The 2012 Scottish Honey Bee Health Surveillance Report

May 2013

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EXECUTIVE SUMMARY

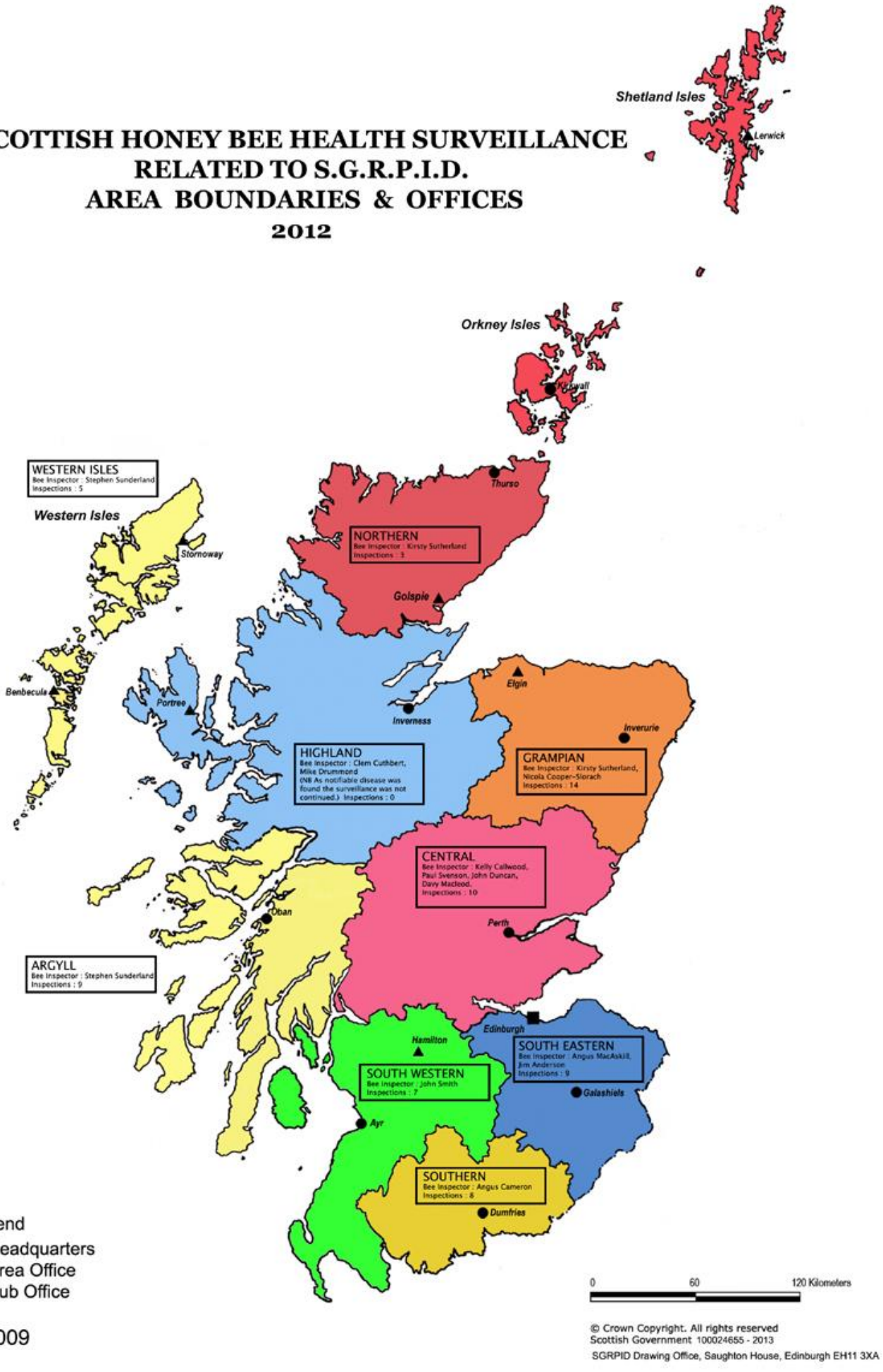
Aim: To assess the health status of honey bees in Scotland and to gain a better understanding of how factors such as husbandry and disease epidemiology affect them. This information is required to evaluate and inform honey bee health measures developed within the Scottish Honey Bee Health Strategy.

Approach: In 2012, a random apiary survey was instigated by the Scottish Government's Animal Health branch. From a randomised sample of 80 beekeepers registered on BeeBase as keeping bees in Scotland (10% of those registered at the time of sampling), 65 took part in all aspects of the survey. The survey consisted of a questionnaire, inspection of all colonies within the apiary, testing of a sample of 30 adult bees for disease symptoms and one week's collection from a hive debris trap. A further short questionnaire was completed in spring 2013 to establish colony losses during the winter which followed sampling.

The survey results have shown that –

- An 'average Scottish beekeeper' has been beekeeping for less than 10 years, manages five or fewer colonies and produces 20-29lb honey per colony annually.
- 39% of beekeepers questioned lost at least one colony during winter 2011-12 and 79% of beekeepers lost at least one colony during winter 2012-13. Risk factors identified by beekeepers were environmental conditions (weather), queen health, starvation and Varroa mites.
- Foulbrood disease and other notifiable pests of honeybees were not found out-with areas of known disease.
- A small pocket of American Foulbrood (a notifiable disease of honey bees caused by the bacterium *Paenibacillus larvae*) was found in Inverness-shire during the survey (within a previous outbreak area). Resources were deployed to eradicate this outbreak and inspect contact colonies for signs of the disease.
- Varroa mites were present in all nine 'regions' inspected, although smaller areas of 'Varroa freedom' may still be present within Scotland.
- Nosema and Acarine disease were detected at lower levels; *Nosema ceranae* (a relatively new disease to Scottish honeybees) is relatively well established and was found in samples from five of the nine regions tested.

SCOTTISH HONEY BEE HEALTH SURVEILLANCE RELATED TO S.G.R.P.I.D. AREA BOUNDARIES & OFFICES 2012



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INTRODUCTION

The European honey bee, *Apis mellifera*, contributes directly to food production and makes an important contribution through pollination to crop production and environmental services. Since the introduction of the Varroa mite (*Varroa destructor*) in 1998, Scottish honey bees have been under significant disease pressure. An outbreak of European foulbrood (a notifiable disease caused by the bacterium *Melissococcus plutonius*) identified in 2009 brought further disease pressure to Scottish honey bee colonies. The Scottish Honey Bee Health Strategy, launched in June 2010, formalised a partnership between the Scottish Government (SG), the Scottish Beekeepers' Association (SBA) and the Bee Farmers' Association (BFA) committed to the health and welfare of managed honey bee populations in Scotland. In order to achieve the aims of the Honey Bee Health Strategy, the SG instigated a honey bee health survey in 2012 to develop an understanding of husbandry practices in Scotland and establish base levels of disease across the country. Results of the first year of surveillance are reported and discussed.

SAMPLING STRATEGY

A total of 80 beekeepers (10% of those registered on BeeBase at the time of sampling) from 9 regions were identified to take part in this survey. However, some were unable to provide samples for all aspects of the survey; where this is the case the number of beekeepers/regions surveyed has been identified within the text.

METHODS

Apiary inspection and questionnaire

A random sample of 80 beekeepers was selected from 800 beekeepers registered on BeeBase as keeping bees in Scotland (BeeBase is a voluntary and confidential computerised register of beekeepers managed by the National Bee Unit at FERA, York). These were divided into geographical regions and contacted by their local SG bee inspector to request participation and arrange a date for inspection. A total of 65 beekeepers out of the 80 beekeepers selected took part in the apiary inspection and questionnaire. On arrival at the apiary, the bee inspector used the attached questionnaire (appendix 1) to establish levels of experience, training and methods of husbandry used.

The apiary (or a representative apiary if the beekeeper owned more than one apiary) was fully inspected for signs of notifiable diseases (European Foulbrood, American Foulbrood, Small Hive Beetle, *Tropilaelaps* spp. mites) by the Bee Inspector. A full inspection means that every colony within the apiary is visually examined for signs and symptoms of pests and disease. If a notifiable disease was suspected by the Bee Inspector, then a sample was taken for confirmation by the bee diagnosis laboratory at Science and Advice for Scottish Agriculture (SASA). In the case of American Foulbrood (AFB) or European Foulbrood (EFB), an antibody based 'test kit' could be used on site for rapid diagnosis, followed by laboratory analysis at SASA of a sample of larvae for final confirmation. Whilst present at the apiary, the SG Bee Inspector collected a sample of 60 bees from the entrance of a representative hive and placed a debris trap in the hive floor for removal by the beekeeper after one week. The bees were killed by freezing at -20°C for at least one hour, and both samples were sent in turn to SASA for analysis.

courtesy of www.highlandphoto.org.uk

Laboratory tests

Foulbrood disease diagnosis

If the Bee Inspector found dead brood (larvae) during apiary inspections, a larval sample was removed from the brood comb and placed into an eppendorf tube. At SASA the sample was analysed for the presence of the bacteria *Melissococcus plutonius* and *Paenibacillus larvae*, the causative agents of European Foulbrood (EFB) and American Foulbrood (AFB) respectively. A sample of diseased tissue was removed from the dead larva using a sterile plastic loop and mixed with a drop of distilled water and 4% nigrosine dye on a glass microscope slide. The slide was then fixed by drying on a hotplate and examined for the presence of bacteria using high power microscopy at x1000 magnification. A proliferation of bacteria morphologically identical to positive control material held within the lab (as determined by trained diagnosticians) was considered to be a positive result.

Adult bee disease diagnosis

The sample of 60 adult bees was received into the lab and 30 were immediately sub-sampled and stored at -80°C for PCR testing at a later date. Each bee from the remaining 30 adult bees was then individually examined for visual symptoms of *Varroa destructor* infestation (an external parasite) and Acarine disease (scarring of tracheae indicative of infestation of the internal parasitic mite *Acarapis woodii*) using a binocular microscope at x10 - x40 magnification. Following examination, all 30 bees were then placed in a 'Bioreba universal sample bag' and 15ml distilled water added before the sample was crushed gently to extract the contents of the bees' guts and mixed by gently squeezing the bag. Two drops of liquid were then removed using a glass rod and placed on a glass slide. Cover slips were added to each drop which were then examined for the presence of *Nosema* spp. (a fungal type microsporidial pathogen) using high power microscopy at x400 magnification.

Nosema spp. confirmation and speciation

4ml liquid was removed from every sample (whether positive or negative) following crushing and testing for *Nosema* spp. spores. The liquid was decanted into a 5ml eppendorf tube and frozen at -20°C awaiting completion of microscopy tests for all samples. In preparation for PCR testing these samples were then collected, defrosted and homogenised for 10 seconds using a vortex. A subsample of 200µl was removed and DNA extracted on the KingFisher using InviMag Tissue KF mL. A duplex PCR reaction using primers from Martin-Hernandez *et al*. (2007) was then used on the DNA product, using a pre-set program 'Nosema' on the ABI veriti thermal cycler. PCR products (5µl per reaction) were then analysed against positive control material for *Nosema ceranae* and *Nosema apis* on a 1% agarose gel, stained with gelred dye and viewed using a UV light transilluminator.

Analysing debris material for Varroa mites

Hive debris material was collected from the bottom of the hive using a hive drop mat, exposed within the hive for one week, then posted to SASA. On arrival at SASA, the debris was placed onto a white sheet of paper and screened for the presence of Varroa mites using a binocular microscope (x8 magnification).

For a regional breakdown of results, see appendix 2.

Experience and Training

From a sample of 65 beekeepers across Scotland, 55% had been a beekeeper for less than 10 years (Figure 1). Just over half (52%) of beekeepers questioned had been mentored as beginners and 88% are members of an association. Most beekeepers (83%) have attended one or more training course, either through their local association or through a SAC (now SRUC)/SG training course. The majority of beekeepers continued their education through reading, with the SBA magazine recorded as the most popular source of information (read by 72% of beekeepers surveyed).

	0-9 years	10+ years	20+ years	30+ years	Total
Argyll	2	1	5	**1**	9
Western Isles	5	0	0	**0**	5
Ayrshire	4	1	1	**1**	7
North East	9	1	0	**4**	14
Caithness & Sutherland	1	1	0	**1**	3
Lothian & Borders	5	3	1	**0**	9
Dumfries	6	0	2	**0**	8
Tayside	4	2	2	**2**	10
Total	**36**	**9**	**11**	**9**	**65**

Figure 1 - Number of years' experience as a beekeeper

Business

Most beekeepers (58%) manage a small number of colonies (five or fewer); a statistic reflected by data gathered on BeeBase. Only five of the beekeepers questioned (8%) managed 20 or more colonies (Figure 2). When asked about their plans for the future, half (49%) planned to increase the number of colonies managed, and only 5% planned to reduce their apiary size. When replenishing stocks, most (71%) source their bees locally using either their own breeding programme or local suppliers, and only 3% had bought bees from overseas.

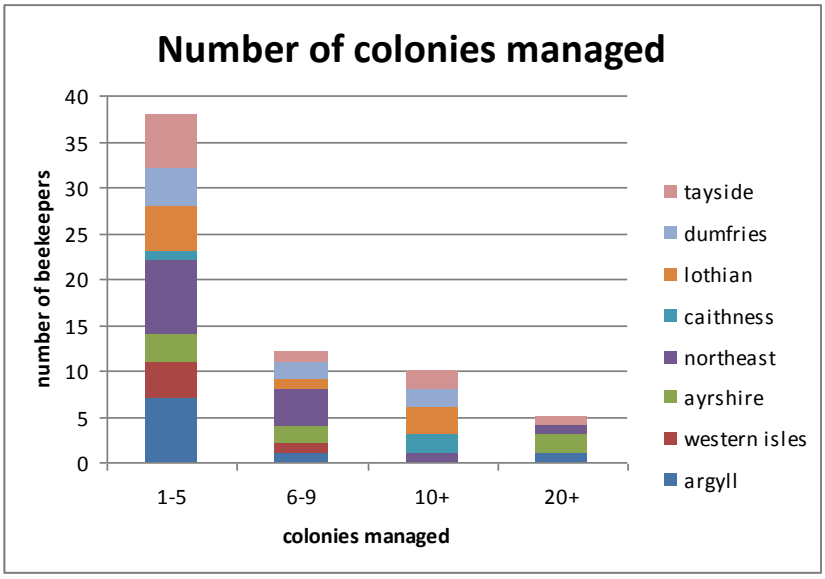


Figure 2 – number of colonies managed

Food sources and honey yield

Nectar sources varied across Scotland. Colonies in Caithness, Sutherland and the Western Isles had the fewest nectar sources; those in Argyll and Ayrshire were more diverse. Beekeepers in the east of Scotland (North-East, Lothian and borders and Tayside) and Ayrshire identified oilseed rape as a significant source of nectar. 39% of beekeepers yielded 20-29lb honey per colony, although some producers were not concerned by honey yield (particularly bee breeders and soft fruit pollinators) (Figure 3). 86% of beekeepers questioned use sugar syrup to supplement feeding, several others use other proprietary supplements e.g. Ambrosia/Apisuc, and only one beekeeper (from the Argyll region),representing 1.5%, used no supplemental feeding.

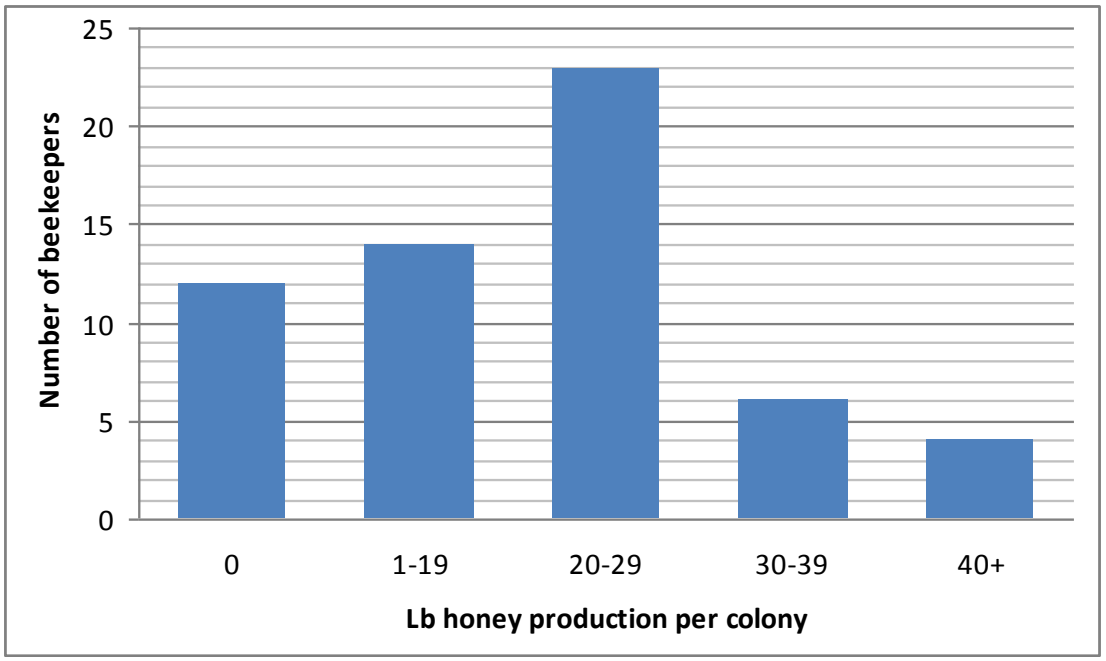


Figure 3 – Honey production per colony

Winter losses

38% of beekeepers reported colony losses during the winter 2011-12, which was not a particularly harsh winter for honeybees in Scotland. This compares to 79% of beekeepers reporting the loss of a colony over winter 2012-13, which was recorded as a particularly bad year for beekeeping as colonies went into winter undernourished after a poor summer then endured an extended period of confinement due to late frosts in spring 2013. These figures equate to a total overwintering loss of 11% colonies across Scotland during 2011-12 and 32% during 2012-13 (Figure 4). The worst individual loss in 2011-12 (7 out of 35 colonies) was recorded in Tayside and the worst individual loss recorded in 2012-13 (18 out of 18 colonies) was from the Highland region. High individual losses were also recorded in Ayrshire, Lothian and Caithness in 2011-12 and Ayrshire and Lothian in 2012-13.

The most common reason for winter loss reported by beekeepers in 2011-12 was problems with the queen (39%). Other common problems included starvation or isolation (25%) and Varroa (14%). The main factor reported for winter losses in 2012-13 was the weather, although this led to subsequent problems with queen viability and starvation.

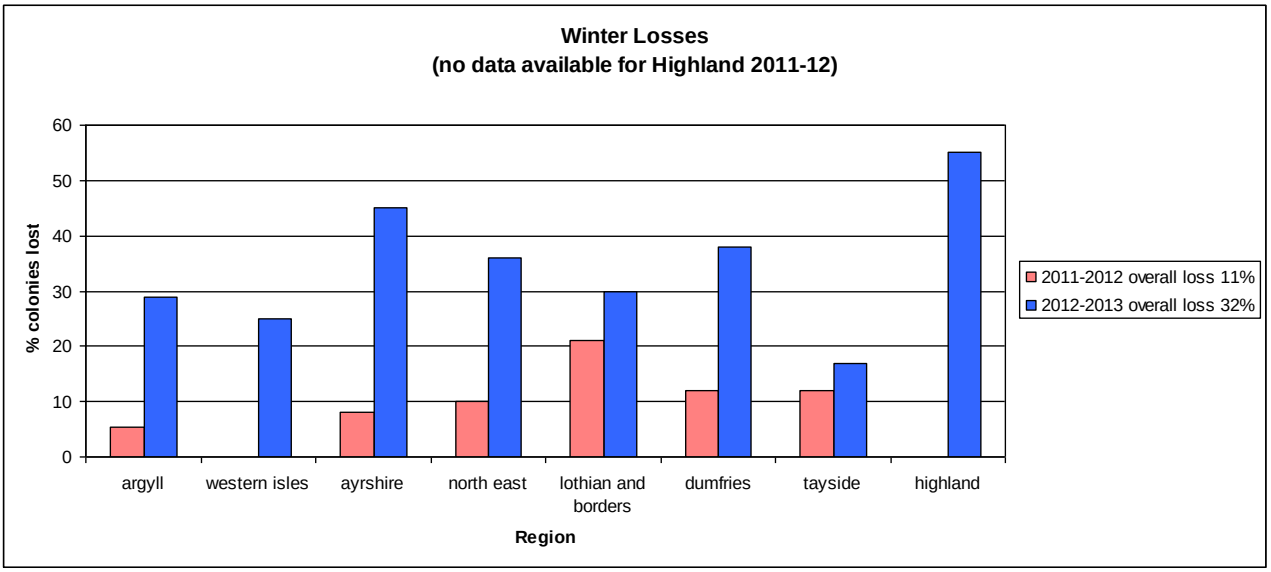


Figure 4 – Winter losses in 2011-12 and 2012-13

Varroa management

Five of the beekeepers involved in the survey claimed to be Varroa free and therefore did not use treatment (testing of hive drop material confirmed no Varroa mites in their samples). Of the other 59 beekeepers, over half (52.5%) used pyrethroids (Apistan and Bayvarol) as part of their Varroa management system. Other popular treatments included Apiguard (thymol based) and oxalic acid (Figure 5). 82% of beekeepers use open mesh floors, however this was not always mentioned within the response covering Varroa management.

Only 13% of beekeepers questioned knew whether pyrethroid resistance (of Varroa mites) was affecting their colony. However, of those who had tested, 86% found Pyrethroid resistance within their colonies.

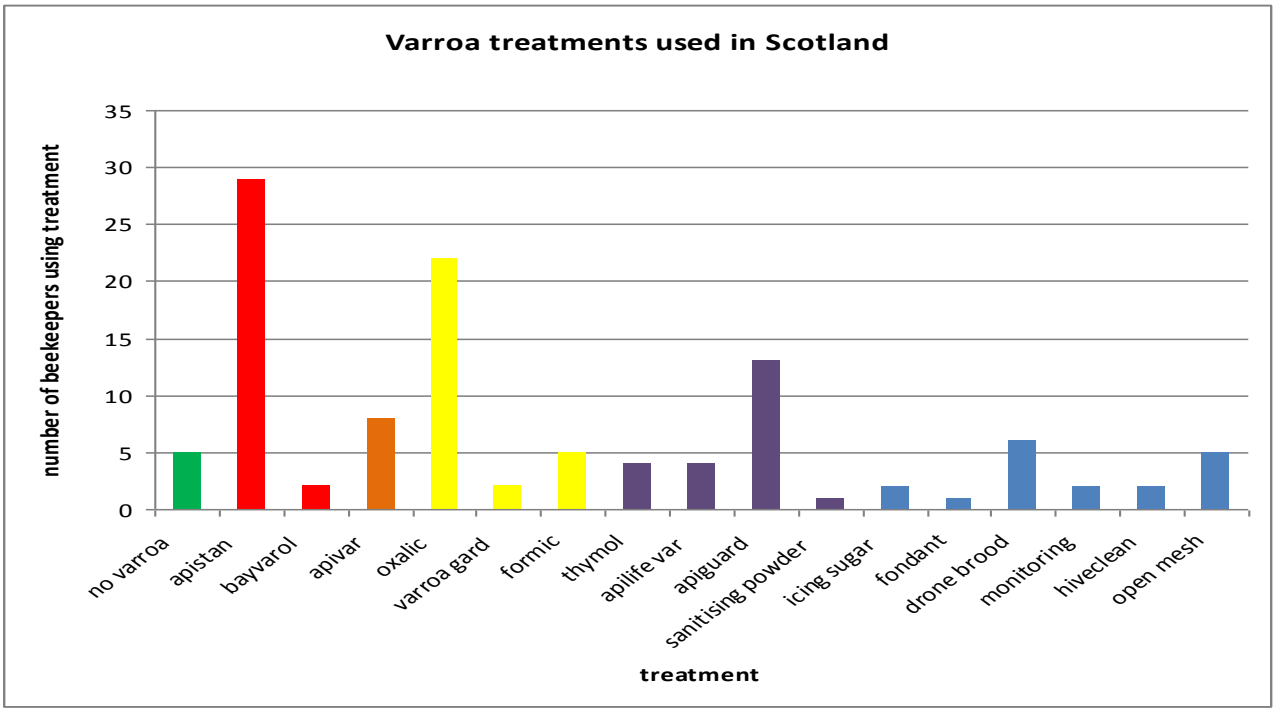


Figure 5 – Methods used to control Varroa; a table of active ingredients can be found in the NBU 'Managing Varroa' leaflet available at https://secure.fera.defra.gov.uk/beebase/index.cfm?pageid=93

Disease testing – Foulbrood disease and notifiable pests

70 apiaries (totalling 305 Colonies) from all regions were inspected and all were found to be free of European Foulbrood, Small Hive Beetle (*Aethina tumida*) and *Tropilaelaps* spp mites. The first apiary inspection in the Highland region revealed a low level of American Foulbrood in one colony (the only finding of a notifiable disease within the survey); as a result of this, resources in that region were redeployed to inspect 'contact colonies' and manage the outbreak.

To assess the relevance of the surveillance results, a comparison can be made against the results of targeted inspections during 2009-2012 (Figure 6). Targeted inspections of Scottish apiaries are made where there is a suspicion of foulbrood in a colony, or where a colony may have been 'in contact' with a foulbrood infected hive (either by 'bee to bee contact' or managed by the same beekeeper), and data are available through BeeBase.

A comparison of the surveillance and targeted inspections using a Chi squared test shows that the likelihood of finding clinical EFB in a 'random' Scottish colony is significantly lower (χ^2 =17.656 , P= <0.0001) than during targeted inspections. The chance of identifying AFB within a surveillance colony was again lower than targeted inspection, however as AFB has only been identified at low levels during 2009-12, the difference was not significant (χ^2 =3.037 , P= 0.0814) . Low findings of either disease within surveillance colonies indicate that foulbrood is not widespread across Scotland, and is more likely to be found when there is suspicion of a foulbrood infection.

SG bee inspections	**Targeted Inspections**				**Surveillance 2012**
	2009	**2010**	**2011**	**2012**	
No. of colonies inspected	2263	3150	3491	1369	305
No. of apiaries inspected	257	213	208	235	70
No. of EFB positive colonies	310	71	127	54	0
No. of EFB positive apiaries	69	25	42	34	0
No. of AFB positive colonies	136	11	5	9	1
No. of AFB positive apiaries	38	8	3	5	1
No. of apiaries infected with both EFB and AFB	2	0	1	0	0

Figure 6 – A comparison of foulbrood inspection results for surveillance and targeted inspections

Disease testing – Adult bee diseases

A total of 68 samples from 9 regions were submitted for testing. Only two colonies (from Argyll and Highland regions) showed symptoms of Acarine disease in adult bees tested, accounting for only 3% of the population (Figure 7). This disease is more symptomatic during periods of confinement (winter), so as samples were taken during the summer months this may not be a true indication of the extent of this disease within Scottish honey bee populations. 11 colonies (17%) tested positive for *Nosema* spp. using microscopy. This correlated to the 11 positives identified by PCR methods. Population distribution of the two species of *Nosema* was fairly even, with four samples testing positive for *Nosema apis*, five positive for *Nosema ceranae* and two showing mixed populations within a single colony (figure 8).

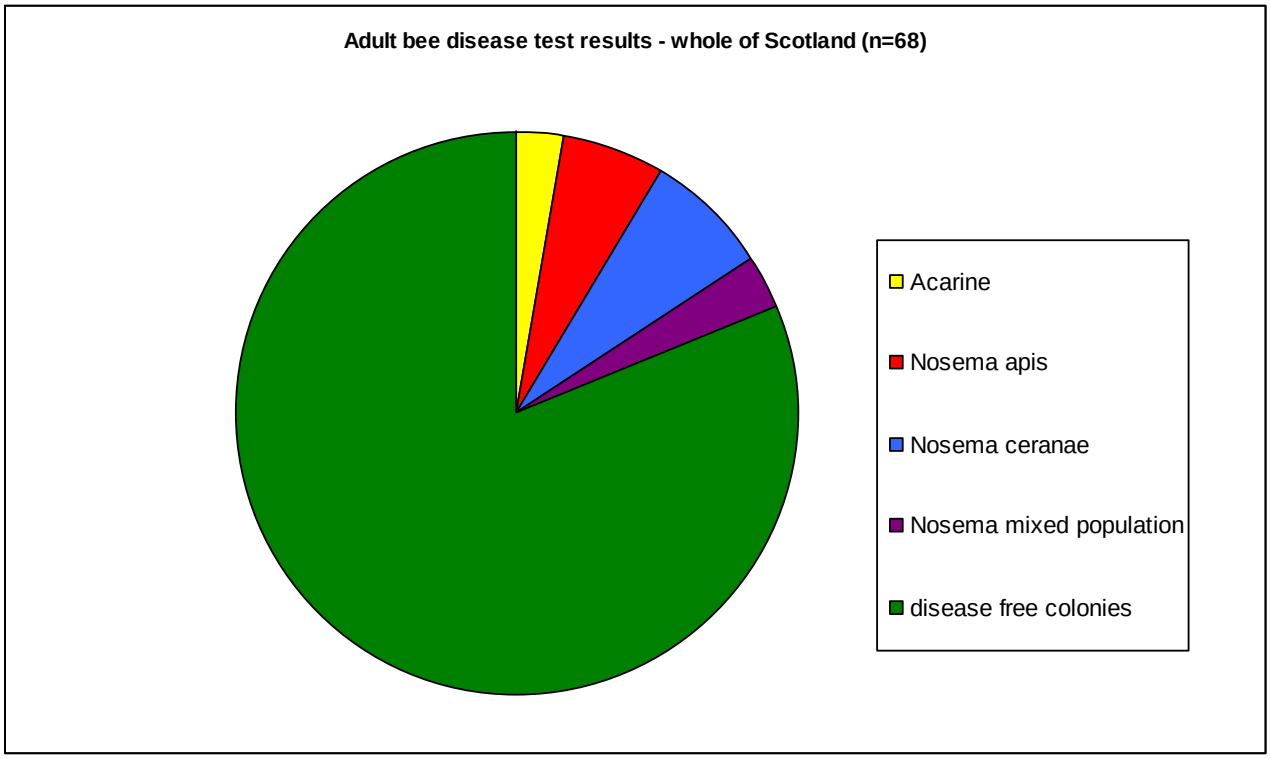


Figure 7 – Adult bee diseases detected in a sample of 30 bees – all colonies tested

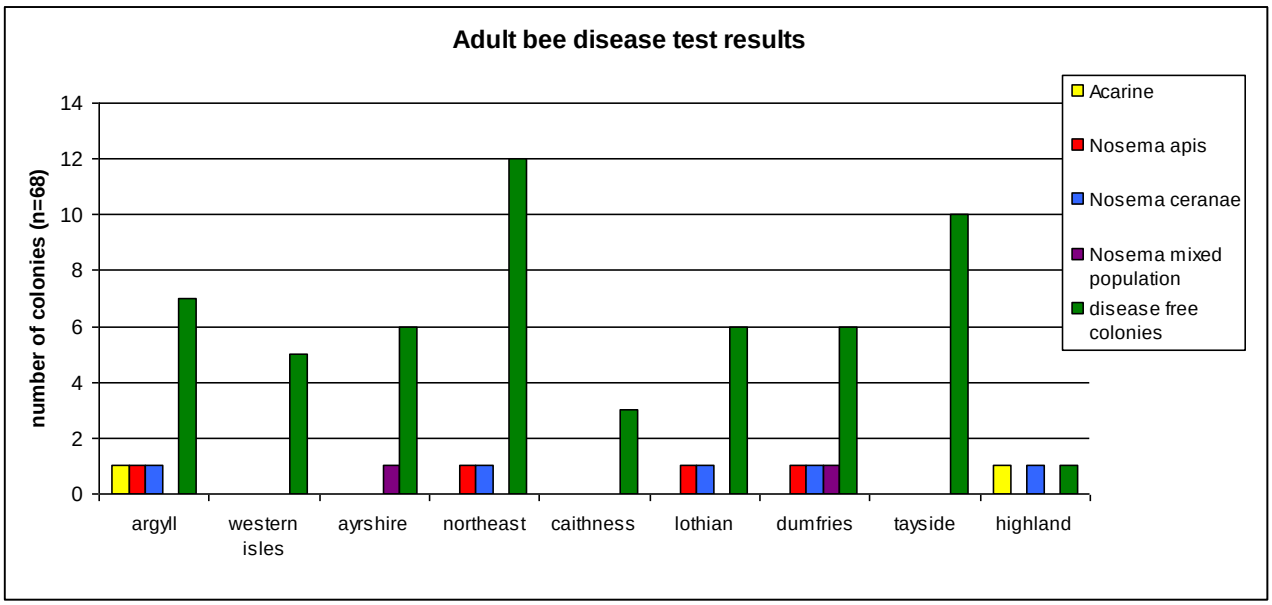


Figure 8 – Adult bee diseases detected in a sample of 30 adult bees – regional breakdown

Disease testing – Varroa

Varroa mites were detected in 70% of samples tested (figure 9), and were present in all of the nine regions tested; samples containing no Varroa mites were also present in all regions tested (figure 10). Few samples were taken from apiaries believed to be within 'Varroa free' areas (see map below), however all five samples taken from within this area were found to be free of Varroa mites.

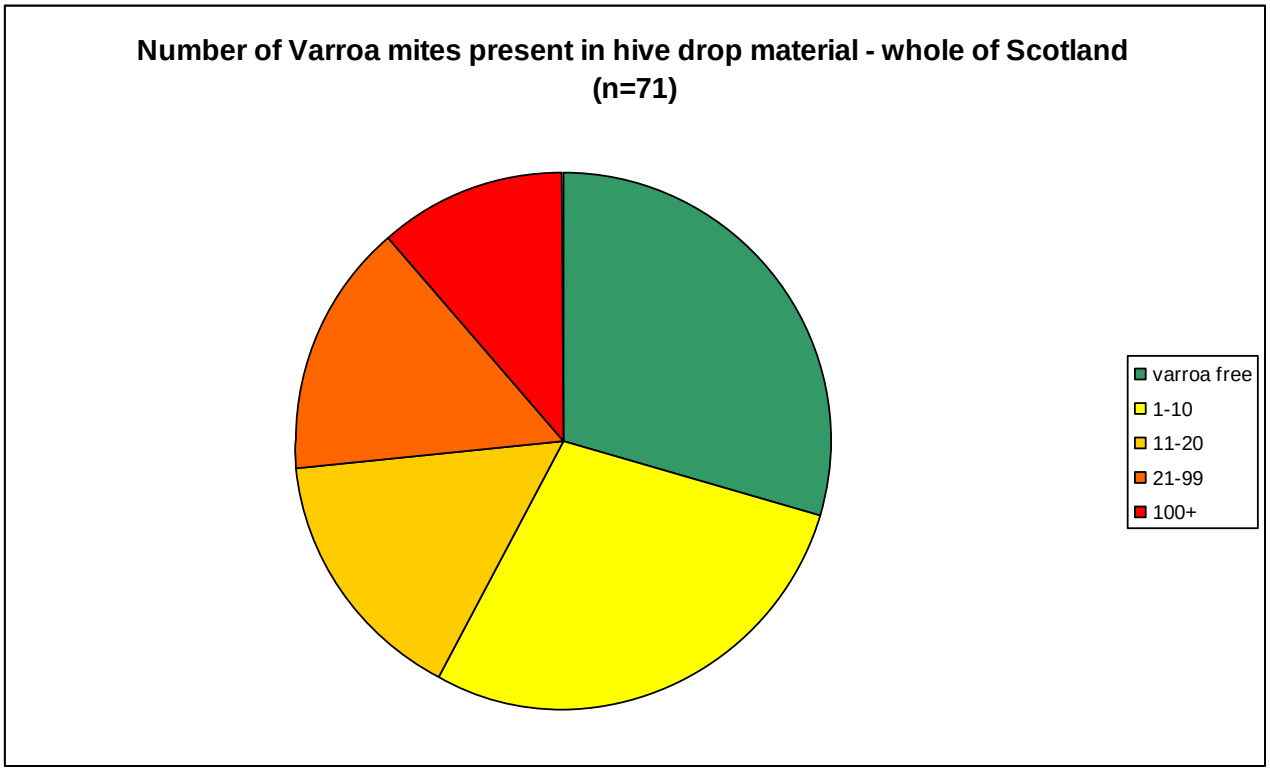


Figure 9 – Number of Varroa mites detected in hive drop samples – all colonies tested

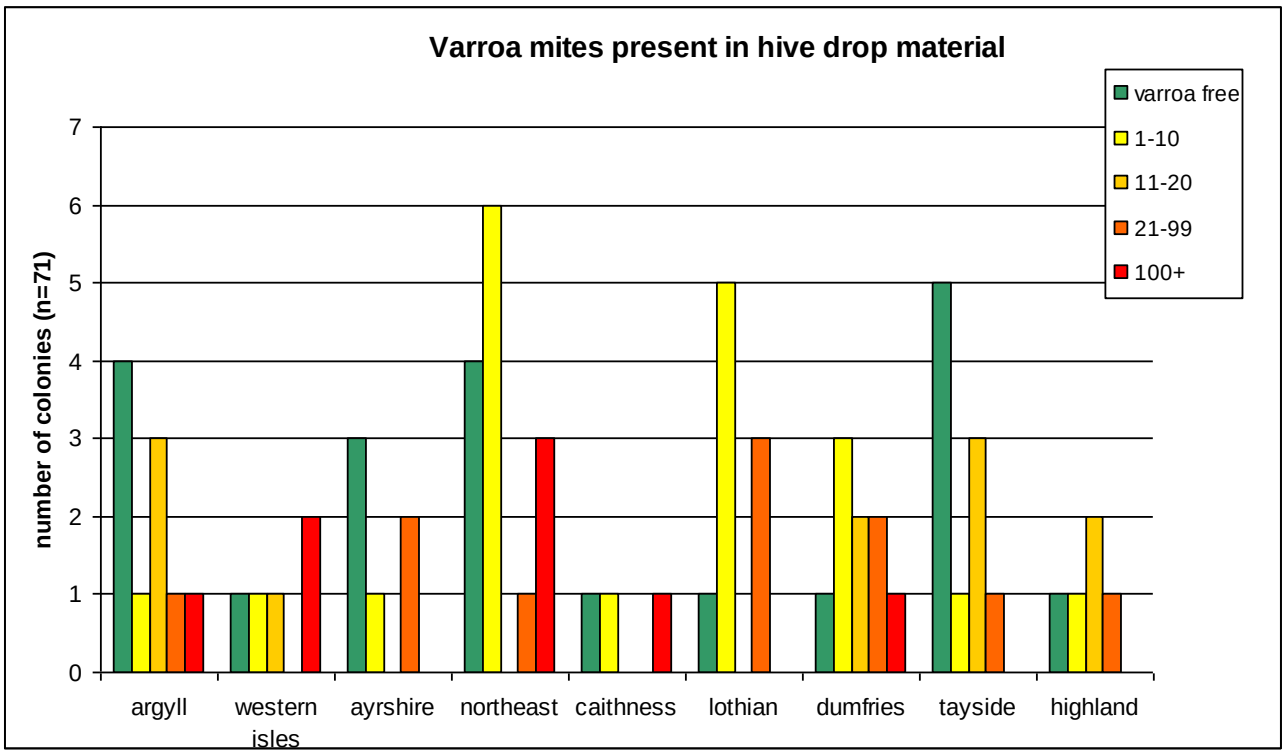
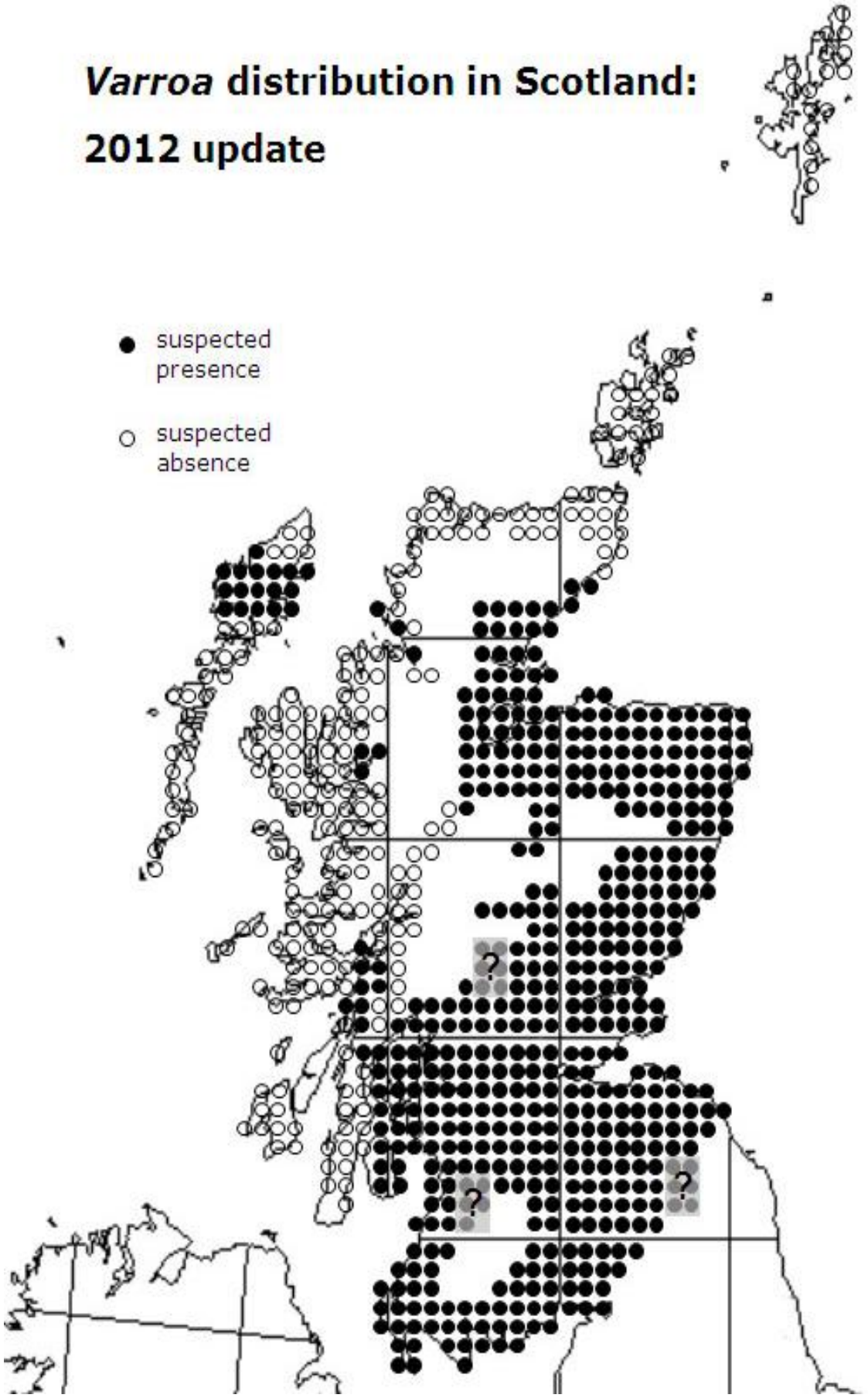


Figure 10 – Number of Varroa mites detected in hive drop samples – regional breakdown



This map shows the areas of known presence and suspected absence of Varroa mites in Scottish honeybees, and was taken from http://www.sbai.org.uk/varroamapping/map_11Apr2011.jpg . The data presented were collected using SBA and local beekeeping association knowledge along with SASA test results up to June 2012.

DISCUSSION

Surveillance data provides us with an opportunity to gain a better understanding of factors affecting bee health in Scotland, to underpin strategies developed to mitigate these factors and ultimately to improve the overall health of Scottish honey bee populations.

Although very few beekeepers manage a significant proportion of the honey bee colonies in Scotland, the majority of honey bee colonies are managed on a very small scale by non-commercial beekeepers (data from Scottish BeeBase statistics). These beekeepers are likely to be members of a local associations, but a significant minority are not involved with such groups and therefore do not have access to usual forms of communication, such as the SBA magazine. The numbers of such 'isolated' beekeepers are likely to be higher than recorded in this survey as beekeepers were selected through BeeBase, and local associations have actively encouraged members to register on this site. Communication with all members of the beekeeping community is an essential component of the Scottish Honey Bee Health Strategy, and communicating with beekeepers not registered on BeeBase or in an association will continue to pose a problem for the Scottish Honey Bee Health Strategy group.

Winter losses are a major concern for Scottish beekeepers, and sustainable methods of re-stocking have to be addressed if populations of honey bees are to be maintained or increased. Queen failure was highlighted as a common reason for winter losses, and more effective queen rearing may be a way of increasing the availability of locally sourced bees. Although the majority of beekeepers may prefer to source their bees locally, it is possible to import bees legally from safe sources further afield, and guidance is available on:

BeeBase - https://secure.fera.defra.gov.uk/beebase/index.cfm?sectionid=47

Nutrition also plays a part in maintaining colony strength, and almost all beekeepers questioned supplement nectar sources by using sugar syrup or alternative feeding supplements. Optimising timing and methods of feeding to take into account local environmental factors may help to improve colony health.

Disease plays a factor in the health of Scottish honey bees. Both Nosema and Acarine disease were identified at low levels within Scottish samples, however Varroa was detected in 70% of all samples and identified by the beekeepers as a factor in winter mortality. Although the data available are too limited to provide an accurate account across Scotland, six out of the seven

beekeepers who had tested their Varroa, found evidence of pyrethroid resistant mites. This highlights the importance of using an integrated pest management (IPM) strategy to control mites, and not relying wholly on traditional pyrethroid treatments (Apistan and Bayvarol) to prevent Varroa-associated losses.

Not all Scottish colonies are affected by Varroa mites, and despite the introduction of *Varroa destructor* in 1998 and its rapid movement across Scotland (and subsequent declaration of the whole of Scotland as a 'statutory infected zone' in 2003), all five beekeepers in 'Varroa free areas' were found to have no Varroa mites in their samples (see SBA data map on page 12). This raises the hope that it is possible for beekeepers in these remote and often harsh environments to maintain their 'Varroa free' status and prevent losses due to the mite and associated viruses with adequate support. As there is currently no legislation in place to restrict movement of bees into these regions, local honey bee breeding programmes and excellent communication (to suppliers and incoming beekeepers) may be the best option for keeping these areas Varroa free.

Since 2009, bee inspection resources have been targeted at known foulbrood outbreak sites, despite little knowledge of base levels of infection across the country. Full apiary inspections by qualified inspectors covering all apiaries involved in the surveillance programme have not identified any new outbreak areas, and indeed within the 'EFB control zone' (one of the worst affected areas), no new cases of disease were uncovered (see appendix 3 – EFB control plan). This indicates that resources have been suitably deployed and that continued targeting of areas of known disease and contact colonies should provide the best possible control of EFB and AFB in the future.

FURTHER INVESTIGATIONS

A continued surveillance programme for 2013 has already been agreed and this should build on the results already available. This information should inform the disease management programmes being developed within the Scottish Honey Bee Health Strategy and increase the awareness and confidence in the role of the SG Inspectors within the Scottish beekeeping community. Further work, looking at bacterial and viral disease in samples taken during 2012 and 2013, awaits completion and further outputs are expected over the next 12 months. These will be reported as they become available.

APPENDICES

Appendix 1 – Full questionnaire as completed by the beekeepers
Appendix 2 – Regional breakdown of answers submitted
Appendix 3 – EFB control plan

REFERENCES

Martin-Hernandez *et al.* 2007.Outcome of Colonization of *Apis mellifera* by *Nosema ceranae*. App Env Microbiol. **73**: 6331-6338

ACKNOWLEDGEMENTS

The authors would like to thank the Scottish bee inspectors, laboratory staff, administrators and beekeepers who contributed to the work detailed within this report.