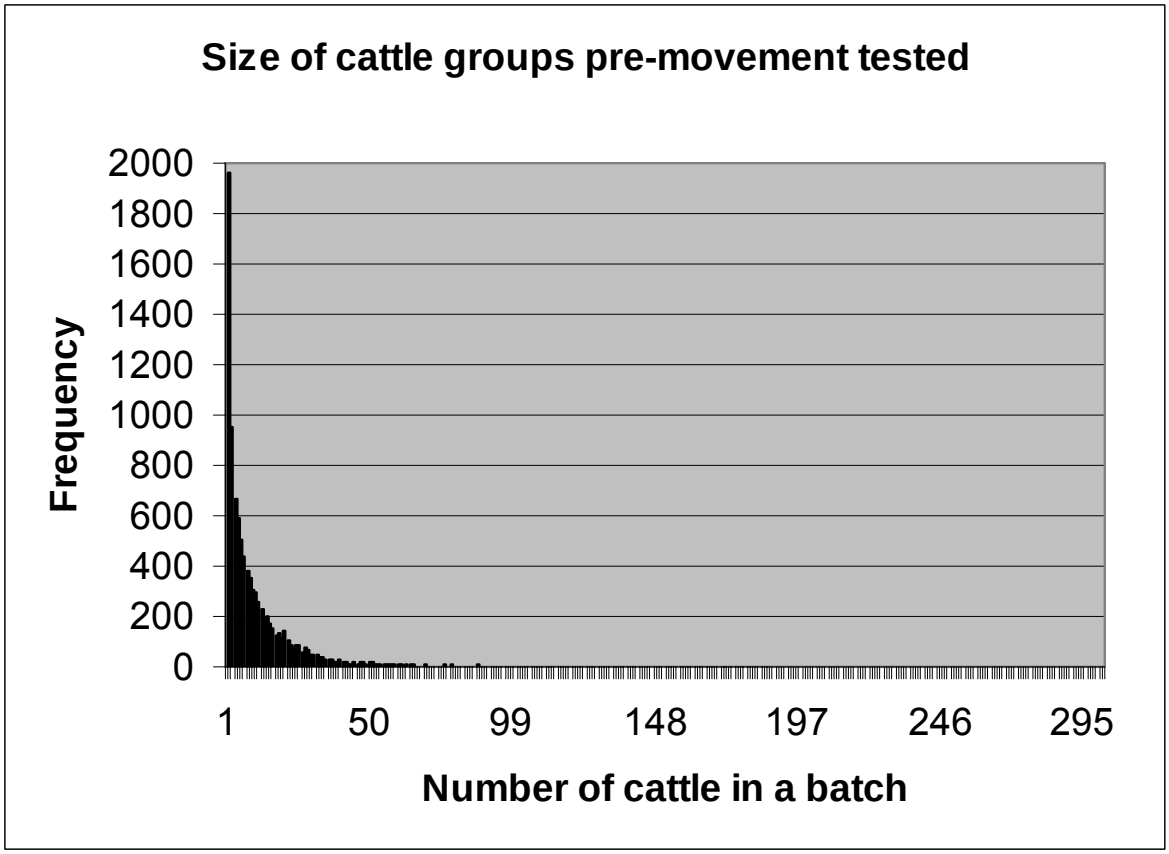

Figure 5 PrMT batch size

The average batch size of PrMTs is 12, but there is a wide variation. About half of the testing occasions involved 5 or more cattle.

3.2 Destination of cattle from high-risk parishes and pre-movement tested cattle

3.2.1 Figures 6 & 7 show the distribution of Parish testing regime moved onto for the 15 months prior to PrMT and for the period since PrMT.

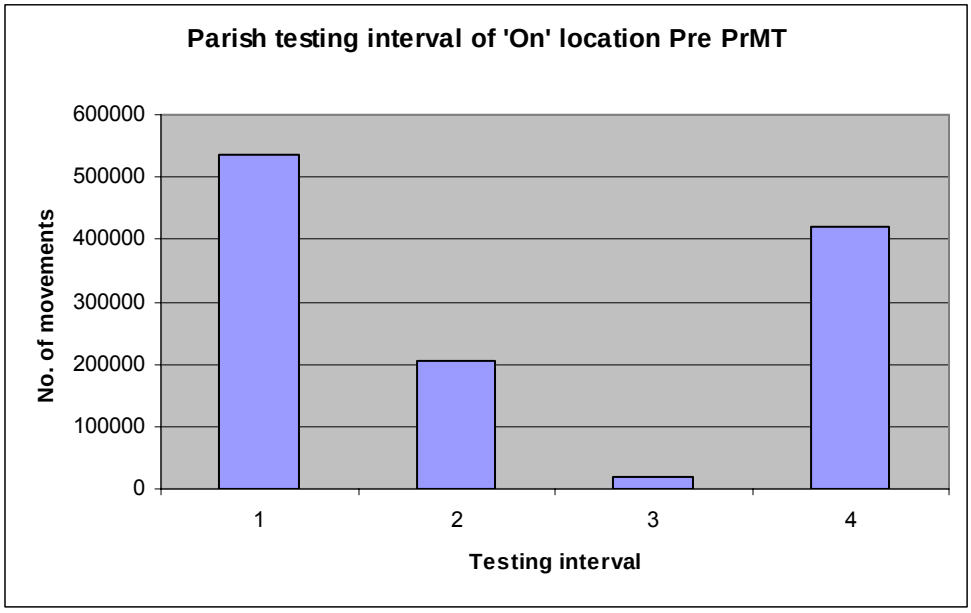

Figure 6- Numbers of animal movements to herds in various parish testing intervals *before* pre-movement testing came in force

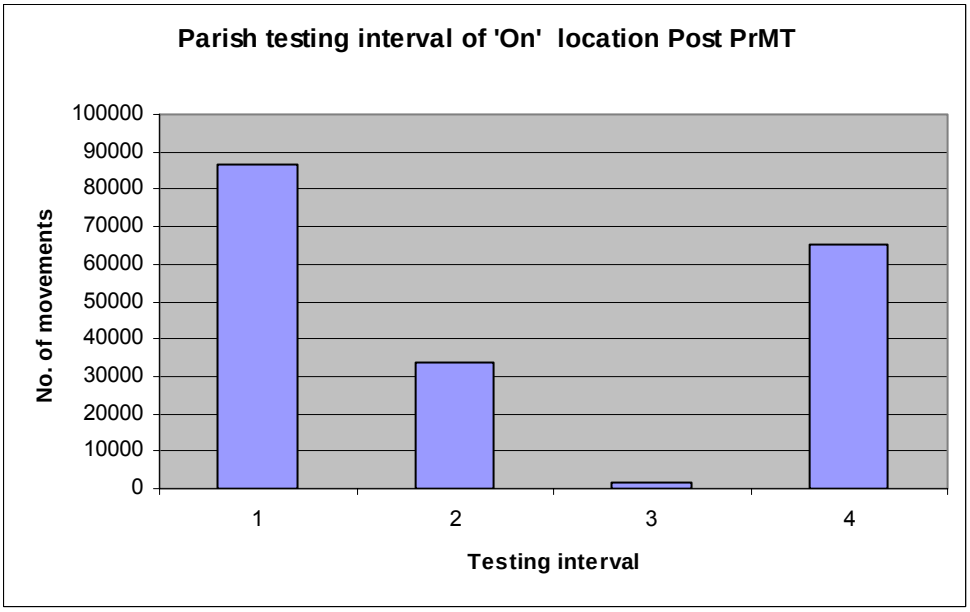

Fig 7 – Numbers of animals movements to herds in various parish testing intervals *after* pre-movement testing came in force

3.2.2 Figures 6 & 7 show that the majority of movements off of 1 and 2 yearly parishes go to 1 and 2 yearly parishes. This is to be expected because the majority of cattle movements are of short distance (see Mitchell *et al*). The distribution has not changed pre and post PrMT.