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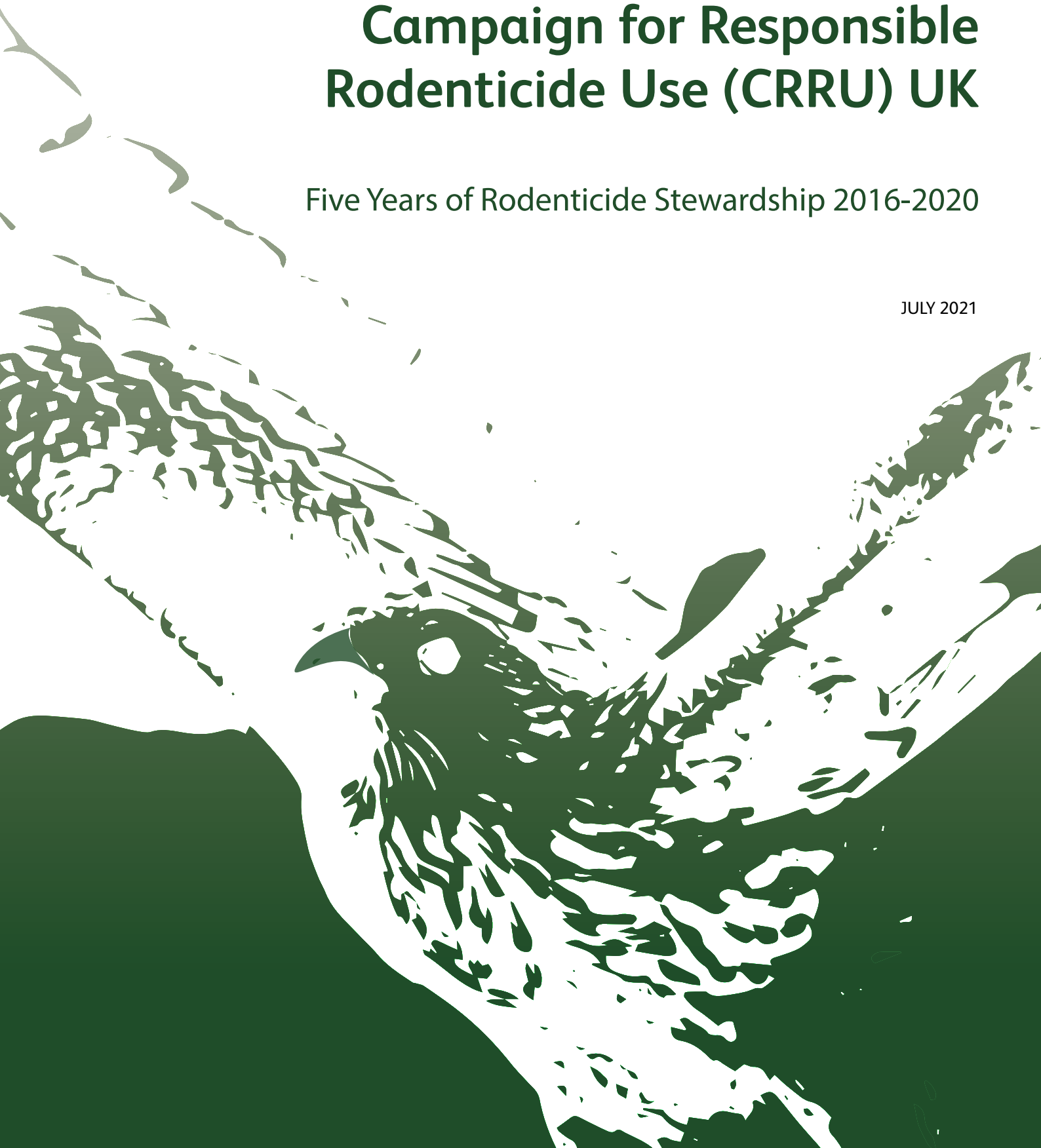
Campaign for Responsible Rodenticide Use
CRRU Stewardship

Campaign for Responsible Rodenticide Use (CRRU) UK

Five Years of Rodenticide Stewardship 2016-2020

JULY 2021



The UK Rodenticide Stewardship Regime
Campaign for Responsible Rodenticide Use (CRRU) UK
Summary Report 2016-2020

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CRRU UK Member Companies:

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Where the acronym CRRU is used in this document it refers to the Campaign for Responsible Rodenticide Use UK.

FOREWORD

Five years have passed since the start of the UK Rodenticide Stewardship Regime in 2016. The UK landscape for the use of rodenticides has changed dramatically in that time. Some change has been driven by the European Commission, with introduction of new product label phrases and a new framework of use scenarios. We have also seen the introduction of many new label requirements concerning the management of resistance and enhanced risk mitigation. The outcome of regulatory changes implemented in the UK by HSE has been to define use patterns, target species, application methods and risk mitigation procedures more precisely, and in many cases to restrict what products can be used, by whom and where.

Over the five-years the work of the Stewardship Regime has been to explain these changes to practitioners through documents presented as guidelines and codes of practice and in continuing professional development programmes. The purpose of all was to improve use practices and risk mitigation. A significant development was the addition of phrases on labels of professional rodenticides making it a requirement to follow CRRU guidance when applying them. For the first time, in 2016, it was necessary to prove competence when purchasing a professional product and this could be done only by certification through CRRU-approved training or membership of a farm assurance scheme with a CRRU-aligned standard.

Monitoring is a central plank of the regime and the profound changes that have occurred among users in the way that rodenticides are perceived and applied are readily apparent in the information gathered by CRRU in periodic Knowledge, Attitude and Practice surveys. Significant changes in user behaviour demonstrated in these surveys indicate the effectiveness of the CRRU communications programme.

When the Regime was established, HSE said that it would undergo 'major review' after five years. That review is now upon us. One goal, however, that of a reduction in the exposure of barn owls to anticoagulants, has not yet been met and we must hope that we are given more time to deliver it. It is reassuring, however, that the extension of use outdoors of some more potent anticoagulants has not resulted in a significant increase in the exposure of wildlife, as once feared. Less reassuring is the apparent spread of anticoagulant resistance among target rodent species, including new strains that carry two different resistance mutations.

This report shows the tremendous progress that has been made in all aspects of the governance and use of rodenticides by professional pest control technicians, gamekeepers and farmers alike. It only remains for me to offer my grateful thanks to all those from the CRRU stakeholder organisations whose work operated the regime over the past five years. They are directly responsible for all that has been achieved. Those who use professional rodenticides as a part of the service they offer, and the general public whose health and well-being depends on the effective control of disease-transmitting rodent infestations, should be profoundly grateful.

Dr Alan Buckle

Chairman CRRU UK,
University of Reading

1. SUMMARY

The UK Rodenticide Stewardship Regime was established in 2016 and designed to meet the 'High Level Principles' set by the Health and Safety Executive (HSE) (https://www.hse.gov.uk/biocides/rodenticides.htm). As the only stewardship scheme that did so, the regime was joined and funded by all manufacturers holding professional rodenticide product authorisations. Supporting more than 700 authorisations, the regime is directed by the CRRU UK Taskforce, currently comprising 32 stakeholder organisations, and implemented through a structure of six work groups. The overriding purpose of stewardship is to deliver three key benefits: governance of the supply chain, a competent workforce and monitoring compliance. Each year of operation, CRRU has reported progress to HSE and the Government Oversight Group (GOG). The GOG found the regime 'fit for purpose' at each annual assessment, although occasionally with elements that required further development.

The declared intention of HSE was to conduct a 'major review' of the regime after those five years. This report, prepared for the review, describes the structure and functioning of the regime over five years of implementation. The objectives and achievements of each of the work groups towards delivering the key benefits are also described. A major part of the regime has been the operation of a series of monitoring studies, each a requirement set by the GOG from the outset of the regime. These are conducted on behalf of CRRU by independent scientific and academic contractor agencies. The report summarises the results of these monitoring studies and a year-to-year progression is described towards the delivery of the key benefits. The highly significant changes brought about by the regime in the way that professional rodenticides are distributed, purchased and applied, across three user groups and tens of thousands of users are readily apparent.

2. INTRODUCTION

2.1 Beginnings of Stewardship

A review of second-generation anticoagulant rodenticide (SGAR) active substances was conducted by the European Commission and Member States during 2005 to 2010, under the terms of the Biocidal Products Directive (BPD).[1] Such was the concern about these substances that rodenticides were one of the first product types to go through this process. The review identified concerns about all SGAR substances, in particular risks to human health and the environment, but decisions about their continued use was deferred until the later stage of product authorisation. These concerns were also considered by the UK Competent Authority for biocides, the Health and Safety Executive (HSE).[2,3] It was found that human health risks could be largely addressed by a combination of risk mitigation and regulatory action. However, environmental risk could not be resolved in the same way, especially when SGAR products were used outdoors.

HSE published regulatory options for environmental risk mitigation for SGAR products and a consultation was held in 2013, in which the opinions of a wide range of interested parties were sought, and which resulted in a stakeholder meeting.[4] The outcome was a proposal from HSE that a stewardship regime should be implemented and that, if a satisfactory framework was found, SGAR product authorisations could continue under the Biocidal Products Regulation (BPR)[5] and, when application was made, all SGAR products could be used outdoors.[6]

The Campaign for Responsible Rodenticide Use (CRRU) UK was invited to submit stewardship proposals to HSE in June 2013. Thereafter began a series of negotiations with HSE and stakeholder organisations for all professional user groups, which lasted more than two years. Proposals were made to all parties, rejected and refined until an agreed framework was established that carried credible promise of effective, broad-based stewardship action to permit HSE to issue product authorisations.[7] Two important decisions were made at that time. It was decided that only professional rodenticide products should be subject to stewardship conditions and that, as well as certification through approved training programmes, membership of a farm assurance scheme, with standards aligned to the CRRU UK Code of Best Practice and with regular on-farm audits for compliance to standards, also provided proof of competence for purchasing professional rodenticides.

The management of the complex transitionary period, and the various requirements placed upon rodenticide users and manufacturers are shown in Figure 1.[8]

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1 European Commission. 1997. Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market. Official Journal of the European Communities L 123/1, 24.04.1998. 63 pp. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31998L0008. Date accessed: 27.02.21.

2 HSE. 2012a. Consideration of the environmental risk from the use of brodifacoum, flocoumafen, difethialone, difenacoum and bromadiolone. Health and Safety Executive. 23 pp.

3 HSE. 2011. Human health risk mitigation measures for anticoagulant rodenticide baits. Draft proposals for BPR product authorisation in the UK. Health and Safety Executive. 14 pp.

4 HSE. 2012b. Environmental Risk Mitigation Measures for Second Generation Anticoagulant Rodenticides Proposed by the UK. Health and Safety Executive. 30 pp.

5 European Commission. 2011. Regulation (EU) No 528/2012 of the European Parliament and of Council of 22 May 2012 concerning the making available on the market and use of biocidal products. Official Journal of the European Communities L 167/1, 27.06.2012. 123 pp. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-%3A31998L0008. Date accessed: 27.02.21.

6 HSE. 2013. Second Generation Anticoagulant Rodenticides (SGARs) Development of a Stewardship Regime. Health and Safety Executive. May 2013. Restricted Draft. 10 pp.

7 HSE. 2015. UK Anticoagulant Rodenticide Product Authorisation and the CRRU Stewardship Scheme. Information document, January 2015. Health and Safety Executive. 12 pp.

8 European Commission. 2012. Regulation of the European Parliament and of the Council of 22 May 2012 concerning the placing on the market and use of biocidal products. Official Journal of the European Communities L 167/1. 123 pp. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0528&from=EN. Date accessed: 27.02.21.

Figure 1. The timelines used in the transition between approvals granted pre-stewardship and those granted with a requirement for rodenticide stewardship.

2.2 Elements of Stewardship

2.2.1 Regime Framework

A condition of authorisation for all SGAR active substances, when used outdoors, was that authorisation holders should demonstrate that stewardship action would be applied for products so as to meet the 'High Level Principles' published by HSE in 2016.[9] The CRRU stewardship regime was the only one in operation in the UK that met these principles and, therefore, it became a *de facto* requirement for all authorisation holders to become CRRU UK member companies and to contribute to the funding, development, management and evaluation of the regime.

The regime comprises elements to meet the HSE high level principles and to achieve three key benefits also defined by HSE, as follows:

- governance of the supply chain, which gives governance over, and provides the driver for, later stages,
- a competent workforce capable of delivering stewardship standards and of demonstrating an appropriate understanding and attitude toward case-specific control of rodents and use of rodenticides,
- monitoring compliance with the regime and its environmental impacts, and if possible of the level of conflict reduction (an assessment of whether rodenticides and stewardship together are actually tackling the problems).

The regime is operated through six work groups, with well-defined remits and objectives (Figure 2).[10] Five of these are led and populated by volunteers from authorisation-holder companies and stakeholder agencies; the sixth, communications, employs a specialist contractor. Implementation of the regime is directed by the CRRU Task Force (Annex 1).

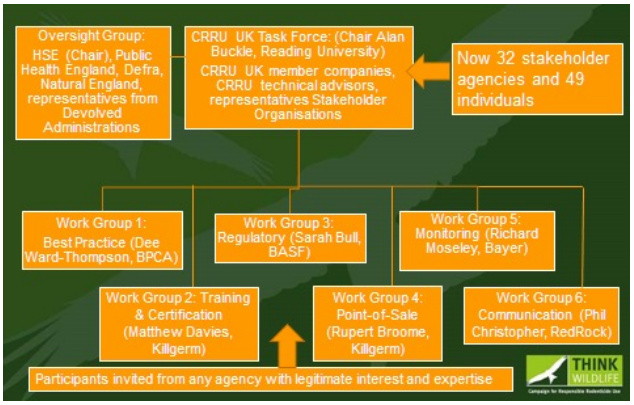

Figure 2. The delivery and oversight structures for the rodenticide stewardship regime.

9 HSE. 2021. Rodenticides. UK rodenticide stewardship regimes. Regime principles. Available at: https://www.hse.gov.uk/biocides/rodenticides.htm. Date accessed: 28.02.21.

10 CRRU. 2015. Outline of CRRU Structure to deliver co-ordination of UK SGAR Stewardship Regime. Campaign for Responsible Rodenticide Use. February 2015. 7 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 28.02.21.

2.2.2 Best Practice

The main purpose of the regime is to promote and support best practice and ensure its diligent application by all users of professional rodenticides. Before it can be applied, however, practitioners need to understand what best practice is. The wide experience and knowledge of CRRU stakeholder organisations is harnessed to provide CRRU best practice guidance. The most important expression of this is, of course, the CRRU Code of Best Practice.[11] This is supported by a range of additional documents, some aimed broadly across all user groups, such as those published on environmental risk assessment and permanent baiting, and some aimed more precisely towards a single user group, such as the guidance document for gamekeepers.[12] An over-arching principle of stewardship best practice is the concept of the 'risk hierarchy', wherein those who conduct any rodent pest management activity must consider all risks and apply those measures which are considered likely to be fully effective and which present the least risk.

One of the most important steps taken towards the delivery of the regime's aims was the decision taken by HSE and authorisation-holders to require users to follow instructions provided by the CRRU UK Code of Best Practice (or equivalent).

2.2.3 Communication

Above all else, stewardship is an exercise in communication, with rodenticide users, those who supply them, those who audit their activities and the many different organisations that seek to support and influence the way they go about rodent pest management. Therefore, communication has been at the forefront of all CRRU activities – with the principal purpose to assure understanding of and compliance with the conditions of use set out on product labels and to promote best practice among those in the three main user groups; farmers, gamekeepers and professional pest management technicians.

CRRU conducts regular surveys of Knowledge, Attitudes and Practice (KAP) among these user groups (see sections 4.6.4 and 4.7.4). The independent market research company that carries out these surveys on behalf of CRRU has expressed the opinion that the three CRRU KAP surveys, conducted in 2015, 2017 and 2020, provide the most comprehensive understanding of a communication process, and changes in user behaviour that it has brought about, ever developed for biocide/pesticide use in the UK.

2.2.4 Training

A fundamental element of the regime is that, for the first time in April 2016 (Figure 1), purchase of professional rodenticides was permitted only to those who could prove competence. One such proof is the possession of certification obtained after participating in training and passing an examination.[12] A training framework was established which set out the basis for the delivery of training, via commercial training agencies, and the setting, invigilation and marking of examinations by independent Awarding Organisations (AO). The required content of CRRU-approved courses was determined and comprised 13 separate elements.[13] AOs were invited to submit existing courses to CRRU for evaluation against the required elements. Those that were found acceptable were CRRU-approved and individuals who already held the certifications/qualification were considered competent through a process of 'grandfathering' (see section 3.3.2 and Table 6).

2.2.5 Farm Assurance Schemes

One of the biggest obstacles to the timely introduction of the regime, and hence the authorisation of SGAR products by HSE, was the requirement for proof of competence in the farming sector. Variously estimated between 80,000 and 120,000, this population of rodenticide users is by far the largest. Rodent control on farms is an inescapable imperative to protect the well-being of those who work on them, the

11 CRRU. 2015. CRRU UK Code of Best Practice. Date Issued – March 2015
Best Practice and Guidance for Rodent Control and the Safe Use of Rodenticides. Campaign for Responsible Rodenticide Use. March 2015. 24 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 28.02.21.

12 CRRU. 2017. CRRU UK – Rat control and game management. 2nd Edition. July 2017. 16 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 28.02.21

13 CRRU. 2015. Proposals for Development of Courses in Rodent Pest Management and Associated Approved Certifications. Campaign for Responsible Rodenticide Use. April 2015. 4 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 28.02.21.

safety of farm produce and, ultimately, the health of those who consume the food produced. This large constituency of users could not be expected to take training and pass examinations in the very limited time available.

A three-stage process was put in place in which, as a short-term measure, all members of CRRU-approved farm assurance schemes (FAS) were considered competent. Criteria for approval at this interim stage were that standards of an FAS should provide coherent guidance on effective rodent control, with all rodent control activities on the assured farm documented and compliance with the FAS standard audited independently on a regular basis. As the second stage, CRRU produced a 13-point template for assessment of alignment between FAS standards and the CRRU Code of Best Practice. During the normal cycle of re-evaluation and improvement of standards, CRRU worked with all approved schemes and, using the template, ensured that any revised standard complied with CRRU requirements. This work was completed by December 2017 and from January 2018 onwards FAS audits required compliance with the new, aligned standards.

All FAS standards carry wording like that found in the Red Tractor Standard for Dairy as follows, "*All staff (including, but not limited to, full and part-time and family members and relief milkers) are trained and competent to carry out the activities they do*". The third stage of the development of competence in the agriculture sector was to develop a suite of sector-specific training courses and to promote the uptake of those courses among farmers. This work is in progress and support from the FASs is sought in this. Furthermore, content for continuing professional development (CPD) in the agriculture sector is to be developed and promoted, with the help of existing CPD providers (Table 5).

2.2.6 Point-of-Sale Controls

Proof of professional competence at the point-of-sale was one of the most significant changes to the supply of biocides in the UK. The successful and rapid implementation of this measure was essential to the ability of authorisation-holders to comply with this key condition of authorisation. The supply chain, from manufacture to user, is complicated and extended. CRRU developed documentation whereby responsibility to comply with conditions of authorisation are passed to, and accepted by, each link in the chain (Annex 5 and 6).

The next requirement was to develop a process in which every supplier at a point of sale, 692 in 2020, made a record of the certification presented at time of purchase and that these records could be scrutinised within an audit process operated by the independent BASIS (Registration) Limited (see section 3.5.4). Many sales are online and guidance was provided to online retailers about the requirement for proof of competence. These sales are also audited by BASIS. In 2020, BASIS reported that 93 % of sales of professional rodenticides were stewardship compliant. Apparently there is scope, albeit limited, for improvement.

CRRU established an online portal whereby anybody who believes they have witnessed the sale of a professional rodenticide contrary to the conditions of authorisation can report to CRRU. These reports are investigated and, when justified, appropriate action is taken.

2.2.7 Monitoring

When it authorised outdoor uses of SGARs with the requirement for stewardship, HSE set out a number of monitoring programmes that were necessary so that progression towards set objectives could be measured.[14] The requirement for monitoring is set broadly across all aspects of the regime (see Annex 2). There are three main HSE-required scientific monitoring programmes and, over the five years of stewardship to date, these have consumed more CRRU resources, in terms of both human capital and money, than any other element of the regime.

KAP surveys were mentioned previously.[15] A baseline study was conducted in 2015 to establish user

14 HSE. 2016. Performance Monitoring and Assurance: Rodenticide Stewardship Regime. Health and Safety Executive. March 2016. 3 pp.

15 Research Engine. 2020. Rodenticide Knowledge, Attitudes and Practices: Survey: August 2020 Re-run. 35-37 Ludgate Hill, London. 171 pp.

knowledge and practice prior to stewardship implementation. Two subsequent surveys, in 2017 and 2020, have charted changes. The degree of understanding and application of best practice appears to differ between user groups. A key finding has been the sudden and profound changes in all recorded metrics for gamekeepers caused by the requirement for them to attend tailor-made courses offered by their trade associations, and to pass an examination, before they were considered competent to purchase and use SGARs. Moreover, across the board, the KAP surveys have recorded very substantial changes towards best practice in all user groups. This is a very significant achievement of the stewardship regime, and its communication function, given the large numbers of users, the short period for implementation and the broad scope of use scenarios.

An overriding concern about the use of SGARs in the UK is the widespread nature of residues in wildlife.[16] No adverse effects on UK populations of exposed species have so far been documented;[17] indeed populations of some of the most exposed species are increasing rapidly.[18,19] Nevertheless, the mere presence of this exposure, and its scope, is a concern that must be addressed. After much consideration, HSE decided that the barn owl (*Tyto alba*), and the extent of its exposure to SGARs, should be sentinel for a wide group of vertebrates species that are exposed to SGARs through their predation upon non-target wild small mammals.[20] At the request of government, CRRU contracted the UK Centre for Ecology and Hydrology (UKCEH) to conduct an annual study of liver residues in a sample of 100 barn owls found dead in the UK (section 4.6.3). The study, now in its sixth year, has resulted in *post mortem* examination of a total of 500 barn owls; among these it was possible to conclude that SGAR exposure contributed to the death of only a single bird.[21] However, mean summed SGAR residues in barn owl livers have neither increased nor decreased during the period 2016-2019, although the time-span is short for detection of significant change since comprehensive implementation in 2018 of all stewardship controls.[22]

The third required monitoring programme is an annual assessment of the status of anticoagulant resistance among rats and mice in the UK. This work was carried out and reported by scientists at the University of Reading, using DNA analysis of tail-tip samples sent in by practitioners to detect the presence of resistance mutations. The accumulated data for 2016 to 2020 show the widespread distribution of resistance foci in both key target rodent species.[23] The inability of practitioners to use effective resistance-breaking active substances in the UK, from their time of introduction in the late 1980s until 2016, resulted in widespread use of ineffective substances against resistant rodent infestations. Notwithstanding the likely adverse impacts on public health, this would have resulted in the spread of resistance, and increase in resistance severity and the unnecessary contamination of wildlife. We anticipate that with improved knowledge of the distribution of resistance foci, the ability since 2016 to use effective anticoagulants against resistant rats and the recent re-introduction of a non-anticoagulant active substance for use against Norway rats and house mice, cholecalciferol, we are able to moderate these detrimental processes.

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16 van den Brink, N., Elliott, J.E., Shore, R.F. and Rattner, B.A. 2018. Anticoagulant Rodenticides and Wildlife. Springer International Publishing AG, Switzerland. 398 pp.

17 Smith, R.H. and Shore, R.F. 2015. Environmental Impacts of Rodenticides. Chapter 16 in Rodent Pests and their Control. CAB International, Wallingford, Oxon. pp 330-345.

18 Buckle, A. and Prescott, C. 2018. Anticoagulants and Risk Mitigation. Chapter 12 in Anticoagulant Rodenticides and Wildlife. (van den Brink et al., eds). Springer International Publishing AG, Switzerland. pp. 319-355.

19 Balmer, D.E., Gillings, S., Caffrey, B.J. et al., 2013. Bird Atlas 2007-2011: the breeding and wintering birds of Britain and Ireland. BTO Books, Thetford. 720 pp.

20 HSE (undated). Potential success criteria for Second Generation Anticoagulant Rodenticide (SGAR) Stewardship Scheme. Draft. 9pp.

21 Walker, L.A., Potter, E.D., Chaplow, J.S., Pereira, M.G., Sleep, D., Hunt, A., Shore, R.F. 2021. Second generation anticoagulant rodenticide residues in barn owls 2019. UKCEH contract report to the Campaign for Responsible Rodenticide Use (CRRU) UK, 25 pp. [https://pbms.ceh.ac.uk/].

22 Shore, R.F., Henrys, P.A. & Walker, L.A. 2014. Power analysis of liver second generation anticoagulant rodenticide (SGAR) residue data in barn owls from Britain: a Predatory Bird Monitoring Scheme (PBMS) report. CEH contract report to the Health & Safety Executive. 45pp. https://wiki.ceh.ac.uk/x/DAIDC.

23 Buckle, A., Jones, C., Talavera, M. and Prescott, C. 2020. Anticoagulant Resistance in Rats and Mice in the UK Summary Report with new data for 2019-20. Report from the Campaign for Responsible Rodenticide Use (CRRU) UK for the Government Oversight Group. The University of Reading. 19 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 01.03.21.

A fourth monitoring programme, not requested by HSE but put in place by CRRU, is the assessment of breeding success of UK barn owl populations. The UKCEH study shows that a high proportion of UK barn owls carry residues of SGARs in their livers. CRRU felt that it would be valuable to monitor breeding in a sample of these birds taken from five separate regions of the UK (section 4.6.5).

2.2.8 Oversight, Report and Review

The stewardship regime is supervised by a Government Oversight Group (GOG), chaired by HSE UK and comprising representatives of other agencies including HSE Northern Ireland, the Department for the Environment, Food and Rural Affairs (Defra), Public Health England, Natural England, the Welsh Government, the Scottish Government and an independent scientific adviser. Annually since the start of stewardship in 2016, CRRU has produced a report and attended a review meeting with the GOG held at the HSE office at Bootle. These interactions have resulted in a series of annual reports from the GOG providing commentary on the government view of the implementation and progress of stewardship and defining areas that require future attention.[24] The GOG reports have concluded that, with certain caveats, the regime initially met the requirements of the high level principles and has continued to do so during the five-year implementation.

When the regime started, the GOG declared that a full review would be conducted of cumulative data in 2020, to help inform an overall assessment of the regime at that time. The COVID-19 pandemic has delayed that timetable. The review will now be conducted during the first part of 2021 and this report is prepared by CRRU to inform the GOG assessment of the regime.

24 GOG. 2019. Report on the Rodenticides Stewardship Regime Assessment of Implementation – January 2019. Rodenticides Stewardship Government Oversight Group. 11 pp. Available at https://www.hse.gov.uk/biocides/rodenticides.htm. Date accessed: 01.03.21.

3. REPORTS FROM THE CRRU UK WORK GROUPS ON PROGRESS DURING 2020

3.1 General

The stewardship regime is operated through six Work Groups (WGs) (Figure 2). Each is headed by a Work Group Leader and five are populated by representatives drawn from the CRRU stakeholder organisations. All of these people have full-time jobs in other companies and organisations but give their time, and considerable expertise, to help the regime to deliver its goals. The sixth WG, communications, employs a specialist contractor. The functioning of all six WGs is directed by the CRRU UK Task Force, comprising 49 representatives from 32 different stakeholder organisations (Annex 1).

The current composition of the six CRRU WGs is shown at the CRRU website (https://www.thinkwildlife.org/stewardship-regime/).

3.2 Best Practice Work Group (Leader, Dee Ward-Thompson, BPCA)

3.2.1 Purpose

The work of the Best Practice Work Group (BPWG) is to provide guidance and promote responsible use of rodenticides to ensure a "*competent workforce*" among all professional user groups. The objective is to ensure that all users of authorised rodenticides, within the UK Rodenticide Stewardship Regime, are aware of and apply the requirements of the CRRU Code of Best Practice (COBP) and other guidance. The WG seeks to report the operations of stakeholder organisations when they monitor and audit the compliance of their members with the COBP. The WG is also the principal point of contact with farm assurance schemes, so that membership of them provides, and may continue to provide, proof of competence at point-of-sale.

With the establishment of various codes and guidance documents (Table 1), which themselves are fundamental to delivery of training and to farm assurance scheme standards, the WG is instrumental in certification at point-of-sale and, thereby, in "*supply chain governance*".

3.2.2 Code of Best Practice and Other Guidelines

The principal instrument by which CRRU promulgates best practice is the CRRU Code of Best Practice (COBP), first published in March 2015 (Table 1). The COBP was based on current knowledge of safe and effective use of rodent pest management techniques, concepts of risk mitigation developing as a result of the implementation of the Biocidal Products Regulation and with consideration to the two HSE legacy guidance documents, one for professional pest controllers and one for farmers, which preceded it. It was finalised and published after a process of consultation with all user stakeholder groups and HSE.

Various regulatory processes, particularly the European Commission and Member States programmes for the renewal of active substance approvals (concluded July 2017) and, more importantly, product authorisations (concluded July 2019) have brought about significant changes to permitted rodenticide use practices in the UK. Moreover, the reintroduction of cholecalciferol to the UK market also added another important reason for revision. In 2020 it was determined that sufficient change had occurred to require a revision of the COBP. This revision has been conducted by a BPWG sub-group and a draft of the revised code has been circulated for consultation. A subsequent draft will go for wider consultation in April 2021, with the intention of publication in June 2021.

Table 1. The principal guidance documents produced by the BPWG and their dates of publication

Title of document*	Date of publication
CRRU UK Code of Best Practice - Best Practice and Guidance for Rodent Control and the Safe Use of Rodenticides	March 2015
CRRU UK Code of Best Practice - Best Practice and Guidance for Rodent Control and the Safe Use of Rodenticides – Revision June 2021	June 2021
CRRU Guidance – Permanent Baiting	April 2016

CRRU Guidance – Permanent Baiting	September 2018
CRRU Guidance – Permanent Baiting	July 2019
CRRU UK - Rat Control and Game Management	July 2017
Non-standard Use Justifications	January 2018
CRRU Environmental Risk Assessment	April 2017
Environmental Risk Assessment Form	October 2016
*all publications are available from the CRRU website: https://www.thinkwildlife.org/downloads/	

Permanent baiting is a significant use practice for the application of rodenticides and one that has been much affected by recent regulatory change. It is considered likely that permanent baiting is a significant source of wildlife contamination and several new label phrases apply to its use. Therefore, the BPWG first issued a separate guidance document on this practice in April 2016, containing a wide range of required risk mitigation measures, and there have been two revisions since then (Table 1).

Gamekeepers are an important user group and their use of rodenticides carries enhanced risk of wildlife exposure given the rural nature of the areas in which they apply them. An existing CRRU guidance leaflet published in 2013 was updated in 2017 to encompass the changes brought about by stewardship and regulation.

The authorisation programme for product renewals completed in 2018 required justification for applications for 'non-standard uses'. These included 'permanent baiting', 'burrow baiting' and the application of bait from 'covered and protected bait points'. Acting on behalf of all applicant manufacturers the CRRU BPWG prepared justification documents, with appropriate risk mitigation actions for these three non-standard uses. These documents supported application for these uses for certain product authorisations.

The importance of the CRRU guideline documents and codes provided by the WG is demonstrated in the label phrases that appear on all authorised professional rodenticide products, as follows:

> *Using this product in a manner that is inconsistent with the label may be an offence. Refer to the CRRU UK Code of Best Practice (or equivalent) for guidance.*
>
> *Follow any additional instructions provided by the CRRU UK Code of Best Practice (or equivalent).*
>
> *Where possible, prior to the treatment inform any bystanders (e.g. users of the treated area and their surroundings) about the rodent control campaign in accordance with the CRRU UK Code of Best Practice.*
>
> *To reduce risk of secondary poisoning, search for and remove dead rodents during treatment at frequent intervals, in line with the recommendations provided by the CRRU UK Code of Best Practice.*

3.2.3 The Risk Hierarchy and Environmental Risk Assessment

The concept of 'risk hierarchy' was a necessary step in implementation of the stewardship regime and is embodied in the first of HSE's 'High Level Principles'.[25] It requires that those intending to use any rodent control method, or combination of methods, should first consider risks. These include risks to non-target wildlife, domesticated animals, human bystanders and the environment. Risks will differ between the situations in which control is to be conducted and, of course, the degree and type of risk presented by various methods will also differ. The use of the risk hierarchy requires that the least severe method(s) (i.e. having the least risk) should be used, provided there is a reasonable expectation that the operation will achieve the results required. Generally, those methods that do not employ a rodenticide, such as improved site hygiene and proofing of buildings, are likely to present less risk than those that require a rodenticide.

25 HSE (2021). Rodenticides. Available at: https://www.hse.gov.uk/biocides/rodenticides.htm. Date accessed: 23.02.21.

An environmental risk assessment (ERA) conducted before the application of rodent control measures will assist subsequent consideration of the risk hierarchy. Because implementation of an ERA is fundamental to use of the risk hierarchy, the BPWG produced a guidance document about how to carry out an ERA. A template form that can be completed while carrying one out is now available for download in editable form from the CRRU website (https://www.thinkwildlife.org/downloads/).

3.2.4 Farm Assurance Schemes

At the introduction of the regime, and the requirement to produce proof of professional competence at the point-of-sale, it was decided that membership of an approved farm assurance scheme (FAS) provided proof of competence.[26] A period of interim acceptance of existing farm assurance scheme standards as proof of competence at point of sale for purchase of professional rodenticides ended on 31st December 2017. The BPWG developed a 13-point template for the assessment of new scheme standards and worked with 17 schemes to bring forward new standards fully aligned with the CRRU COBP. The WG assigned rapporteurs to each scheme to streamline the consultation process. With a deadline of March 2018 for all schemes to demonstrate published standards compliant with the CRRU COBP, this piece of work was a substantial undertaking by WG members. In addition, support and guidance was offered to schemes to ensure that auditors are aware of the new requirements and understand how to assess compliance.

January 2018 saw the new CRRU-approved FAS standards come into force, ahead of the March deadline. Memberships of 17 different schemes, totalling more than 94,000 farm businesses, are now audited regularly to the schemes' standards that comply with the CRRU COBP.

For the first time in 2020, the WG rapporteurs requested and obtained data on pass/fail rates for farm audits conducted on behalf of each FAS. These data refer only to audits as a whole and data specific to the rodent control section are unavailable. That said, results for passes and fails are encouraging and most of the schemes have managed to complete audits during 2020, even in these challenging times with COVID-19. These data from the FAS will be provided to the GOG in confidence.

Table 2. The CRRU-approved farm assurance schemes, their membership numbers and the frequency of audits conducted in 2019.

Assurance scheme	No. of members	Geographical Coverage	Audit Frequency
Agricultural Industries Confederation	2,012	UK	12months
British Egg Industry Council Code of Practice for Lion Eggs	1,850	UK	6 months
Red Tractor Farm Assurance - Beef and Lamb	22,773	England	18 months
Red Tractor Farm Assurance - Dairy	11,327	UK	18 months
Red Tractor Farm Assurance - Crops	16,509	England, Wales	12months
Red Tractor Farm Assurance - Fresh Produce	2,036	UK	12 months
Red Tractor Farm Assurance - Pigs	2,211	England, Wales, NI	12months
Red Tractor Farm Assurance – Chickens	2,053	UK	12 months
Quality Meat Scotland - Beef & Lamb	9,321	Scotland.	12 months
Quality Meat Scotland - Pigs	179	Scotland	12 months
Farm Assured Welsh Livestock - Beef & Lamb	7,102	Wales	18 months
Scottish Quality Crops	3,358	Scotland	12 months
Northern Ireland Farm Quality Assurance Scheme - Beef and Lamb	12,121	NI	18 months
Northern Ireland Farm Quality Assurance Cereals Scheme	790	NI	18 months

26 HSE (2017). First Report on the Rodenticides Stewardship Regime Assessment of Implementation – February 2017. Rodenticides Stewardship Government Oversight Group. Available at:https://www.hse.gov.uk/biocides/Rodenticides-Stewardship-Regime-GOG-rev-Feb2017.pdf. Date accessed: 23.02.21

"Laid in Britain"	42	England, Wales, Scotland	12 months
Red Tractor Farm Assurance – Turkeys	327	UK	12 months
Red Tractor Farm Assurance – Ducks	57	UK	12 months
Total	**94,068**		

3.3 Training and Certification Work Group (Leader, Matthew Davies, Killgerm Chemicals Ltd.)

3.3.1 Purpose

All aspects of the work of the Training and Certification Work Group (T&CWG) are intended to support the development and maintenance of a "*competent workforce*" and disseminate the fundamental requirements of responsible rodenticide use across the three user sectors: professional pest control, gamekeeping and farming. "*Governance of the supply chain*" is also implemented through the certification procedure applied by the T&CWG and implemented at all points-of-sale.

3.3.2 Training Courses and Certification

The major deliverable of the work group continues to be provision of CRRU-approved training through over 150 training providers serving four awarding organisations (AOs), namely BASIS (Registration) Ltd., City and Guilds/National Proficiency Tests Council (NPTC), Royal Society for Public Health (RSPH) and Lantra. In the period August 2019 to July 2020, nine different CRRU-approved courses were offered and examined. A total of 3,916 certificates were awarded to training participants during the period, bringing the total number of certificates awarded for CRRU-approved courses to 27,454 during the five years of the regime (Table 3). This continues to be a very substantial contribution to maintenance of a "competent workforce". A report containing more details of the courses provided and certificates awarded has been provided, since 2016, in confidence to the GOG. From 2019 and 2020 all the AOs provided, to GOG, information on examination pass rates.

Table 3. The total numbers of CRRU-approved training certificates and qualifications awarded by the following awarding organisations: BASIS (Registration) Ltd., City & Guilds, Lantra, Royal Society for Public Health.

Time Period	Total number of certificates/qualifications issued
August 2015 to July 2016	7,285
August 2016 to July 2017	6,044
August 2017 to July 2018	5,498
August 2018 to July 2019	4,711
August 2019 to July 2020	3,916
Total	27,454

3.3.3 Continuing Professional Development

The Continuing Professional Development (CPD) component of the regime continues to be available. The expertise of CRRU UK member companies, stakeholder organisations and individuals has been harnessed to create a series of CPD training modules made freely available at the CRRU UK website (http://www.thinkwildlife.org/training-certification/continuing-professionaldevelopment-cpd-and-stewardship). The modules, each comprising a PowerPoint presentation taking 45-60 minutes for completion, are supported by detailed trainers' notes. The modules are viewed independently by professional rodenticide users as a method of self-teaching. Additionally, they are downloaded by training organisations and used during face-to-face or online education events.

Trainers have been registering these events with relevant CPD AOs (see Table 4) and participants have claimed CPD awards from such activities. An additional CPD scheme has been developed for the

professional pest control sector in 2019 (Table 5), in addition to existing long-standing and successful schemes for this sector and others. Membership of a registered CPD scheme is strongly promoted by CRRU UK for all competent professional rodenticide users, although it is not presently a mandatory condition for proof of competence at point-of-sale.

Table 4. The total numbers of downloads of CRRU learning resources to support CPD (correct at 29.01.2021)

CPD presentation	**Total number of times downloaded (most introduced 31st June 2018)**
Changes to the Classification of Anticoagulants and Permitted Pack Sizes	2,001
Environmental Risk Assessments	4,345
Direct bait application in burrows. Justification and mitigation measures	2,371
Exposure of Wildlife to Rodenticides	2,116
Anticoagulant rodenticide resistance in rats and mice (April 2019)	1,508
Total	**12,341**

Modules 1-4 were published on 31 July 2018. A module on the status of anticoagulant resistance in rats and mice in the UK was published in April 2019. The five CPD modules currently available are:

1. Environmental Risk Assessments.
2. Exposure of Wildlife to Rodenticides.
3. Direct application of bait in burrows. Justification and mitigation measures.
4. Changes to the classification of anticoagulants and permitted pack sizes.
5. Anticoagulant rodenticide resistance in rats and mice.

A further resource to support CPD released in 2020 is an educational video 'Less Wasteful Way of Feeding Pheasants (and Rats)' produced by GWCT.

There has been a total of 12,341 CRRU CPD module downloads (Table 4, correct at 29.01.2021) since the introduction of the scheme on 31 July 2018, which is up from 7,632 quoted in the 2019 annual report and 2,091 from 2018. The module on Environmental Risk Assessment has proved particularly popular, with 4,345 downloads since CPD support was established.

These CPD resources are reviewed annually to check their suitability. A review of content in 2020 highlighted the need to update 'Anticoagulant rodenticides resistance in rats and mice' due to new resistance data and reintroduction of the non-anticoagulant cholecalciferol to the market. This will be completed in 2021.

Further CPD modules, scheduled for release in 2020, were delayed due to the impacts of COVID-19. It is intended that these will be introduced in 2021. They include, among others, a module to support correct application of permanent baiting, an update on the objectives, achievements and progress of the UK Rodenticide Stewardship Regime and a module to explain the scientific background and role of wildlife residue monitoring in the assessment of the scheme's effectiveness. Others could include a resource based around the CIEH NPAP rodent procedures manual and changes to the CRRU Code of Best Practice.

Table 5. Those involved in rodent control are encouraged to maintain their knowledge gained from achieving approved certification, by joining an established CPD scheme. The following established CPD schemes are available to those in the professional pest management, farming and gamekeeping sectors. Note: CRRU signposts users to these schemes and promotes scheme membership, but does not provide formal approval.

Established CPD schemes	
Scheme Name	**Provider (Awarding Organisations administering CRRU- approved training and certification)**
NRoSO (National Register of Sprayer Operators)	City & Guilds/NPTC (National Proficiency Tests Council)
PIPR (Pig Industry Professional Register)	City & Guilds/NPTC (National Proficiency Tests Council)
BASIS Professional Register	BASIS Registration Ltd.
BASIS PROMPT Register	BASIS Registration Ltd.
BASIS Amenity Training Register	BASIS Registration Ltd.
Lantra Skills Plus	Lantra
Other schemes	**Other providers**
AHDB Dairy Pro	AHDB (Agriculture and Horticulture Development Board)
BPCA Registered	British Pest Control Association
PestWise	Skills Passport
In-house schemes are available in the professional pest management sector	
An alternative option	**Awarding Organisations**
Training and Certification: users can repeat the approved training and certification options at regular intervals, in order to maintain their knowledge to stewardship levels	BASIS, City & Guilds, Lantra, RSPH

3.3.4 A Summary Timeline of the CRRU UK T&CWG Achievements

- 2015 (March): A 'training framework' for the review and approval of training courses and their certification was established. This included enlisting a panel of AOs.
- 2015: A major piece of work was reviewing available training courses (existing and new) for compliance with framework requirements and publishing updated lists (since April 2015) of those approved (Table 5, correct at 29.01.21).
- 2015, 2016, 2017, 2018, 2019, 2020: maintaining updated lists of CRRU-approved certification to purchase and use professional rodenticides labelled under stewardship requirements.
- 2015, 2016, 2017, 2018, 2019, 2020: a number of T&C WG participants represent AOs and Training Providers and thus have been directly involved in administration and delivery of training and certification to end users.
- 2015 (July): CPD sub-group formed.
- 2016 (June): AOs and CRRU T&C WG agreed processes of training and certification data submission to the Monitoring Work Group and therefore GOG.
- 2017 (May): CPD support was agreed and implementation began.
- 2018 (31 July): CPD learning resources launched.
- 2019 (April): Annual review of CPD learning resources and addition of new material.
- 2020: Annual review of CPD learning resources, updates identified, and new material added.

3.3.5 Ideas and Proposals

The points below are to be discussed from March 2021 for possible future implementation:

- Training Framework review: the validity of the 13 pieces of necessary course content have been re-confirmed.

- Training Framework review: from July 31 2022 all CRRU-approved training and certification will be Ofqual regulated. The processes to arrange this will commence from July 2021.
- Ofqual regulation provides extra rigour, further security measures and 'comparability' between similar qualifications. For example, invigilation is a requirement. This will mean that unsupervised rodent control examinations will not be possible in future. It is expected that the 'comparability' considerations will include learning hours and closer alignment of this.
- Lifespan of certificates: it has been agreed that certificates will bear the phrase 'Relevant CPD, or refresher training within 5 years, is recommended' from June 2021.
- Advice that users should keep their knowledge up to date has been requested as an addition to the CRRU Code of Best Practice.
- The farming sector has been asked whether all users on-farm, of professional rodenticides under stewardship, should have CRRU-approved training and certification, even if operating under an approved Farm Assurance Scheme, as an attempt to address highlighted knowledge gaps.
- A series of meetings will take place, in 2021, to discuss further that users should hold a stewardship-approved certificate obtained within the last five years or evidence of the alternative of CPD participation (or other suitable regular check of knowledge / best practice), which should be introduced over a five-year period.

Table 6. Certification allowing purchase and use of professional rodenticides labelled under stewardship requirements (correct at 29.01.21)

Current certification
RSPH/BPCA Level 2 Award in Pest Management (2010 onwards)
RSPH/BPCA Level 2 Certificate in Pest Management (2010 onwards)
City & Guilds NPTC Level 2 Award in the Safe Use of Pesticides for Vertebrate Pest Control for Rats and Mice (QCF) (PA-R&M) (2013 onwards)
Lantra: Responsible and Effective Control of Commensal Rodents (2015 onwards) Online: elearning.lantra.co.uk
Lantra: Rodent Control on Farms (2015 onwards) *Online: elearning.lantra.co.uk
Rat Control for Gamekeepers (2015 onwards, through BASIS)
Killgerm Principles of Rodent Control (2016 onwards, through BASIS)
RSPH Level 2 Award in the safe use of rodenticides (2015 onwards)
BPCA Using Rodenticides Safely (2015 onwards, exam through BASIS)
Note: CRRU Wildlife Aware (accredited by BASIS). For holders of qualifications listed above issued before the dates shown, this is an approved update to certified status.
*The customised training provision version of 'rodent control on farms' is not endorsed by Lantra as of 1st March 2018 and is not 'Current certification'. It is now listed under 'Grandfather certification'. Certificates are identified by the text 'customised provision'

Grandfather certification
RSPH Level 3 Diploma in Pest Management (2010 – 2016)
RSPH/BPCA Level 2 Certificate in Pest Control (2004 – 2010*)
RSPH Level 2 Certificate in Pest Control (2000 – 2004*)
RSH Certificate in Pest Control (pre-2000 inclusive*)
BPCA Diploma in Pest Control Part 1
(Previously 'BPC Diploma Part 1', 'RSH/BPC Certificate in pest control', 'BPC Diploma', 'Operators certificate of proficiency', 'British Pest Control Association Certificate in general pest control' and 'Certificate pre-1988') (pre-2004 inclusive)
NPTC Level 2 Certificate of Competence in Vertebrate Pest Control (assessed in the context of rats and mice) (2002 – 2014)

Lantra: Rodent Control (previously Rat and Mouse Control) (2009 – 2015)
Lantra: Rodent Control on Livestock Units (2013 – 2015)
Lantra: Rodent Control on Farms (2015 – 28th February 2018 inclusive) Note: This entry refers only to the customised training provision version of 'rodent control on farms'. Certificates are identified by the text 'customised provision'.
Killgerm Principles of Rodent Control (previously Killgerm Rodent Biology and Control) (2004 – 2015)
*RSH / RSPH certificates may bear a date up to two years after the end date stated above. These are still acceptable at the point-of-sale.
Note 1: The 'BPC Certificate of Proficiency (1989 – 1994)', 'BPCA Diploma Part II (1995 – 2008)' and 'BPCA Accredited Technician in Pest Control (2008 onwards) which became the BPCA Advanced Technician in Pest Management from 2016 are all accepted at the point-of-sale because other approved certification is a prerequisite for these.
Note 2: CRRU Wildlife Aware (accredited by BASIS) For holders of qualifications listed above issued before the dates shown, this is an approved update to certified status.

3.4 Regulatory Work Group (Leader, Sarah Bull, BASF plc)

3.4.1 Purpose

Since inception, there has been no change to the remit of the CRRU Regulatory Work Group, which is to:

- Work towards harmonisation and simplification of product labels to permit all appropriate risk mitigation measures to be understood and applied by all user groups.
- To provide stewardship monitoring data to HSE (as required by the UK Rodenticide Stewardship Regime).
- To support the three key benefits of the regime, namely "*supply chain governance*", "*competent workforce*" and "*monitoring compliance*".

A requirement for the UK authorisation of a professional rodenticide product is provision by the authorisation holder of a full range of product stewardship actions meeting the 'High Level Principles' published by HSE.[27] This requirement is satisfied by membership of CRRU UK, and thereby participation in the UK Rodenticide Stewardship Regime.

3.4.2 Initial Activities To Gain Product Authorisation Under Stewardship

At the outset, the priority of the CRRU Regulatory Work Group was to facilitate a smooth and cost-effective application process for authorisation of rodenticides under the stewardship regime. This was achieved by raising and discussing concerns with HSE and agreeing solutions. For example, a phased application process was agreed in order to alleviate the difficulties with functionality of the electronic application system (then version R4BP3.2). The Work Group's (WG) concerns regarding excessive fees were addressed by HSE's commitment to streamline applications and their reassurance that all applicants would be invoiced fairly.

Another important aspect for a successful transition to stewardship authorisation was the timeline in which new authorisations would be issued. The WG highlighted to HSE the requirement for all stewardship authorisations to be granted at the same time in order to minimise confusion in the market. Co-ordination with other aspects of stewardship, such as training and certification and point of sale procedures was also needed. The HSE agreed these points and subsequently provided a definitive date for all product authorisations under stewardship (Figure 1).

Formation of the CRRU Regulatory Work Group coincided with that of the EU 'AVK SPC Working Party' which had the remit to agree standard sentences and format for the 'Summary of Product Characteristics' (SPC). The SPC defines permitted uses of the product in question. The WG was invited by HSE to comment on several of the proposals arising from discussions at EU level and it welcomed these opportunities to comment to maximise the efficiency of rodent control, whilst minimising environmental and human exposure.

27 HSE (2021). Rodenticides. Available at: https://www.hse.gov.uk/biocides/rodenticides.htm. Date accessed: 23.02.21.

Nevertheless, the WG considers improvements can still be made regarding simplification of SPCs and product labels and proposes that the UK's exit from the EU provides an opportunity to re-visit risk mitigation for SGARs and improve labels. We encourage HSE to involve authorisation holders in discussions about how this may be achieved in time for the next product renewal process.

As a condition of authorisation, monitoring data continues to be submitted by the Regulatory Work Group to HSE (see section 4.6).

3.4.3 Product Re-classification and Renewal

Following a successful transition to gain product authorisation under stewardship, authorisation holders were tasked to manage two major changes for their products:

i) Reclassification of rodenticides in accordance with the 9th ATP (Adaptation to Technical Progress) of the Classification, Labelling and Packaging Regulation (applicable from 1st March 2018).

ii) Renewal of product authorisations following active substance renewal.

Reclassification of rodenticides was implemented independently of product renewal and consequently led to the phase-in of new labels in advance of the implementation date. At the same time, evaluation for product renewal was ongoing which introduced new EU harmonised rules which differed according to active substance in the product and category of user. The new EU rules impacted pack sizes, label phrases and ultimately how products could be used.

The WG provided feedback to HSE on some conditions of authorisation agreed in the EU, such as the 'public area use' phrase and continued to seek advice from HSE on how EU harmonisation would impact authorisations in the UK, for example, the definitions of 'trained professional', 'professional' and 'general public' user categories. Late in the evaluation process HSE advised that justification was required to support non-standard uses such as burrow baiting and permanent baiting and CRRU responded by providing justification documents for these uses (section 3.2.2).

Each of the above changes led to much complexity in the market with multiple phase-in and phase-out deadlines to follow. Authorisation holders were dedicated to managing these important changes and fully engaged with their customers to ensure that numerous changes in sale, supply and use of rodenticides were fully understood to promote clear communication throughout the supply chain and facilitate smooth transition to new labels.

3.4.4 Authorised Products Supported by the Stewardship Regime

A total of approximately 580 professional rodenticide products are currently supported by the work of CRRU and the stewardship regime. Products that are marketed carry labels requiring the implementation of stewardship conditions.[28] Eight different active substances are used in 'stewardship' products, as follows: difenacoum (222 products available), bromadiolone (149), brodifacoum (172), difethialone (22), flocoumafen (7), coumatetralyl (2) , cholecalciferol (2) and warfarin (1). The majority of these are permitted for use outdoors around buildings, while products are also authorised for use outdoors in open areas, outdoors at waste dumps and in sewers. Although HSE has said it would consider applications for open area use of products containing, brodifacoum, difethialone and flocoumafen, industry has chosen not to make such applications. [N.B. All figures quoted for numbers of products were correct on 10 March 2021.]

3.4.5 Other and Future Work

The WG actively contributes to documents issued by other CRRU Work Groups, for example guidance for internet sales, guidance for permanent baiting and has supported CPD by provision of the resource "Changes to the Classification of Anticoagulants and Permitted Pack sizes".

Authorisation-holders are now determining actions required and costs associated with maintaining and

28 HSE 2021. GB authorised biocidal products. Available at: https://www.hse.gov.uk/biocides/uk-authorised-biocidal-products.htm. Date accessed: 10.03.21

gaining authorisations following the UK's exit from the EU. We encourage HSE to involve authorisation-holders in discussions on future regulation of rodenticides with the objective to further improve effective rodent control, user-friendliness of labels and ultimately safety of rodenticide application in the UK.

3.5 Point-of-Sale Work Group (Leader Rupert Broome, Killgerm Chemicals Ltd.)

3.5.1 Purpose

The Point-of-Sale Work Group was created in March 2015 primarily to support the UK Rodenticide Stewardship Regime efforts to deliver "*governance of the supply chain*".

3.5.2 Structure, Representation and Objectives of the CRRU UK Point-of-Sale Work Group

Although participation is dynamic, over the past five years the CRRU UK Point-of-Sale Work Group has involved up to 17 participants from 13 organisations and/or companies. The current participant list is given at the CRRU UK website (https://www.thinkwildlife.org/stewardship-regime/).

These participants include representation from:

- Authorisation Holders
- Channel Partners
- Professional Pest Control Service Sector
- Agricultural Sector

The objectives of the CRRU UK Point-of-Sale Work Group have remained consistent throughout the five-year review period and are set out in Annex 3.

3.5.3 Initial Baseline Achievements of the CRRU UK Point-of-Sale Work Group

Understanding the Supply Chain

A simplified Supply Chain model was developed and agreed. This facilitated development of the required Supply Chain Compliance checks up to the final sale to end users, and the Proof of Competence checks at the final Point-of-Sale. The Simplified Supply Chain is set out in Annex 4.

Supply Chain Compliance Declarations

A one-page declaration form was developed and agreed. Although not compulsory, this template was designed to support the process of gaining a positive commitment to deliver point-of-sale controls from all supply chain partners acting between authorisation holders all the way through to final point-of-sale to end users. In some cases, formal supply agreements which capture the key element of these supply chain controls obviate the need for a Supply Chain Compliance Declaration. The Supply Chain Compliance Declaration template is set out in Annex 5.

Point-of-Sale Declarations

Two declaration forms were developed and agreed, each one-page long. One template was for users who possess CRRU Approved Certification, and the other was for users who are members of CRRU-aligned farm assurance schemes. Although not compulsory, these declarations were designed to support the process of ensuring proper checks are made for proof of competence prior to the sale of stewardship labelled rodenticides. In some cases, other processes have been developed and implemented by suppliers which are equivalent to the use of these declarations. The two Point-of-Sale Declaration templates are set out in Annex 6.

Point-of-Sale Question and Answer Support for Implementation

To assist in the interpretation and implementation of the Supply Chain Compliance declarations, and the

Point-of-Sale declarations, a comprehensive Question and Answer set of guidance was developed and agreed. This is an eight-page document, the front page is set out in Annex 7 and the full document is available at the CRRU UK website (https://www.thinkwildlife.org/downloads/).

Communication Roll Out of Supply Chain/Point-of-Sale Checks

A dedicated section relating to point-of-sale was created on the main CRRU UK website, acting as an information hub for suppliers and end users from all sectors. The wider CRRU UK Task Force has been fully informed and consulted in the development of all CRRU UK point-of-sale collateral to date and has approved it. The outputs of the CRRU UK Point-of-Sale Work Group, in particular the Supply Chain Compliance Declarations, the Point-of-Sale Declarations, and the Question & Answer guidance have all been communicated to all sector groups (professional pest controllers, gamekeeping, agriculture). In addition, all CRRU UK member companies have been cascading these outputs down their respective supply chains.

3.5.4 Independent Audit Process for Point-of-Sale Compliance

Background

A cornerstone of the stewardship regime is imposition of competence checks at the point-of sale. As well as "*supply chain governance*", these checks drive the "*competent workforce*" benefit because only appropriately competent personnel can purchase professional rodenticides. The fundamental importance of this measure within the regime overall made necessary a procedure to audit its application. Following a successful pilot project in 2017, a full Rodenticide Point-of-Sale (RPOS) audit procedure was implemented in 2018 and this has continued since then. The RPOS audit process is conducted by an independent organisation, BASIS Registration Ltd. It is the responsibility of all product authorisation holders to ensure that their products are placed on the market only through outlets which are registered with the RPOS audit scheme and have passed an audit. From 1st January 2019, only outlets which have successfully passed an RPOS audit and can demonstrate their current compliance are allowed to sell professional use rodenticides in the UK.

RPOS Audit Process

BASIS created a question bank to support the RPOS audit process, based on the checks on proof of competence at the point-of-sale which all outlets selling professional use rodenticides should be implementing on a routine basis. This question bank is routinely reviewed (annually) and amended when necessary to ensure that the audit process remains up to date and relevant.

BASIS operate a team of approximately 11-13 independent auditors across the UK and have the capability to increase the audit capacity depending upon demand levels. All BASIS auditors are on a Continuing Professional Development (CPD) scheme and they are each audited annually. The normal RPOS audit window each year is between February and November however BASIS retains flexibility to conduct RPOS audits outside of those planned dates if required.

Outlets which undergo RPOS audits broadly fall into two categories:

1. Existing members of the BASIS Store Inspection scheme. RPOS Audit fees per outlet for 2020 were £30.

2. Non-members of the BASIS Store Inspection scheme who do not need to become members. RPOS Audit fees per outlet for 2020 were £183.

Outlets selling professional use rodenticides via the internet are included in these two categories and are not treated any differently to the more traditional 'bricks & mortar' outlets.

After each RPOS audit, BASIS confirms the outcome to the outlet via email. At the end of each annual audit cycle, in November/December each year BASIS invoice in advance all outlets registered on the RPOS

audit scheme. Payment is made in advance of the next annual audit cycle. For outlets which have passed the RPOS audit, their official certificate is issued once payment is made for the next annual RPOS audit cycle. Certificates remain valid for the calendar year following audit.

RPOS Audit Gradings

There are four grades for the RPOS audits shown in Table 7.

Table 7. RPOS audits are conducted annually in all outlets that offer professional rodenticide products. The outcomes of audits fall into one of four categories.

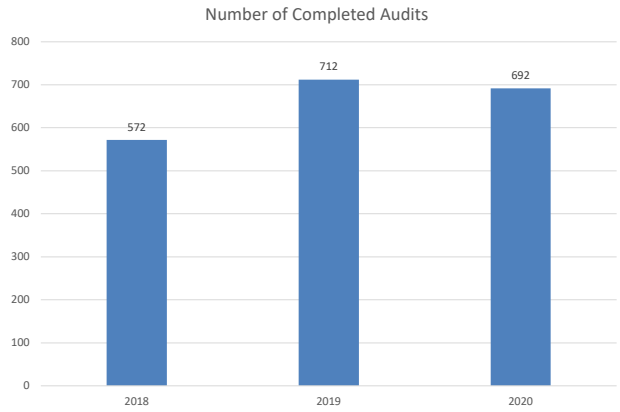
	Audit outcome
Pass	No issues, or only very minor items identified. (Example: Out of date declaration form, but no sales to that customer.) Certification is automatic.
Pass Noted	Minor issues identified. (Example: The sales transactions checked were compliant, but systems are deficient for checking expiry dates of Farm Assurance Scheme membership.) Outlet needs to clear all actions with BASIS within 4 weeks of the RPOS audit. Certification is only issued once all actions are cleared.
Qualified Pass	Multiple minor issues and/or some more serious issues identified. (Example: Training certificates not held on file, or Farm Assurance Scheme expiry dates not being routinely checked for sales transactions.) Outlet needs to clear all actions with BASIS within 4 weeks of the RPOS audit. Certification is only issued once all actions are cleared.
Fail	Several serious issues identified. (Example: Complete lack of records and/or a lack of awareness.) No certification issued. Outlet would need to undergo a full re-audit and pass in order to become certificated.

All grades are "initial" at the time of audit. For those outlets which do not achieve an outright "Pass" during the audit, follow up actions offer the opportunity to fully address any required actions raised by BASIS auditors. If those actions are subsequently "cleared" by BASIS then the initial grade may be increased to a "Pass" as a final grade. If those actions are not "cleared" by BASIS then the initial grade remains unchanged and is confirmed as a final grade. Only outlets which achieve a "Pass" either in the initial audit, or through successfully addressing any actions, obtain certification confirming they have passed the RPOS audit.

RPOS Audit – Key Outcomes

From the start of the initiative, all of the 14 UK authorisation holders for professional use rodenticides have supported the RPOS audit process and have committed to implement RPOS audit requirements throughout their respective supply chains in the UK. The number of outlets registering for audit has risen by 24% from the first full audit year (n = 572) to the second full audit year (n = 712) (Figure 3).

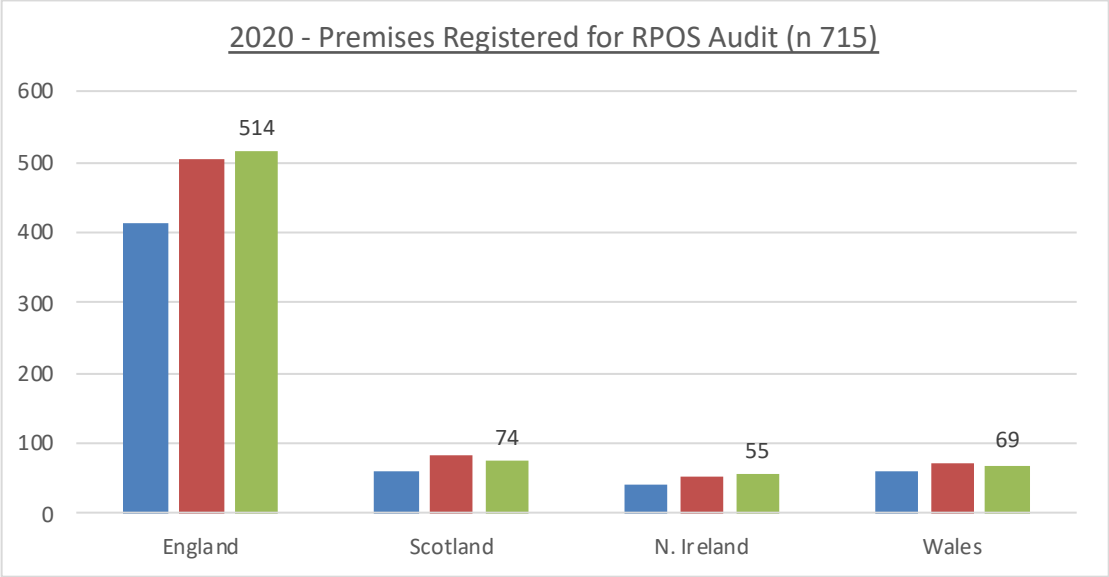
Figure 3. The numbers of completed RPOS audits during the three years of operation of the scheme.



Although there is no evidence to support the assumption that not all outlets had registered for an RPOS audit during the first audit year, it would seem a reasonable assumption that this may have been a factor. The increase in outlets which were audited in the second year could suggest that this has come about in part due to continued communication efforts of CRRU UK and CRRU UK Member companies, but also due to controls in the supply chain coming into effect when outlets without the required RPOS certification were denied supply in 2019. By the third audit year (2020) the number of outlets registered for audit had risen to 715. It is worth noting that by the end of 2020, a small number of outlets (n = 23) which had registered for an audit subsequently decided not to proceed and so the number of completed audits in 2020 was 692.

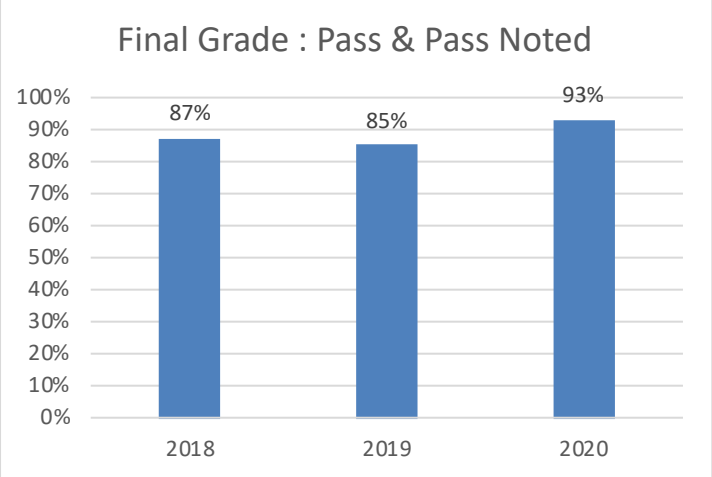
The regional split of outlets registered for audit is shown in Figure 4.

Figure 4. Regional disposition of premises undergoing RPOS audits in 2020



Initial grades in which outlets achieved a "Pass" have risen from 67 % in the first audit year to 72 % in the second audit year and 84 % in the third audit year (2020), showing steady progress in terms of outlets getting it right first time. Final Grades in the most recent audit year were almost 93 % of outlets achieving a "Pass" or "Pass Noted" as at the end of December 2020 (Figure 5).

Figure 5. Outcomes of RPOS audits in 2020 among a total of 692 audits conducted.



For outlets which fail to achieve a "Pass" rating, BASIS provides guidance as to what measures they need to undertake in order to achieve compliance.

Table 8 provides a summary of the milestones achieved in the development and delivery of the RPOS procedure.

Table 8. Key RPOS milestones 2018-2020.

Year	Milestone
2017	Pilot audit created, tested & refined April to September 2017.
	October 2017 – RPOS audit scheme launched across the UK.
2018	First RPOS audit cycle February to November 2018.
	572 outlets audited in the UK of which 67 % passed the initial RPOS audit and 83 % achieved certification with their final grading.
2019	January 2019 – First RPOS certificates issued confirming which outlets have passed the RPOS Audit during 2018.
	712 outlets audited in the UK of which 72 % passed the initial RPOS audit and 85 % achieved certification with their final grading.
2020	January 2020 – RPOS certificates issued confirming outlets have passed the RPOS Audit during 2019.
	March 2020 – temporary suspension of RPOS audit process due to Coronavirus pandemic & UK Government restrictions.
	May 2020 – recommencement of RPOS audit process, with audits being run remotely by BASIS.
	715 outlets registered for RPOS audit in the UK of which 692 were audited and 84 % passed the initial RPOS Audit. Of those audited 93 % went on to achieve certification with their final grading.

3.5.5 Online Reporting Tool

Since October 2017, an additional supporting measure for governance of the supply chain has been put in place by CRRU UK. This is an on-line tool for reporting allegations of incidents where a failure to comply with point-of-sale competence checks, or a wider failure to comply with the Stewardship Regime, is said to have been observed. The reporting tool is available at: https://www.thinkwildlife.org/stewardship-regime/report-a-concern/.

The reporting tool is administered by the CRRU UK secretariat, with primary oversight provided by the CRRU UK Chairman, and additional support – if required – given by the Leader of the Point-of-Sale Work Group.

For allegations with sufficient information to merit investigation, details are passed to the CRRU UK member company(s) whose products are alleged to have been involved. The relevant CRRU UK member company(s) then investigates the detail of the allegation, takes appropriate action, and reports back to CRRU UK the outcomes of their investigation. CRRU UK provides responses to complainants so that those who are motivated to make a complaint see the results of their action. Complainants remain anonymous throughout the procedure.

During the period from October 2017 through to the end of November 2020, CRRU UK has received a total of 62 allegations via the reporting tool, summarised as follows:

- 59 of these have been unique allegations. The others were repeats of the same allegation.
- Of all the allegations, 54 related to internet sales of rodenticide.
- Of those allegations relating to internet sales:
- 11 were not upheld.
- 27 resulted in the listing being removed, or in one instance the website being taken down.
- 6 were instances where the wording of the listing was amended to become compliant.
- 6 were apparently illegal sale of rodenticide and were reported to HSE.

3.6 Monitoring Work Group (Leader, Richard Moseley, Bayer CropScience Ltd.)

3.6.1 Purpose

The Monitoring Work Group provides oversight of and reports studies from independent contracted agencies on the progress of the stewardship regime to meet the HSE/GOG key benefit "*monitoring compliance*". Furthermore, through the supply of anticoagulant resistance information to practitioners, to allow them to make informed choices about the use of active substances, the WG also supports the key benefit of a "*competent workforce*". The scope of required stewardship monitoring is shown in Annex 2.

3.6.2 General

The UK Rodenticide Stewardship Regime set out to bring about far-reaching changes to the way professional rodenticides are purchased and used. An important purpose was to reduce the exposure of UK wildlife to anticoagulant rodenticides. This was to be achieved by stimulating a wide range of practical and behavioural changes among the three user groups. Therefore, a series of studies was established, using contracts with independent agencies, to monitor the important elements of the delivery of the regime and its effects.

Three of these studies, a periodic assessment of knowledge, attitudes and practice (KAP) among the three user groups, an annual assessment of the frequency and concentrations of SGAR residues in barn owl livers, and an annual review of the distribution of anticoagulant resistance in rats and mice, are directly required by the government oversight group. A fourth was put in place by CRRU UK to maintain a degree of surveillance on the breeding performance of barn owls in the UK, because this species had been chosen as the sentinel wildlife species for environmental effects.

3.6.3 Anticoagulant Residues in Barn Owls (UK Centre for Ecology & Hydrology)

Current Rodenticide Use in the UK

The presence of anticoagulant residues in UK barn owls is related to the quantities of products used and their use patterns. Five second-generation anticoagulant rodenticides (SGARs) are currently authorised for use in the United Kingdom – brodifacoum, bromadiolone, difenacoum, difethialone and flocoumafen (see section 3.4.4). Among all product authorisations, brodifacoum, bromadiolone and difenacoum predominate. Only difenacoum and bromadiolone were historically authorised for use both in and around buildings and in open areas in the UK. The other three compounds were restricted to indoor use as a mitigation measure to reduce unintentional primary and secondary exposure and poisoning of non-target species. All five SGARs are currently eligible for broadly similar authorisations that can include in and around buildings. Only bromadiolone and difenacoum are authorised for use in permanent baiting. Industry has voluntarily agreed to make no applications for authorisations for the use of brodifacoum, difethialone and flocoumafen in 'open areas'.

Barn owl as sentinel species and SGAR liver residue analysis

The barn owl (*Tyto alba*) is used for SGAR exposure monitoring as it is considered a sentinel for wildlife species that are generalist predators of small mammals in rural areas.[29] The specific work reported is conducted under contract for CRRU by UK Centre for Ecology and Hydrology and forms part of the wider Predatory Bird Monitoring Scheme (PBMS), of which CRRU UK is a co-funder (see https://pbms.ceh.ac.uk/). Every year 100 barn owls are tested for liver SGAR residues. Carcasses are submitted to the PBMS by members of the public from across the whole of Great Britain, although predominantly England and Wales. All barn owls received by the PBMS are autopsied and are found to have died from various causes, mainly road traffic collisions and starvation. Usually more than 100 barn owl carcasses are submitted to the PBMS and all undergo autopsy. As age is known to have an effect on the magnitude of SGAR residues accumulated by barn owls, each year approximately 70 % of the birds selected for liver analysis are in their first year of life.

29 HSE. 2015. UK Anticoagulant Rodenticide Product Authorisation and the CRRU Stewardship Scheme. Information document, January 2015. Health and Safety Executive. 12 pp.

The annual residue data are compared with those from 395 barn owls that died between 2006 and 2012 (hereafter termed baseline years), prior to changes in anticoagulant rodenticide (AR) authorisations and onset of stewardship.[30]

Shore et al. (2014)[30] outlined how new data on residues should be compared to the baseline dataset. The authors also estimated the number of years that would need to elapse for changes in the concentrations of residues to be detected at a level that is statistically significant. For statistical reasons, the analysis of data on residue concentrations is divided into two sub-sets: (i) so called "low" residues, which are <100 ng/g w.w. and include non-detected values (assigned a numerical value of zero), and (ii) "high" residues, which are >100 ng/g w.w. These two sub-sets are analysed separately and as a ratio of one to the other. This approach is used for liver residues of difenacoum, bromadiolone and brodifacoum and for summed residues (∑SGARs); summed residues are the arithmetic sum of residues of the five SGARs. There were few barn owls in the baseline dataset with liver residues of flocoumafen and difethialone; therefore statistical comparison with concentrations in later years was not possible. Instead, change in exposure to each of these two compounds is assessed through comparison of proportions of birds with detectable residues in baseline and subsequent years.

Overall, three metrics of change are assessed as proposed by Shore et al. (2014):[30]

a) Change in the ratio of birds with detectable residues of flocoumafen and difethialone.

b) Changes in the ratio number of owls with "high" concentrations: number of owls with "low" concentrations for brodifacoum, difenacoum, bromadiolone, ∑SGARs.

c) Change in "low" and "high" concentrations of brodifacoum, difenacoum, bromadiolone, and summed SGARs (∑SGARs).

The 2020 CEH report of Barn Owl liver residues

The 2020 report based on samples collected in 2019, as yet only seen in draft, is the fifth in a series of annual reports (2015-2019) that describe the monitoring of SGAR liver residues in barn owls in Great Britain.[31] Among the 100 birds sampled in 2019, 87 % carried residues of one or more SGARs. For the first time, a bird was found as a part of the study where autopsy findings and liver residues led to the conclusion that SGAR poisoning contributed to its death.

The main findings of the study were summarised by the authors as follows: "Overall, there were few differences in liver SGAR accumulation between barn owls that died in baseline years and in 2019. The lack of significant reductions in SGAR residues in barn owls in 2019 suggests that full implementation of stewardship since 2016 has yet to result in a statistically significant reduction in exposure of barn owls to SGARs." This finding is broadly similar to that for the preceding reports for birds that died in 2015 to 2018. However, there is no evidence of an associated adverse effect on barn owl populations and previous declines in barn owl numbers are likely to have been the indirect consequence of the earlier use of organochlorine pesticides and subsequent changes in the agricultural management of grassland (Smith and Shore, 2015).[32]

Summary of Report Results - 2015 to 2019

The presence or absence of liver SGAR residues in barn owls is a relatively crude measure of exposure. Therefore, it is not one of the agreed metrics used for assessing outcomes of stewardship, except for flocoumafen and difethialone which occurred too infrequently in baseline years to allow statistical analysis

30 Shore, R.F., Henrys, P.A. & Walker, L.A. 2014. Power analysis of liver second generation anticoagulant rodenticide (SGAR) residue data in barn owls from Britain: a Predatory Bird Monitoring Scheme (PBMS) report. CEH contract report to the Health & Safety Executive. 45pp. https://wiki.ceh.ac.uk/x/DAIDC.

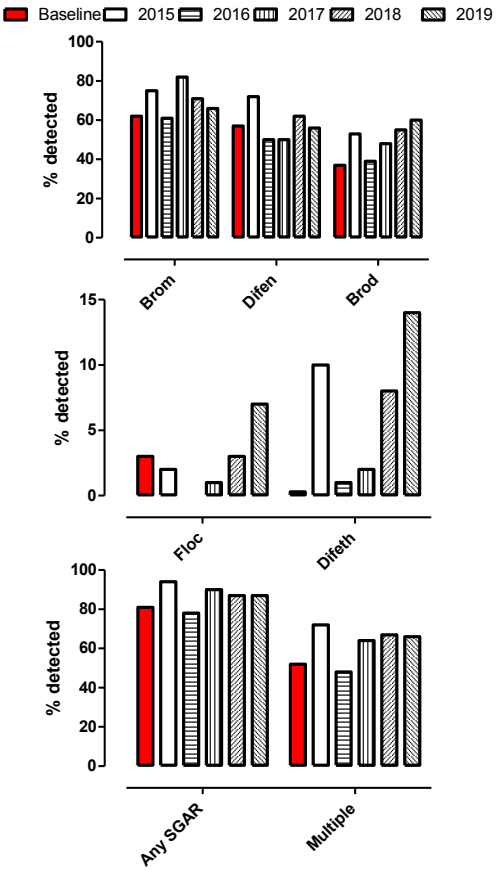
31 Walker, L.A., Potter, E.D., Chaplow, J.S., Pereira, M.G., Sleep, D., Hunt, A., Shore, R.F. 2021. Second generation anticoagulant rodenticide residues in barn owls 2019. UKCEH contract report to the Campaign for Responsible Rodenticide Use (CRRU) UK, 25 pp. [https://pbms.ceh.ac.uk/].

32 Smith, R.H. and Shore, R.F. 2015. Environmental Impacts of Rodenticides. Chapter 16 in Rodent Pests and their Control. CAB International, Wallingford, Oxon. pp 330-345.

of residue concentrations similar to that done for the other SGARs.[33] However, the simple measure of "% detected" is easy to understand and is commonly used in publications to describe the extent of contamination of barn owls by SGARs. Therefore it is presented for all compounds for general information (Figure 6). The analysis conducted for flocoumafen and difethialone, showed for the former compound significant increases in the proportion of birds carrying residues of this substance, probably because of the developing market presence of products carrying this SGAR.

Figure 6. Percentage of barn owls with detected residues of SGARs in their liver. No birds found in 2016 had detectable residues of flocoumafen in their livers. Brom: bromadiolone; Difen: difenacoum; Brod: brodifacoum; Floc: flocoumafen, Difeth: difethialone. From Walker et al., 2021.

Figure 6.



Each individual of the 100-bird sample is autopsied for cause of death and this is usually given in UKCEH reports as: "found to have died from various causes, but mainly from road traffic collisions or starvation", without further detail. However, it is interesting to note that for the first time in the 2019 sample a bird was found to have died carrying a residue of brodifacoum without other signs of physical trauma. It was determined that, given the necropsy observations and a relatively high SGAR concentration in its liver (494 ng/g w.w.), it is possible to conclude that SGAR exposure contributed to the death of this bird. However, none of the other 500 birds autopsied during the period 2015 to 2019 showed any similar pathology and therefore none was considered to have died following SGAR poisoning.

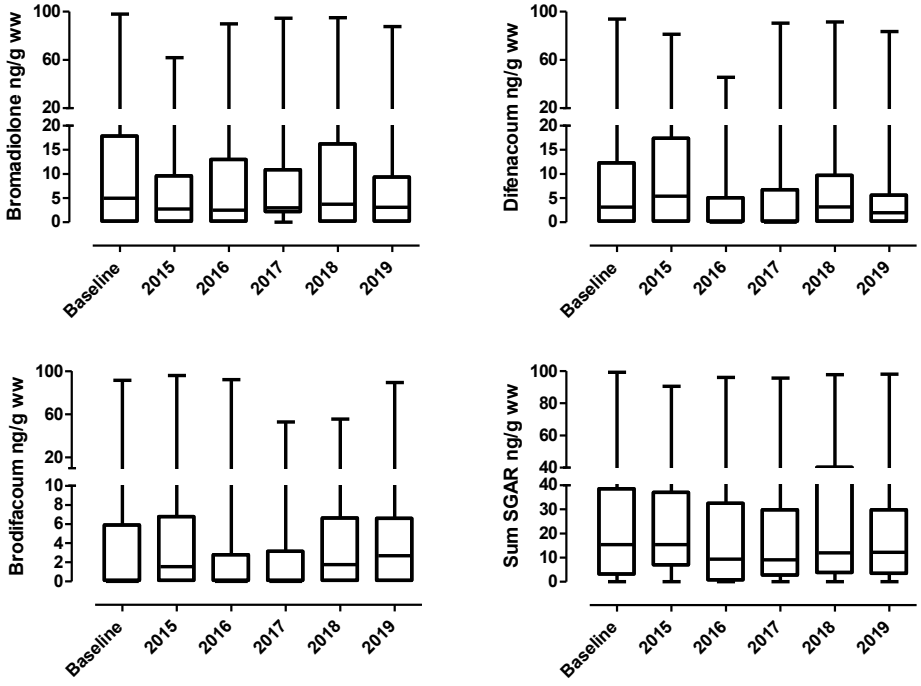
Liver residue concentrations are obtained for brodifacoum, bromadiolone and difenacoum by LCMS-MS analysis and expressed as nanogram per gram wet weight (ng/g w.w.). Each year, individuals in 100 bird sample are allocated to one of two data sub-sets, those with residue levels of <100 ng/g w.w. and those with >100 ng/g w.w.. Figure 7 shows the residue levels for these sub-samples for the period 2015-2019 and for the baseline years. Up to this point analysis has been done only to compare data from each year, for both individual substances and for combined values for all SGARs, with the equivalent data from

33 Shore, R.F., Henrys, P.A. & Walker, L.A. 2014. Power analysis of liver second generation anticoagulant rodenticide (SGAR) residue data in barn owls from Britain: a Predatory Bird Monitoring Scheme (PBMS) report. CEH contract report to the Health & Safety Executive. 45pp. https://wiki.ceh.ac.uk/x/DAIDC.

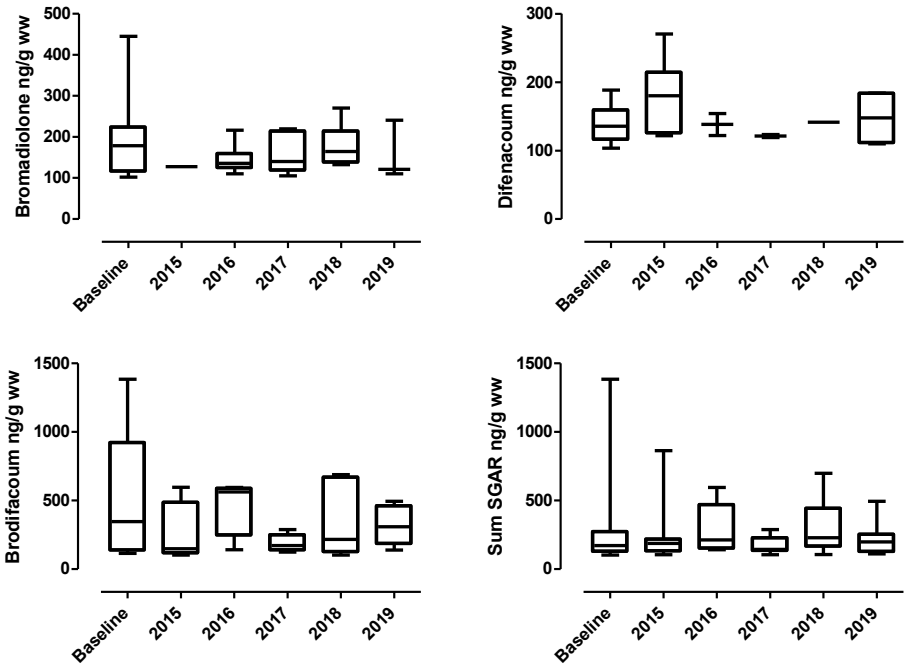
baseline years. During the five-year period of study, statistically significant differences have occasionally been found between individual years and baseline values for residue concentrations. For example, in the study of birds submitted to the PBMS in 2019 a significant increase was seen in the median "low" residues of brodifacoum. However, individual findings such as this, among a large number of non-significant statistical comparisons, should be treated with caution. This is because, for example, when the 95 % probability level is chosen for statistical significance, one in twenty of all comparisons found to be significant will have occurred by chance alone. To date, no trend analysis has been done and this is something that may be considered in the future.

Figure 7. Box and whiskers plot of brodifacoum, difenacoum, bromadiolone and ∑SGARs liver concentrations in the cohort of owls with residues a) <100 ng/g wet weight ("low" residues), b) >100 ng/g wet weight ("high" residues) found dead in the 2006-2012 (Baseline), and year 2015 to 2019. Horizontal line, box and whiskers represent median, 25-75th quartile range and minimum maximum range, respectively. From Walker et al. (2021).

a) <100 ng/g wet weight ("low" residues)



b) >100 ng/g wet weight ("high" residues)



Overall, the studies show that few statistically significant changes in concentrations of SGAR residues in barn owl livers, both 'low' and 'high' residues, have occurred during the period 2015 to 2019 in comparison with the baseline data from 2006 to 2012. This apparently indicates that changes brought about by the stewardship regime to user knowledge, attitudes and practice have not yet acted to reduce significantly the levels of exposure of UK barn owls.

A significant regulatory change took place at the start of the regime in 2016. This was the authorisation of products containing the resistance-breaking substances brodifacoum, difethialone and flocoumafen for use 'outdoors - around buildings'. Previously, and for a period of about 30 years, these substances were restricted to use 'indoors'; which virtually precluded their use in the control of Norway rats. This regulatory policy was adopted and maintained because of concern about wildlife exposure and contamination with these more potent substances. It is apparent from the UKCEH study that the 2016 change in regulatory policy did not bring about significant increases in the concentrations of summed SGAR residues in barn owl livers, as had been feared. However, with the substantial increase in the severity and geographical spread of resistance in the UK (see section 4.6.5), it is to be anticipated that use of these three substances may increase in future and use of the widely resisted difenacoum and bromadiolone decrease. Thus, the relative contributions of the five substances within the observed 'summed residues' data is liable to change. This may be offset in part by the fact that, generally, successful treatments of resistant Norway rat infestations with the more potent active substances utilise considerably smaller quantities of bait and, therefore, engender substantially smaller environmental emissions.[34]

Conclusions

One of the objectives of the stewardship regime set by the GOG was as follows:[35] "There should be a significant decrease in the exposure of the sentinel species – Barn Owl – in terms of sum residues of SGARs detected in livers of barn owl carcasses collected over the first four years." Quite clearly this objective has not been met within the time stipulated. There may be several reasons for this and, of course, causation may not be restricted to a single factor. The first, of course, is that the measures implemented under the stewardship regime are either insufficient or are misdirected in order to achieve this objective. This will be considered by the GOG and is under continuous review by CRRU UK. A second possible reason is that initiation of controls by the regime was not a synchronous event in 2016. Implementation was necessarily conducted as a staged procedure over a number of years. Only in 2018 were all the controls initially conceived to be required by the regime fully implemented.[36] The exposure of barn owls to SGARs and the toxicodynamics of those residues in the livers of birds are complex biological processes that are not fully understood. About 70 % of barn owls whose livers are analysed annually are first year birds, so the SGAR residues in their livers will be the result of rodenticide use during the year prior to their deaths. Therefore, among all the residues discussed here for the period 2015-2019, only those in the 'young birds' sample in 2019 will have been acquired exclusively when SGAR products were being used under full stewardship controls. It is the position of CRRU that the objective to show decline in residues in the first four years, given the long-term and complex nature of the biological systems involved, was probably unrealistic. More time is required, with stewardship under full implementation, to achieve this important goal.

The finding from the UKCEH studies that only one of 500 barn owls examined over the period 2015-2019 was possibly killed by SGAR poisoning provides important information on acute effects. It is the likely reason that, as well as the barn owl, the populations of other SGAR-exposed predatory bird species such as red kite (*Milvus milvus*) and buzzard (*Buteo buteo*) are increasing rapidly both in numbers and geographical distribution.[37]

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34 Buckle, A.P., Jones, C.R., Rymer, D.J. et al., 2020. The Hampshire-Berkshire focus of L120Q anticoagulant resistance in the Norway rat (Rattus norvegicus) and field trials of bromadiolone, difenacoum and brodifacoum. Crop Protection 137: 105301. ISSN 0261-2194.

35 HSE. 2017. An information paper by the Rodenticides Stewardship Regime Government Oversight Group. First Report on the Rodenticides Stewardship Regime Assessment of Implementation – February 2017 Rodenticides Stewardship Government Oversight Group. 13 pp. Available at: https://www.hse.gov.uk/biocides/rodenticides.htm. Date accessed:03.03.21.

36 CRRU UK 2018. Campaign for Responsible Rodenticide Use (CRRU) UK. The UK Rodenticide Stewardship Regime 2018 Annual Report CRRU Stewardship. January 2019. 20 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 24.02.21.

37 Harris, S.J., Massimino, D., Balmer, D.E. et al. 2020. The Breeding Bird Survey 2019. BTO Research Report 726. British Trust for Ornithology, Thetford. 36 pp. Available at: https://www.bto.org/our-science/projects/bbs. Date accessed: 25.02.21

The data provided annually in the UKCEH reports are relatively simple, being mainly mean residues for different SGAR substances and comparisons with the baseline. More detailed analysis should be possible now with a total of 500 samples. The examination of geographical information in terms of the location of the carcase when found, and the nature of the surrounding environment, would provide useful information to allow stewardship action to be directed more precisely, both in terms of locality and particular landscapes. A second area of possible enhanced use of data would be statistical analysis of trends, rather than the current backward comparison of a given year with the baseline period. CRRU will seek to explore both possibilities with colleagues at UKCEH.

3.6.4 Rodenticide Knowledge, Attitudes and Practices (KAP) Surveys

General

A Knowledge, Attitude and Practices (KAP) survey is a quantitative method, using predefined questions formatted in a standardised questionnaire, that provides access to quantitative and qualitative information. The KAP survey is a widely used tool to observe changes in behaviour, and in the level of adoption of advice, in a wide range of scenarios. KAP studies collect information on what is known, believed and done in relation to a particular topic in a specific community.[38] However, it must be noted that a KAP survey records an "opinion" and is based on the "declarative" (i.e. statements). In other words, the KAP survey reveals what was said in response to questions or propositions posed to correspondents, but there may be gaps between what is said and what is done.

The third KAP survey conducted on behalf of CRRU was competed and published in 2020.[39] All three KAP surveys have been collated and published by Mike Heisig from Research Engine on behalf of CRRU. Previous surveys were carried out and results and provided to the GOG in 2015, prior to the introduction of the stewardship regime, and in 2017, two years after initiation.

Sampling Frame and Sample Sizes

The sampling user segments and sample sizes for the three KAP surveys are shown below (Table 9). All sample targets for interview were achieved through a combination of telephone and online interviews. The object of the report submitted to CRRU by Research Engine is as follows:

- Measure awareness of rodent control strategies and control approaches used.
- Define rodenticide products used, situation, frequency, quantities applied, and methods used.
- Assess knowledge and attitudes regarding potential adverse impacts on humans, non-target animalsand the environment for different ways of controlling rodents.
- Quantify knowledge and degree of implementation of risk mitigation measures.
- Define awareness, understanding and attitudes to codes of practice, (in particular the CRRU 7-point code of practice and in 2017 the CRRU UK Best Practice guideline) and impact on use practices.
- Identify influencers and influences and their impact on attitudes and behaviours, including, advice sources, training programmes, and communications.
- Compare and contrast knowledge, attitudes and practices between different types of users (farmers, gamekeepers, professional pest controllers).

As with previous KAPs the rodenticide user community is broken into segments, with the livestock farming segment further divided into sub-segments to reflect different types of farm enterprises (Table 9). The other segments, gamekeepers and pest control technicians, are homogeneous.

38 Kaliyaperumal K. 2004. Guideline for conducting a knowledge, attitude and practice (KAP) study. AECS Illumination 4:7–9.

39 Research Engine. 2020. Rodenticide Knowledge, Attitudes and Practices: Survey: August 2020 Re-run. 35-37 Ludgate Hill, London. 171 pp.

Table 9. KAP survey 2020 user segments, sub-segments and sample sizes

Segment	Sub-segment	Sample sizes achieved		
		2015	2017	2020
Farming - Arable	-	50	100	100
Farming - Livestock	Dairy	30	64	64
	Sheep	30	62	62
	Pigs	30	60	60
	Poultry	30	60	60
Gamekeepers	-	43	63	93
Pest Control Officers (PCO)	-	55	120	150
TOTAL SAMPLE	-	268	512	589

It is clear from the 2020 KAP that there have been universal improvements amongst all sectors regarding the seven points listed above, and these developments are highlighted below. The three user groups may be at different stages of development regarding CRRU guidance and stewardship, but they all reflect positive changes in knowledge, attitude and practice from the base line survey carried out in 2015 prior to stewardship implementation.

Sample sizes were once again increased in 2020 in the gamekeeper and PCO sectors to provide better statistical precision. A sample size of 30 respondents per sub-set as used in 2015 is the minimum size to provide statistical accuracy (+/- 15 % at 90 % confidence level). Collectively, livestock farmers in 2015 provided a total sample size of 120 respondents, giving an accuracy of +/- 7.5 % at the 90 % confidence level. Samples of 100 and 50 respondents will give an accuracy of +/- 8.2 % and +/-11.6 % respectively, at the 90 % confidence level.

Demographics – Key Information

The data collected shows that membership of assurance schemes across the farming sectors has been largely static during the period of the three KAP surveys and remains at a high level, varying between 93 % and 100 % , with some growth noted. Red Tractor is by far the highest membership assurance scheme across the three KAPs in the farming sector.

A notable improvement has been made in the gamekeeping sector regarding membership of schemes. This is one of a number of key indicators throughout this report that demonstrate the positive work and collaboration that has been undertaken by CRRU with stakeholder agencies in the gamekeeping sector in the development of better working practice when using rodenticides.

Assurance schemes in the PCO demographic remain prominent and 74 % of the 2020 respondents were members of one of the two major recognised trade bodies, NPTA and BPCA.

Other demographics such as age range, sex and other variables can be found in the full report.[40] One topic of note was a reduction in the average age of respondents among gamekeepers compared to previous surveys, suggesting a younger demographic may be employed in this industry – this may ultimately lead to a change in emphasis around topics such a training methods.

Qualifications and Training

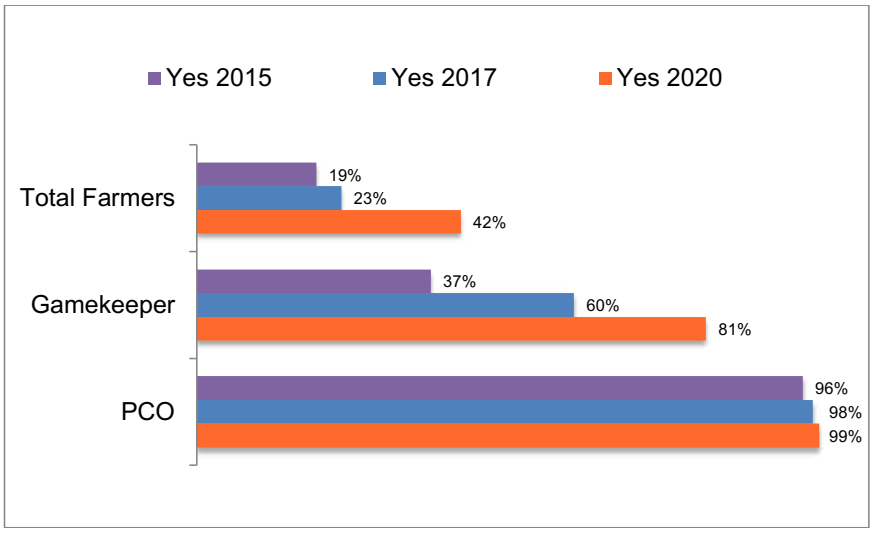
The 2017 KAP survey observed an increase in formal training, a trajectory that continues in 2020, with all sectors reporting an increase (Figure 8). The 2020 KAP reports that:

"The training landscape is changing significantly; 5 years ago, it was very polarised with highly trained PCOs and relatively untrained farmers and gamekeepers. In 2020 the evidence is that this gap is closing."

40 Research Engine. 2020. Rodenticide Knowledge, Attitudes and Practices: Survey: August 2020 Re-run. 35-37 Ludgate Hill, London. 171 pp.

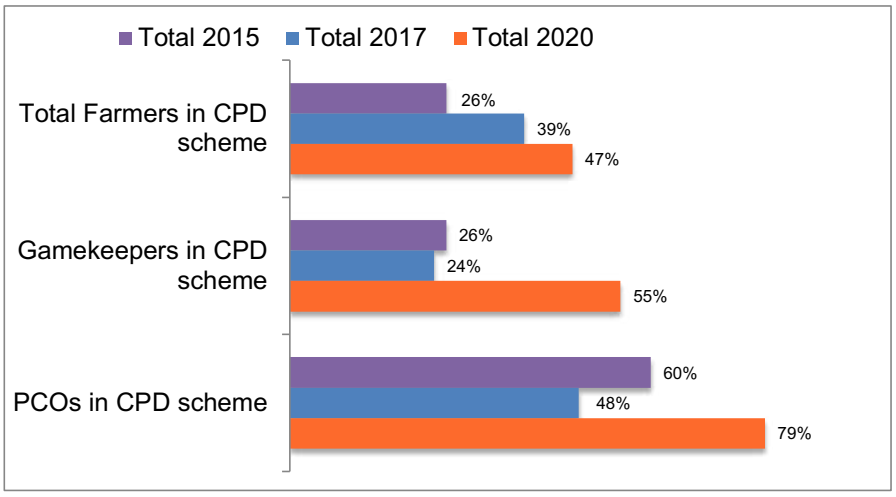
The data show that City and Guilds and Lantra qualifications are the most widely used by the Farming community. Gamekeepers predominantly complete the BASIS qualification developed in conjunction with CRRU, and PCO's tend to follow the RSPH qualifications route.

Figure 8. Responses to question C1. Do you have a formal qualification relating wholly or in part to decisions about rodenticide usage or the application of rodenticides?



Encouragingly, alongside the uptake in formal qualification highlighted in 2020, there is also an increase in all sectors for membership of a recognised Continuing Professional Development (CPD) scheme (Figure 9). This is seen as a vital aspect of the stewardship scheme to maintain best practice levels amongst those who use professional rodenticides. Information shows that farmers tend to be members of the NRoSO scheme, PCO's are generally BASIS or BPCA members, and gamekeepers use a number of different schemes for CPD membership. With the wider uptake of CPD across the three sectors it is clear that this should continue to be a route that CRRU employs to support and educate on the topic of the safe use of rodenticides.

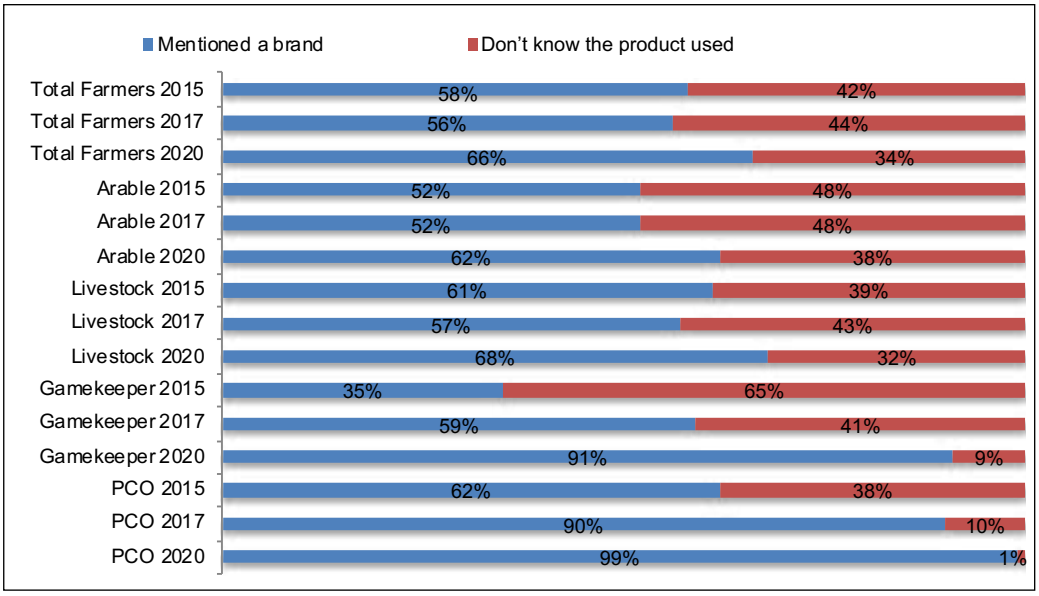
Figure 9. Responses to question C4.Which of these CPD schemes are you part of (overview of all schemes)?



Usage and Awareness of Brands and Products

As part of this survey, respondents were asked to name the last brand of rodenticide they used. All sectors showed increased awareness across the five-year period of the brands of rodenticide that they were using (Figure 10). Gamekeepers and PCOs were much more aware of rodenticide brands they have used in 2017 compared with 2015 and in 2020 both arable and livestock farmers have made progress in terms of developing a wider understanding of rodenticide brands, and being able to distinguish between them.

Figure 10. Responses to question D1. What was the last or latest brand of rodenticide that you used? (Base: all respondents.)

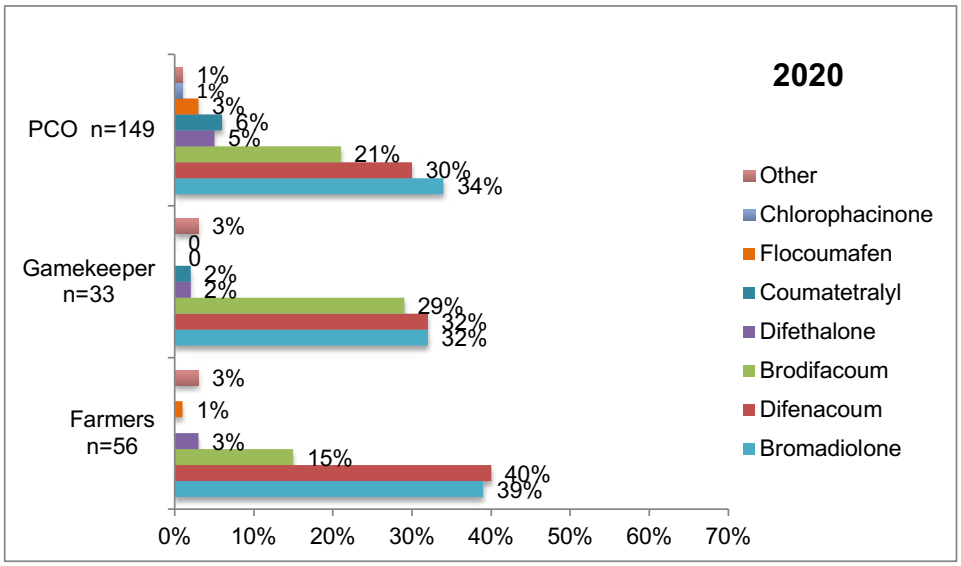


Effectiveness and recommendation remain the main drivers behind product choice for most of the farming sector. However, across all sectors there is a general drift away from just considering effectiveness and recommendation as the only drivers for product selection and concerns, such as non-toxic solutions, become more apparent in the data, showing a developing knowledge and attitude that does not automatically see rodenticide application as the first step of a treatment process.

Some farming sectors remain unaware of active ingredients in the rodenticides they use. In contrast, the impressive increase in knowledge levels of gamekeepers is further indication of progress in this sector over the last six years. This knowledge is particularly relevant because of the restricted number of products that can be used in 'open areas', the predominant gamekeeper use pattern.

Another interesting difference between surveys in 2015 and 2020 was the change in active ingredients used (Figure 11). Bromadiolone and difenacoum dominated usage in all sectors groups in 2015. By 2017 this dependence started to shift and this movement continues in the 2020 report, with a wider range of actives being considered by all sectors. The 2020 figures also indicate there is a reduction in the amount of rodenticide being purchased by the contributors across the three user groups.

Figure 11. Responses to question D3. What is the active? (Base = all who stated they knew the active of the brand recently used.)

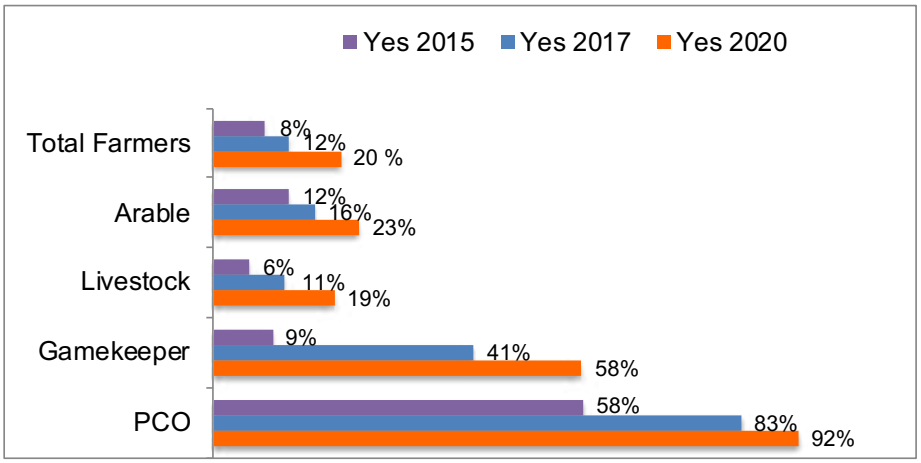


Awareness of CRRU

Awareness of CRRU is growing in the farming sector and continues to make significant strides amongst gamekeepers and PCOs in 2020 (Figure 12). This can be attributed to the CRRU stewardship campaign from 2015 onwards.

Both PCO's and gamekeepers demonstrated knowledge of what the acronym CRRU stands for, farmers were less able to provide the name, but nevertheless showed evidence of good progress in knowledge.

Figure 12. Responses to question F4. Have you heard of READ OUT: 'Crew' that is spelt CRRU? (Base: all respondents.)



However, knowledge of the UK Anticoagulant Rodenticide Stewardship Regime is different. Having made progress across all sectors from 2015 and 2017 awareness appears to have stalled in 2020. Gamekeepers continue to perform well in this area, and their understanding of what the regime is trying to achieve outstripped the PCO sector in some areas.

Knowledge of environmental risk assessment was high in 2017, and knowledge generally improved further in 2020. However, gamekeeper value fell back slightly in this area, but when assessed against general progress in the last three years this should not be a concern.

Awareness of Rodent Control Issues

Looking at the trend through 2017 into 2020, the charts clearly show significant growing understanding of secondary poisoning and its direct causes.

All sectors reflect the same pattern:

- A reduction, compared with 2015, in the belief that secondary non-targets eating rodent bait directly cause poisoning. This might be driven by a general view that all rodents are legitimate targets.
- A generally static, but important, view that secondary poisoning is caused by dead rodents being eaten after they have ingested poison.
- And a growing perception that that secondary poisoning is caused when animals eat small birds and non-target rodents that have primarily eaten rodenticides directly. This must be linked to growing understanding of barn owls and predators being threatened by rodenticides.

This may suggest that work needs to be done to help users of rodenticides understand how non-targets get direct access to baits.

The 2017 and 2020 results show that, in general, there is much more widespread understanding of the risks of leaving rodenticide (in a bait box or dead rodent) unmanaged in the environment. This shows that one of the key CRRU messages is being assimilated by the three user groups.

Accessing Information

The 2020 survey continues to show that PCOs remain the most active information seekers followed by gamekeepers, with livestock farmers least active and some subgroups remaining static since the last survey. As this doesn't necessarily support the earlier questions raised regarding training and CPD membership, this may suggest that although respondents did not actively seek information, none the less passively they are exposed to information, such as articles in the sector press.

The recent re-focus by CRRU regarding communications through media channels, including social media, is part of a process designed to improve communications with groups who do not seek information along 'traditional' routes.

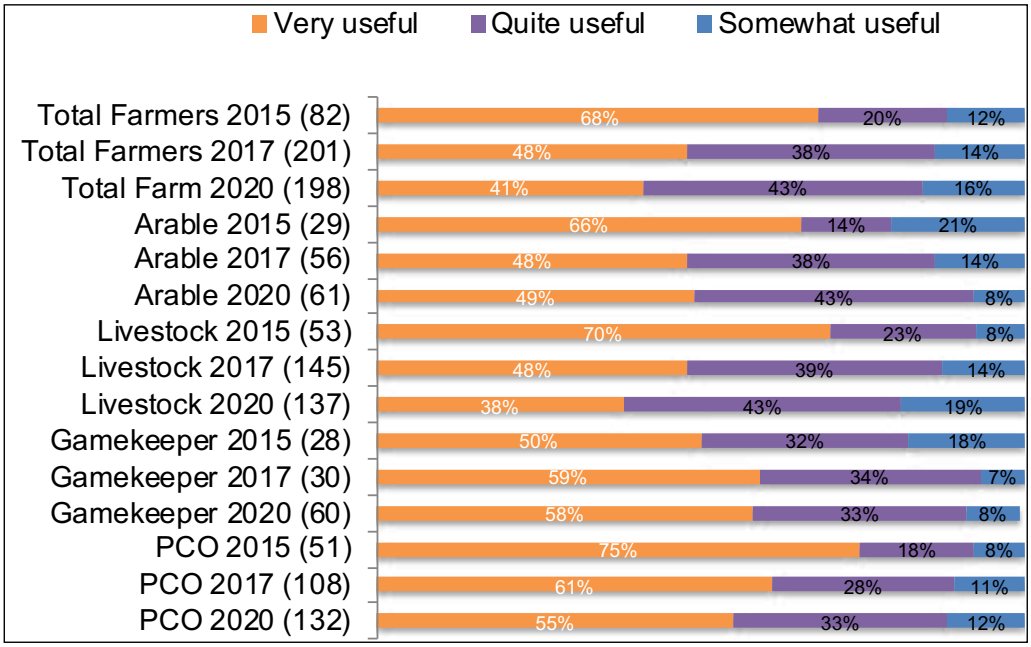
A new source of information and advice about rodenticide use for farmers in 2020 was found in their contacts with farm assurance schemes. This was not evident in 2017 and represents a major change for farmers. It should be remembered that the CRRU Best Practice Work Group has worked very closely with a number of farm assurance schemes to make sure that their specifications are CRRU compliant (section 3.2.2). This means that, although farming sectors may not be necessarily communicating directly with CRRU, they are picking up the key messages and adhering to the CRRU requirements through their interactions with assurance schemes. This is the first evidence that CRRU work with assurance schemes is having effect. At the same time the 2020 results also show CRRU as directly growing as an information source for both gamekeepers and PCOs.

What Information is 'Consumed'

The main topic for information was generally the same in 2020 as in 2017 and 2015: safe and effective usage. However, in the last five years PCO's especially have also progressively embraced a wider range of messages with more enthusiasm, whereas farmers appear to have focused their enquiries more narrowly into three core areas: safety, efficacy and usage legality.

One issue of note is that information received by the user groups was felt to be less useful than in previous surveys (Figure 13). This could mean the message is becoming old, or familiar, but it could also mean that user groups are now more comfortable with product labels after recent re-registrations and label changes.

Figure 13. Responses to question G4. IF YES AT G1: How useful was this information. (Base: those obtaining information about rodenticide use.)



The 2020 data may indicate that different user groups are on different development curves regarding stewardship. Fewer gamekeepers and PCOs stated that information they had gleaned had changed their approach whereas more farmers said they had made changes based on information received.

The counter argument is of course that if PCO practice and approach are close to ideal then there is less room for change for the better. What we may be seeing here is that each audience is in a different stage of a growth scale as the message is getting through and acted upon. In 2015 and 2017, PCOs clearly led the way in terms of accessing information and implementing changes whereas the other sectors lagged behind.

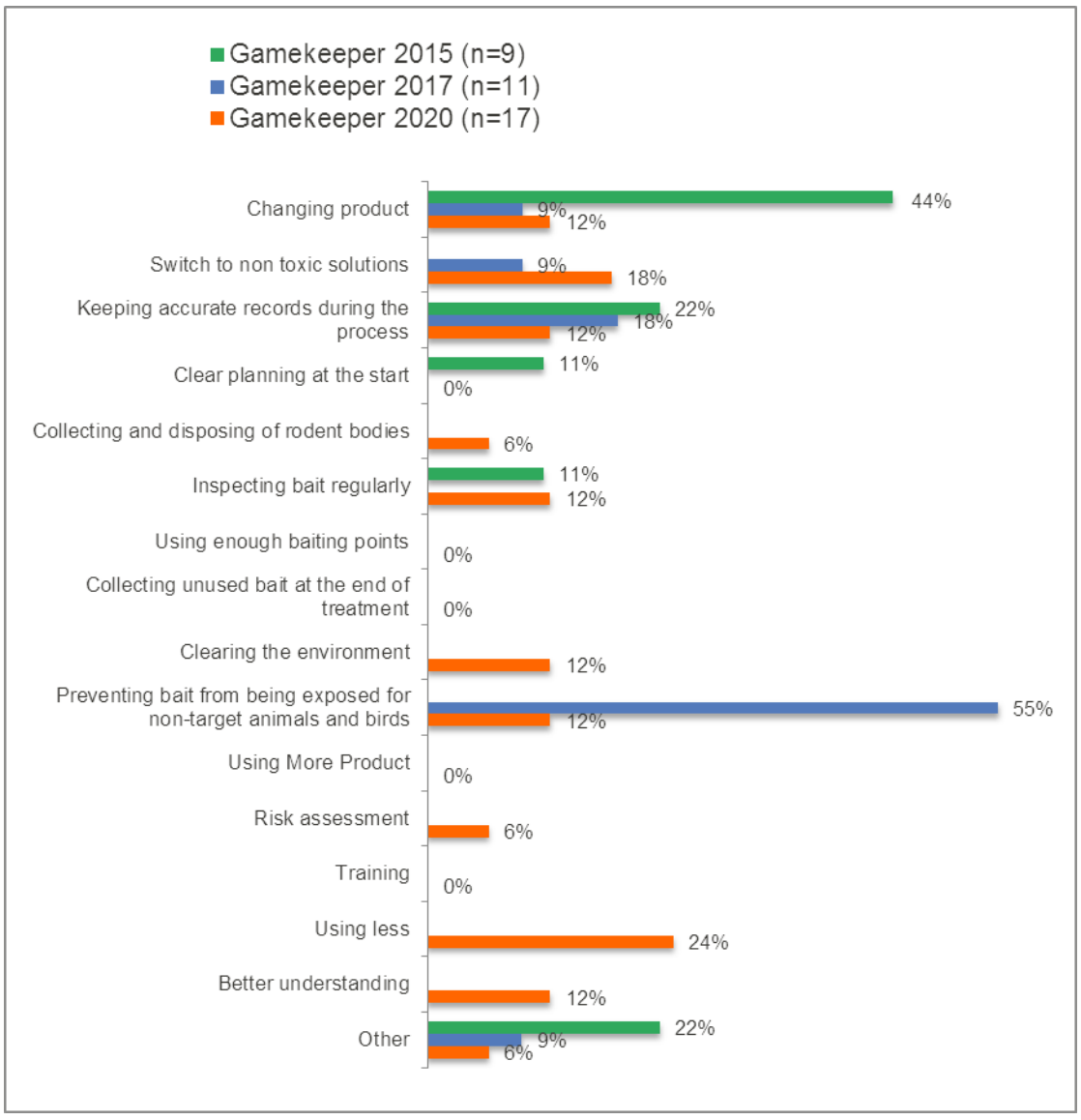
How does information influence application?

There were growing indicators in the 2017 survey that environmental safety became a bigger consideration than it was in 2015. In 2020, this has progressed even further in a very clear but different way in each of the three main sectors.

Farmers: The main trend amongst the farming sector is general growth in awareness of risk to the environment and non-targets. Comments made by farmers referred to covering poison, using bait boxes and removing spent bait.

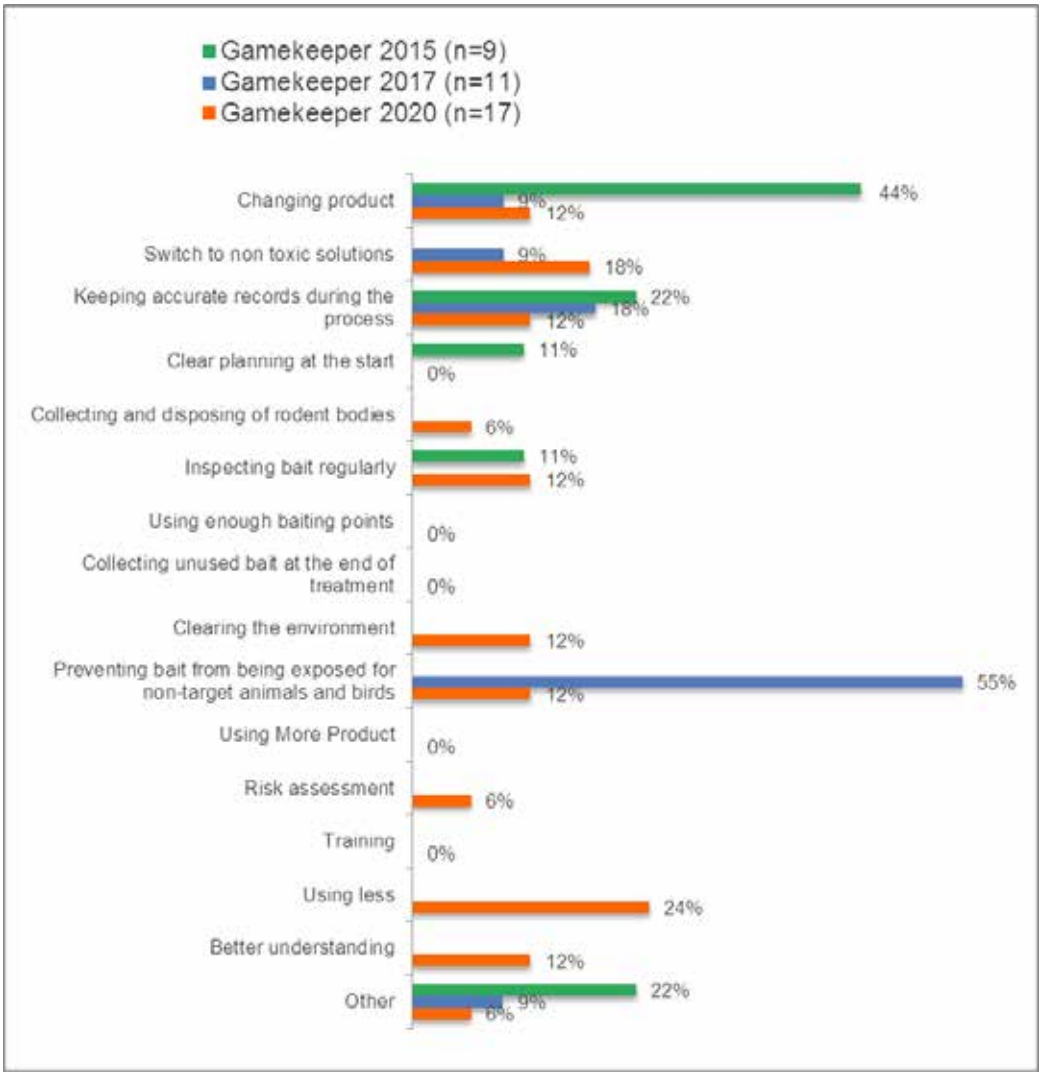
Gamekeepers: The 2020 data showed a clear trend towards using less rodenticide and this was often also linked with increased trapping – here identified under the category of 'switch to non-toxic solutions (Figure 14).

Figure 14. Responses to question G6. What changes did you make? (Base: Those making changes after receiving information.)



PCOs: The link between these two related actions, using less rodenticide and using more trapping (switch to non-toxic solutions) was even stronger amongst PCOs. The 2020 data is showing that attitudes to using rodenticides are changing (Figure 15).

Figure 15. Responses to question G6. What changes did you make? (Base: Those making changes after receiving information.)



Information sources for non-seekers

The 2020 data show the expectation amongst rodenticide users that do not seek information is that if they did need it, it would be obtained from their immediate relevant business support network -distributor or local PCO. This is primarily important for farmers but as the data show, gamekeepers and PCOs also look in other directions such as CRRU, the product label and manufacturers directly. Finally, PCOs also use trade media quite extensively.

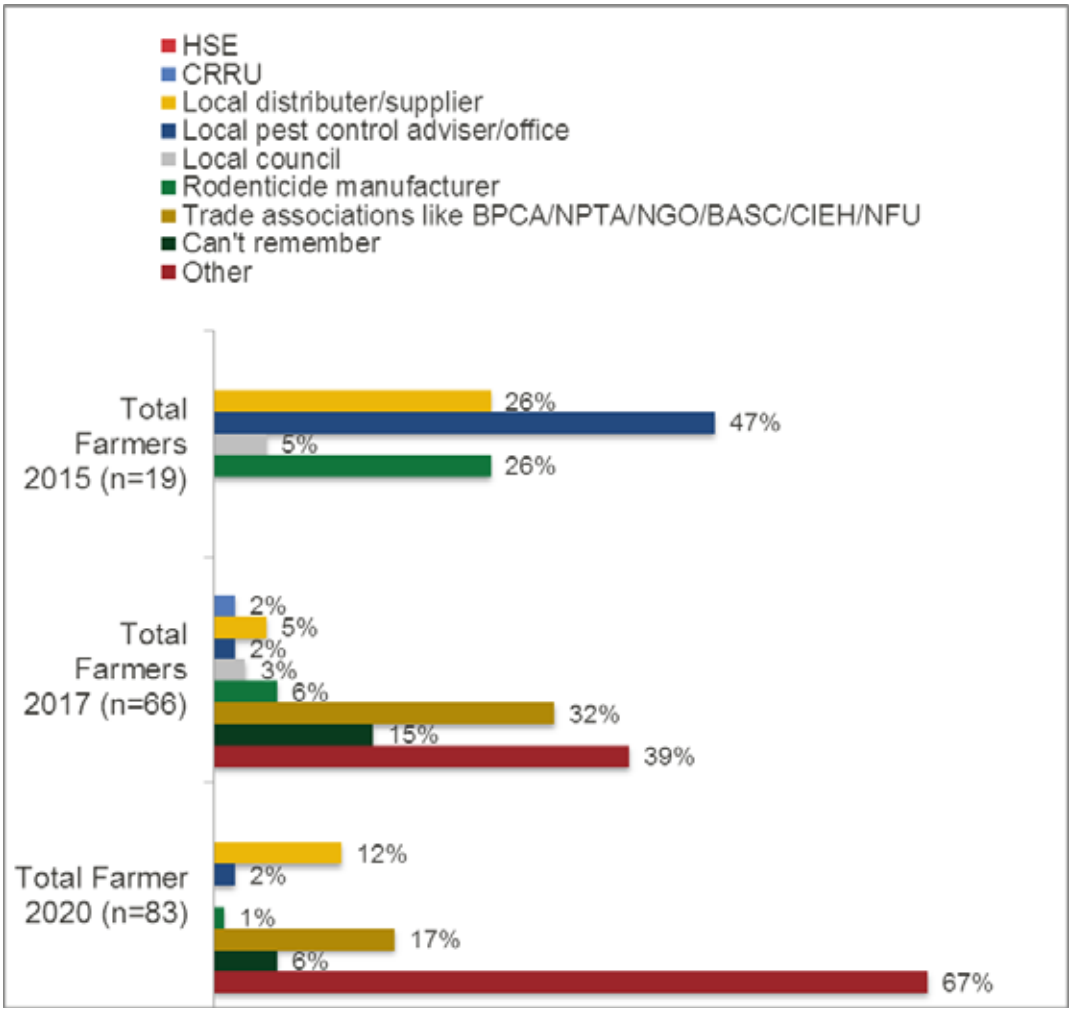
One of the key messages in the report is that the industry needs to find mechanisms to get its message across to the various audiences. Making information accessible to rodenticide users that are not actively looking for information may mean using multiple channels to alert users to the presence of the information should they need it. Examples of this might be using the regular emails sent out by BASC/ NGO/GWCT to gamekeepers, or perhaps considering using social media channels such as the Farming Forum to get the message out to farmers. There are undoubtedly other examples like this that will be reviewed as part of refreshed communications strategy to continue the momentum gained over the last five years (see section 4.7).

Training

The training situation for PCOs and gamekeepers was clear in 2020 and continues to show a continuation of the pattern established in 2017; these two sectors rely on official trade organisations/bodies. Whilst farmers may have told us that they have increased the training in rodenticide use, the puzzling question is where this training has come from? The survey included most of the relevant training sources for each sector. However, the 2020 farmers appeared not to recognise these training options and so chose the "other" category (Figure 16).

Figure 16. Responses to question G9. IF YES AT G8, Can you recall who ran the training or the seminar? (Base: Those attending training.)

One encouraging message also emerging from the 2020 study is a general decline in the numbers of respondents stating that regarding training they "never thought it was necessary". There is a suggestion amongst gamekeepers that that more have realised that training is necessary, but have come up with the classic excuse that it's not convenient for them. When stewardship was launched gamekeepers could not



buy bait unless they had a training certification. Many gamekeepers rushed through their training and got certificated in order to maintain access to bait. This potentially removes any further incentive for training. One of the key points to take from this section of the KAP is that cost of training is still not a barrier.

Product Labels

The 2020 data taken as whole provide clear indication that more attention is paid to the product label. Most values are up from 2017 and the patterns seen in previous years, about the priority attributes of the product label, still hold true and the order remains:

- Dosing and placing.
- Human safety.
- Environmental safety.
- What to do when it goes wrong.

In general, there is increased appreciation of the product label across all sectors. The fact that the 2020 survey contains more comments about the product labels enforces the view that they are being read and considered by the user. Issues such as print size, standardised labels and making labels simple to comprehend were again raised in this survey.

Rodenticide resistance

In the 2020 KAP, one third of farmers do not feel resistance to be a consideration with their treatments and it appears that gamekeepers and PCOs show more concern than farmers. Perception of resistance has grown steadily with gamekeepers across this five-year period. This could be due to education but also the fact that they are generally limited to using difenacoum and bromadiolone. However, it is apparent that brodifacoum products are used by gamekeepers with surprising frequency, possibly indicating a lack of understanding about use restrictions on this substance (Figure 11). This needs to be addressed with urgency.

Within the PCO community, resistance perception has also increased slightly, though not as dramatically.

In recent years, for farmers faced with resistance, there has been a shift from mainly thinking that it's just about changing product/active to a two-pronged response of looking at both active ingredient and formulation. Also amongst farmers, in the background is growing awareness of the option to also use trapping as means of controlling resistant populations. All this must be noted as a major step forward in farmers' understanding of rodent control. The 2020 data also suggest that resistance is now back in focus for PCOs after a dip in 2017 and that they are in fact using a holistic management approach and using a wider range of solutions including non-anticoagulants and wider tail testing of rodents.

Baiting levels

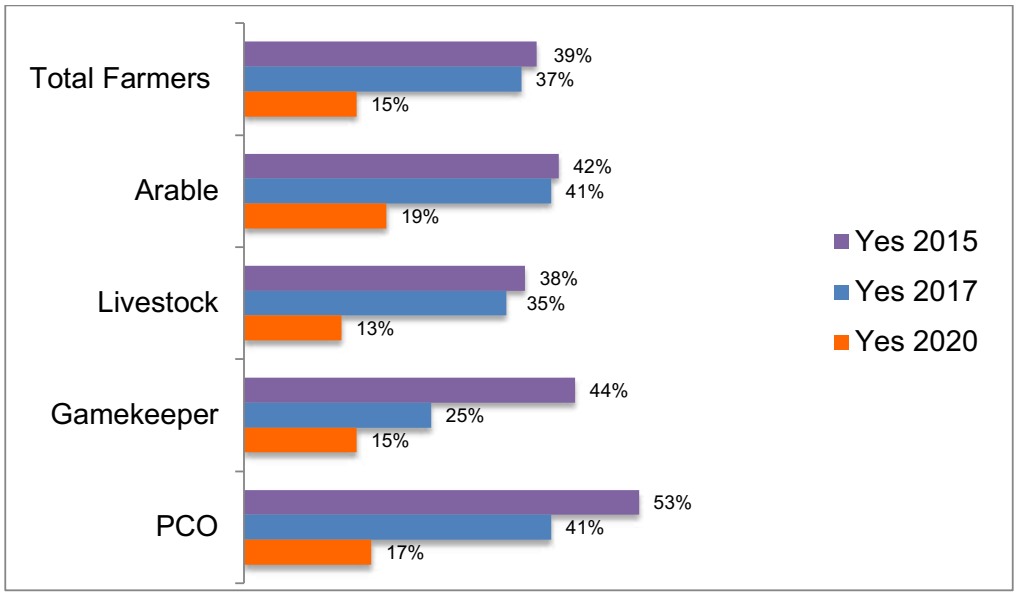
The 2020 KAP data show two divergent groups: one group that relies on their own expertise to judge what is right and the other group that relies on the advice on the label. The emerging difference may be more about how the professional experience is translated into a practical baiting strategy. Farmers in the main use their professional experience together with practical trial and error, whereas gamekeepers and PCOs use their professional experience together with the instructions on the product label. Just as there is a constant message in the professional pest control sector that the product label is a legal contract, farmers require a similar focussed communication campaign to impress this requirement upon them.

One of the most notable and positive changes measured in 2020 is a significant universal decline in permanent baiting. The survey clearly shows that all sectors have reduced their reliance on permanent baiting and that one of the key messages of the rodenticide regime has been absorbed by the users of professional use rodenticides over the last five years (Figure 17).

Planning vs reactive treatment

It is generally understood that people faced with a rodent problem (or any long-term challenge) may respond proactively or reactively. From 2015 to 2017 there was a decline in the proportion of farmers and gamekeepers taking a reactive approach. Since then, the 2020 data reveal a return to reactive thinking, especially amongst farmers. However, the 2020 figures also show a more holistic approach to reactive triggers for treatment, with an average of 2.0 triggers (e.g. sightings, droppings) in 2015 and an average of 3.3 triggers in 2020, which reveals a deeper level of awareness and understanding amongst reactive users across the last five years. 'Planners' also show more knowledge, relying on 3.1 triggers in 2020 compared to 1.9 in 2015.

Figure 17. Responses to question D8. Are there any situations of usage where you employ permanent baiting, that is baiting 365 days of the year with fresh bait irrespective of whether you see a problem or not? Y/N. (Base: All respondents.)



It is worth noting that both reactors and planners are using more evidence to understand the nature of a rodent problem. The 2020 KAP shows that both are able to demonstrate increased professionalism, and both reactive and proactive treatment processes could be interpreted as different ways of expressing professionalism. The 2020 results also highlight that both planners and reactors now look for a wider range of evidence to indicate how successful a treatment has been, again indicating a development in knowledge in the five years of the stewardship regime covered by the three KAP surveys. Reactors also reveal in the 2020 KAP that they check their bait more regularly than planners. As reactors are typically treating active infestations, these data support better knowledge about how to deal with infestations, and how best to minimise issues such as secondary poisoning, with regular visits to search for and remove dead rodents.

Response to scenarios

In order to understand how each of the sectors would react to a rodent challenge, respondents were given a scenario relevant to their work practice. Each time the survey has run, the volume of answers to these questions increases. Usually this means that people actually know more, and this is another indicator of growing knowledge and professionalism. For example, through the three KAP studies, preventative measures progressively become more important to farmers; gamekeepers focus on food removal and the use of traps as opposed to rodenticides; and pest controllers reflect a more holistic approach , using a number of control measures, and viewing rodenticide as a back-up rather than primary control measure.

As practice improves across all sectors, each appears to have developed a greater understanding and awareness of the environmental consequences of rodent control. In 2020, all sectors reveal greater awareness of the term risk hierarchy. However, farmers appeared less able to differentiate between the questions on risk hierarchy, and this may indicate further work is required to support understanding of this term amongst all sectors. This is to be addressed in the revised CRRU Code of Best Practice and in planned initiatives of training and communication.

When the sectors were asked about the adverse impacts of rodenticides, reactions across all three KAP studies were generally consistent – contributors stated risk to wildlife and domestic animals were the greatest perceived risks. From 2015 to 2020, when probed about the details of environmental consequences, there was strong agreement that most people involved in rodent control will state that they take ALL risk factors into account.

Minimising the risks of using rodenticides

For farmers, the main focus remains to ensure that bait is well protected and removing dead rats that have anticoagulant residues. Beyond this, there is a long list of secondary actions, and the most important of these is a renewed focus on:

- Using traps.
- Avoiding the use of anticoagulants where possible.
- Checking bait.
- Removal of old bait.

The data for gamekeepers and PCOs are remarkable in the extent of progress that these two audiences have made since 2017. In some respects, these results appear to be too good, too advanced, compared with other findings reported and, in others they seem in line with other progress that has been reported, maybe with an added dose of enthusiasm.

Conclusion: What it shows is that there is a growing awareness of the plethora of actions that may be taken to minimise environmental risks and optimise control of rodents.

The information in the above report clearly indicates that in almost all areas of the Knowledge, Attitude and Practice surveys conducted on behalf of CRRU, there has been marked improvement in the five years covered by the studies. All rodenticide user groups have reflected developments in training, CPD, environmental awareness and product knowledge that clearly indicate that the CRRU stewardship message is being absorbed and understood. However, although the implementation of the stewardship regime is an important driver for best practice among all user groups, it should be noted that there are many other influences that serve to reinforce the stewardship message. The KAP also shows that there are areas for improvement in each user group, and CRRU has already begun the process of better using different information routes to help ensure that the key stewardship messages are being adsorbed by some of the more difficult-to-reach sectors covered by the KAP.

3.6.5 Barn Owl Breeding Performance (University of Reading and Wildlife Conservation Partnership)

General

After careful consideration of alternatives, it was the decision of the GOG that the barn owl (*Tyto alba*) was an appropriate sentinel species indicative of rodenticide exposure for a range of wildlife species relying on wild small rodents, mainly mice and voles, as prey.[41] A study of one aspect of the biology of this species, the distribution and concentrations of liver residues of SGARs, is presented elsewhere in this report (see section 3.6.3). Given the sentinel significance of the barn owl in stewardship monitoring, CRRU adopted a second monitoring approach. The Barn Owl Monitoring Scheme (BOMS) records certain breeding parameters in selected UK barn owl populations. The project is operated as collaboration between independent barn owl experts (Wildlife Conservation Partnership), who conduct field work, and the University of Reading, where data analysis, interpretation and reporting is carried out. An important feature of the study is the ability to follow the same nest sites from year to year. This is not possible in other surveys and permits estimation of percentage nest site occupancy, which is an important metric in barn owl breeding performance. Each year, a report is produced giving data on barn owl breeding during the preceding breeding season, and these data are compared with similar information obtained during previous years.

The BOMS was conceived to provide surveillance of UK barn owl breeding performance so that significant breeding perturbations could be observed and, hopefully, explained. The purpose also was to obtain information about barn owl breeding among a sub-set of the UK barn owl population to permit reporting of breeding among birds carrying SGAR liver residues that are typical of those found in the annual studies

41 HSE. 2015. Potential success criteria for Second Generation Anticoagulant Rodenticide (SGAR) Stewardship Scheme. Health and Safety Executive. February 2015. Draft. 9pp.

reported by UKCEH. This latter point is challenged by government scientists, however, because no residue data are obtained directly within the BOMS for the birds studied and therefore no empirical evidence of levels of exposure of BOMs birds is obtained. This is impossible, of course, because the BOMS is concerned with the breeding performance of live birds, while liver residues can only be obtained after death. However, given the ubiquitous nature of low-level residues revealed by the UKCEH study (section 3.6.3) it seems inconceivable that the BOMS birds would not be similarly exposed.

The BOMS rationale is that the sample obtained by UKCEH is a sub-sample of the UK barn owl population, provided by those who find and send in the carcases of dead barn owls; most are road casualties. The BOMS sample of approximately 130 nests annually is, likewise, a sub-sample of that same UK barn owl population; in this case study nests are selected by researchers from five widely separated geographical regions, so as to be typical of those within the wider UK population. It is the considered opinion of experts involved that breeding metrics at BOMS nests are typical of wider UK populations. This is supported by the close agreement between certain comparative data from BOMS nests and those from a much wider national survey of barn owl nests conducted by the British Trust for Ornithology, through their nest record and ringing surveys (see https://www.bto.org/our-science/projects).

Recent breeding performance

Estimating population numbers of birds is problematic for all species because numbers fluctuate from year to year as individuals breed, die, immigrate and emigrate. Estimates of population size are commonly derived from surveys, and for barn owl, such surveys rely heavily on estimating numbers of breeding pairs over successive breeding seasons.[42]

In the 18th century, barn owls were regarded as the most common species of owl over much of the country. Traditional low-intensity agricultural practice, together with high reliance on livestock, provided prey-rich habitats for barn owls. However, a decline in the numbers of this bird was evident by the early 1900's following changes in agricultural practice.

The most recent organised national survey of the barn owl breeding population was undertaken between 1995 and 1997, and provided an estimate of c. 4,000 breeding pairs, using a standardised survey design,[43] although the authors subsequently considered this to be on the low side.[42]

Over subsequent years, considerable conservation effort has been targeted at Britain's barn owl population, and expert groups and organisations have reported UK population estimates of c. 9,000 breeding pairs in 2011 and 2014. The breeding population is currently estimated at between 9,000 and 12,000 pairs and considered likely close to the upper end of this range.[44]

The Avian Population Estimates Panel (APEP) is a collaboration between UK statutory conservation agencies and relevant non-governmental organisation, with the role of collating best estimates of breeding and non-breeding bird populations. Their most recent report provided a 2016 UK estimate of between 4,000 and 14,000 breeding pairs.[45]

The improved conservation status of the barn owl population over the last 21 years has been acknowledged by 'The State of the UK's Birds 2016' report, downgrading it from the 'Amber List' in 2015 to the 'Green List' (least critical) in 2016.[46] This report considers the status of UK breeding and non-breeding birds in the UK, taking into consideration results from annual, periodic and one-off surveys and monitoring studies, such as those conducted by the BTO, which have reported a 217 % increase in population size between 1995 and 2015.

42 Toms, M. 2014. Owls. The New Naturalist Library, Volume 125. HarperCollins, London. 419pp.

43 Toms, M.P., Crick, H.Q.P. and Shawyer, C.R. 2001. The status of breeding Barn Owls Tyto alba in the United Kingdom 1995-97. Bird Study, 48: 23-37.

44 Shawyer, C.R. 2019. Barn Owls in 2019. Available at: https://www.bto.org/news-events/news/2018- 04/barn-owls-2018-update-colin-shawyer. Date accessed: 03.09.2019.

45 Woodward, I., Aebisher, N., Burnell, D., et al. 2020. Population estimates of birds in Great Britain and the United Kingdom. British Birds 113: 69-104.

46 Eaton, M., Aebischer, N., Brown,A., et al. 2015. Birds of Conservation Concern 4: the population status of birds of the UK, Channel Islands and Isle of Man. British Birds 108: 708-746.

Two extreme years for barn owls were the breeding seasons of 2013 and 2014. The month of March 2013 was the coldest reported since 1962 and, during that month, numbers of dead barn owls reported to the BTO's ringing scheme were about three times above normal. With nest occupancy estimated to be below 72 % of the 'all-years' average, 2013 was considered to be one of the worst barn owl breeding seasons since 1958. The mild winter of 2013-14 was followed by an early spring and one of the warmest summers on record. Subsequently, 2014 became a peak year for small mammals, and in spite of the low breeding productivity during the summer of 2013, and higher than average barn owl mortality in the winter of 2013 and 2014, both nest occupancy and breeding productivity in many areas was especially high in 2014. The estimated 9,000 pairs that attempted to breed in 2014, with most traditionally used nests sites occupied by breeding birds, provided a reliable UK population estimate for the species at that time.

With such marked annual fluctuations in the barn owl breeding population, nest occupancy and productivity data in any one year are unlikely to provide an accurate reflection of the actual barn owl breeding population. The most recent surveys use a standardised methodology that is conducted over several consecutive years, using the most productive years to estimate population size.

Overall, 2015 was a poor breeding season for barn owls in the UK, although not as bad as that of 2013; while 2016 and 2017 were a better breeding seasons, primarily as a result of repeat and second nesting attempts, following in both years a highly productive June and July. The 2018 breeding season in the UK was poor compared with 2017, with below average nest occupancy and brood size. The reasons for these year to year fluctuations in breeding success are discussed in later sections of this report, and in some detail area by area in annual reports from organisations such as the Barn Owl Trust.[47]

Examination of the breeding range of the barn owl shows that, in the UK, the species is at the northernmost limit of its geographical distribution.[48,49] Indeed, even within the UK, differences have been reported in their abundance from the lowland south to the highlands of the north. It is therefore unsurprising that prey abundance and weather conditions, in particular climatic extremes, can exert a significant effect on the breeding performance of barn owls in the UK.

Barn owl breeding and rodenticides

Thus, we have information from a variety of sources giving estimates over more than a century for UK barn owl populations. The overall trend was one of sharp decline throughout much of the 20th century, most of this long before the introduction of the SGARs. Latterly, there has been an increase in the barn owl population from a low point of about 4,000 breeding pairs during the 1990s to, currently, an estimate of as many as 14,000 breeding pairs. The reasons for this substantial apparent increase are complex and likely to include climate, but the effects of intensive conservation efforts by a number of agencies are also highly significant. Scarcity of available nesting sites had been restricting population growth and schemes to provide nest boxes (e.g. see: https://www.barnowltrust.org.uk/barn-owl-nestbox/) have been so successful that it is now estimated that at least 75 % of UK barn owl pairs breed in a provided nest box.[50]

The relationships between any putative rodenticide effects on barn owl breeding, and hence on barn owl populations, have been the subject of ongoing debate and much speculation. The first effect to examine is that of direct mortality, wherein acute secondary exposure to a rodenticide causes the deaths of individuals. During the period 2015 to 2019, within the UKCEH study (see section 4.6.3), a total of 500 individual barn owls were autopsied to discover cause of death. The vast majority died as the result of road traffic collisions and, indeed, only one bird among the 500 was found to have died probably the direct result of SGAR poisoning. It seems unlikely that a UK barn owl population that is apparently robust to the much greater level of mortality caused by road traffic collisions would be susceptible to impact by the apparently low incidence of mortality caused by rodenticides. However, the point is sometimes made that birds found and submitted to the PBMS by the general public are likely to be biased towards those

47 Barn Owl Trust. 2020. State of the UK Barn Owl population – 2019. Available at: https://www.barnowltrust.org.uk/wp-content/uploads/State-of-the-UK-Barn-Owl-Population-2019-V2.pdf. Date accessed: 25.06.2020.

48 Toms, M. 2014. Owls. The New Naturalist Library, Volume 125. HarperCollins, London. 419pp.

49 Balmer, D.E., Gillings, S., Caffrey, B.J. et al., 2013. Bird Atlas 2007-2011: the breeding and wintering birds of Britain and Ireland. BTO Books, Thetford. 720 pp.

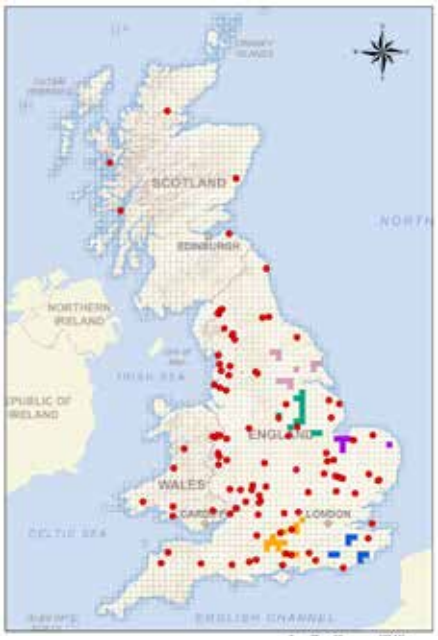
50 Shawyer, C. R. and Richards, P. (2020). The HS2 Phase 1 Barn Owl Mitigation Plan. HS2 Ltd. London. 60 pp.

dying in areas of human activity, such as alongside roads. Whereas, those that succumb to rodenticide poisoning are more likely to die away from areas with public access. It is difficult to conceive a practical procedure to overcome this bias.

Another ongoing and probably more justifiable concern is, of course, the high prevalence of low-level residues of SGARs in barn owl livers (see section 3.6.3) and the possibility that these residues exert a currently unknown adverse effect. Until 1990 government surveys provided data on the use of rodenticides in the UK among pest control professionals and farmers (the UK Pesticide Usage Survey (https://secure.fera.defra.gov.uk/pusstats/surveys/). This information was useful to show temporal and geographical trends in quantities of different active substances used, and recorded for example gradual replacement of FGARs with SGARs as anticoagulant resistance became more prevalent. Regrettably, current government surveys in England, Wales and Northern Ireland no longer record rodenticide use. However, one of the first studies which attempted to establish a relationship between rodenticide use and barn owl breeding was conducted using those data.[51] Breeding records for the years 1988-1990, similar to those provided by BOMS, were compared with government rodenticide use data for the same period. Temporal and geographical trends were studied and no significant statistical relationships were found among any of the parameters examined, although the authors remarked on the very low power of the analysis because of small sample sizes. The cessation of provision of rodenticide use data by government in 1990 thence precluded any future similar study that might have provided much larger sample sizes and opportunity for a more definitive outcome.

Figure 18 shows the geographical position of the BOMS study quadrats and the location of birds found dead and submitted to the PBMS in 2019. The five years of the BOMS data (2015-2019), and four base-line years (2011-2014), show substantial fluctuations in barn owl breeding performance (Table 10). For example, in 2013 only 83 chicks fledged from a total of 99 nests studied, with only 23.2 % of nests producing at least one fledgling. In contrast, 121 nests were studied in the following year (2014) and these produced a total of 336 chicks, with 64.5 % of nests productive. Such significant fluctuations are principally caused by either weather events or by substantial changes in prey availability caused by the periodicity of vole population cycles, or a combination of both (Figure 19).[52] After these two extreme years, breeding during the period 2015-2019 was more stable.

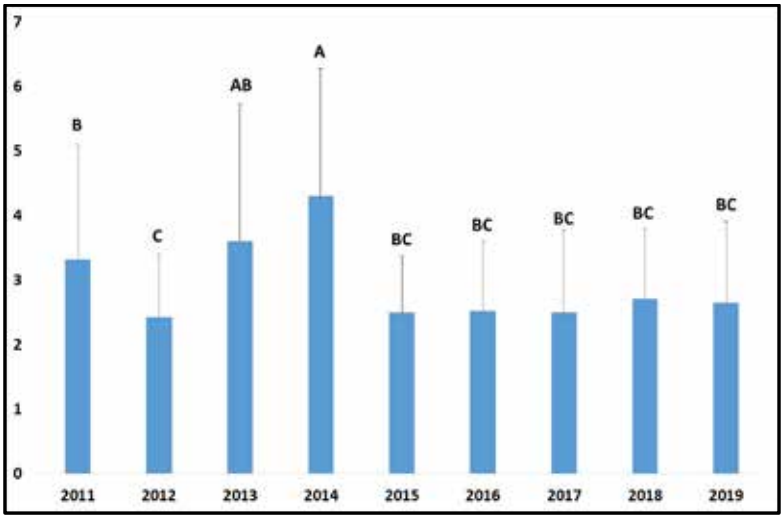
Figure 18. A map of the United Kingdom showing the locations of the 10 kilometre squares in each of the five Regions containing the barn owl nest sites surveyed for BOMS in 2019. The location of the barn owls obtained by UKCEH for the CRRU liver residue analysis survey in the same year are also presented (red circles).



51 Henderson, I.G., McCulloch, M.N. & Crick, H.Q.P. 1993. Barn owl productivity and survival in relation to the use of second-generation rodenticides in 1988-1009. BTO Research Report No. 106. British Trust for Ornithology, Thetford. 20pp.

52 Toms, M. 2014. Owls. The New Naturalist Library, Volume 125. HarperCollins, London. 419pp.

Figure 19. Mean number of fledgling barn owls produced per successful nest (with standard deviations) for all nests monitored between 2011 and 2019. Letters denote *post hoc* groups derived from a General Linear Model (using Tukey Pairwise Comparisons) among which means do not vary significantly.



This provides insight into what may be 'normal' barn owl breeding performance. In this, 30 % to 50 % of all breeding attempts are successful and each successful nest fledges about 2.6 chicks. If we take a modal point of 9,000 for the barn owl population estimate (4,000 to 14,000) breeding pairs, and assume 40 % of nests fledge young, this provides an estimate for UK recruitment of 9,360 fledglings in a 'normal' season. The mean number of chicks ringed at nests in the UK in the same period was 8,063 (range 4,969 – 10,963) (see: https://app.bto.org/ringta/ringing-totals.jsp?archive_euringNo=7350&archive_year=ALL). We lack information on changes in the quantities of rodenticides used in England, Wales and Northern Ireland during the period 2011-2019, however there is little to suggest that fluctuations seen in barn owl breeding during that period are significantly influenced by rodenticide use.

3.6.6 Resistance in UK Rats and Mice (University of Reading)

General

An annual report of the status of resistance monitoring in UK, and elsewhere in EU, is a requirement for delivery of the stewardship regime set by the GOG (Annex 2). In localities from which samples have been obtained, resistance foci are found in widely distributed locations. Whether this can be taken to mean that the distribution of resistance is widespread, including places not yet sampled, is a moot point. Until proved otherwise, the responsible assumption is that resistance genes are widespread in the UK among both house mice and Norway rats.

At least five resistance mutations occur in Norway rats that are known to have detrimental effects on efficacy of some active substances, and at least two in house mice.[53] Therefore, provision of information to practitioners on geographical distribution of resistance mutations in UK rodent populations will have significant benefits for the outcome of the stewardship regime. Use of only fully effective substances in areas where resistance is present will ensure that control is achieved using the smallest quantity of active substance and thereby minimise emissions to the environment. It will also ensure that resistant infestations are removed efficiently to prevent selection that will result in the spread of resistance and increased severity. More potent and persistent anticoagulant substances are required in resistance foci and effective rodent control within foci means that less severe substances maintain their efficacy, once again conferring benefits for the environment.

53 Buckle, A. P. 2013. Anticoagulant resistance in the UK and a new guideline for the management of resistant infestations of Norway rats (Rattus norvegicus Berk.) Pest Management Science 69(3):334-341.

To provide resistance information for practitioners, permitting informed choices about product use for resistance management, the University of Reading has conducted annual surveys of resistance using the DNA sequencing technique. Annual reports are published which give maps showing the scope of existing resistant Norway rat foci.[54] Although limited information is available for house mice, what is available shows the wide distribution and high prevalence of resistance. These UK resistance data were provided to the international Rodenticide Resistance Action Committee and this organisation maintains interactive maps wherein users can search to find the status of resistance in their locality and obtain information about effective interventions (see: https://guide.rrac.info/resistance-maps.html).

With the closure of resistance testing at the University of Reading, CRRU has entered into a contract with the Animal and Plant Health Agency (APHA) for continuation of the resistance-testing service. Pre-addressed and labelled bags are available from CRRU, containing instructions for tissue sampling and other necessary packaging to facilitate postage of samples to APHA (Figure 20).

Figure 20. Posting kits have been produced to facilitate the safe transportation of tail tip samples to the APHA laboratory. Kits are available from CRRU at https://www.thinkwildlife.org/crru-uk/.

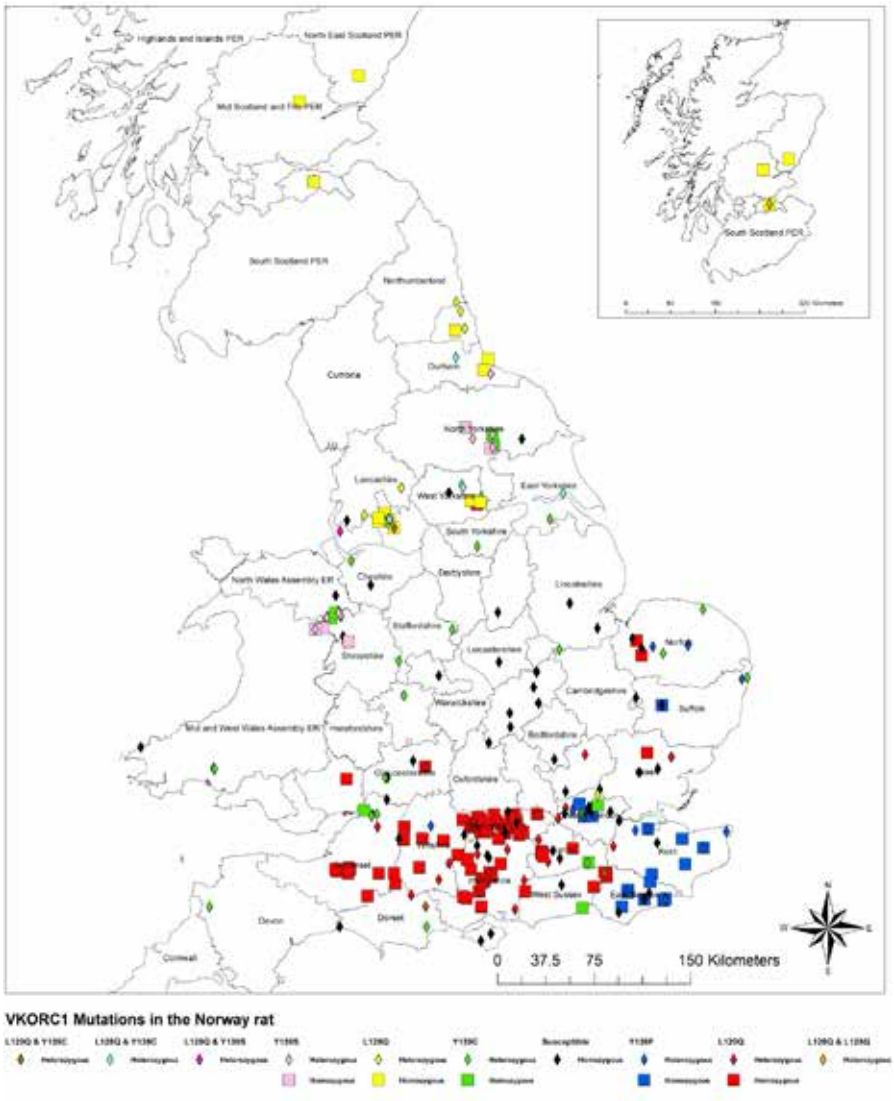
Resistance in the Norway rat

A total of 531 Norway rat tissue samples had been submitted for DNA sequencing since the project began in 2015 to the end of 2020. Among these samples 403 carried one or more resistance mutations, giving an incidence of resistance in UK Norway rats of 75.9 %. Among those that were resistant, 165 were heterozygous and 238 were homozygous, giving an incidence of homozygosity of 59.1 %. This high degree of homozygosity is indicative of long-term selection pressure applied by the use of ineffective products against resistant rats. However, the samples analysed have some bias because they are submitted by practitioners who are facing control problems and therefore may not show the true incidence of resistance.

These samples also provided knowledge of the geographical distribution of Norway rat resistance mutations in UK populations, with a reasonable degree of site specificity (Figure 21). The UK has more detailed information about Norway rat resistance than any other country worldwide, as the result of projects conducted at the University of Reading. All of the five main Norway rat resistance mutations are present, some over very wide areas (Figure 21).

54 Buckle, A., Jones, C., Talavera, M. and Prescott, C. 2020. Anticoagulant Resistance in Rats and Mice in the UK – Summary Report with new data for 2019-20. University of Reading. Report Series VPU 20/002. 19 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 26.02.21.

Figure 21. Map showing the geographical locations of all Norway rat tissue samples submitted to the Vertebrate Pests Unit to date and their resistance status.



It may be useful to review available geographical information for each resistance mutation separately. Information about effective active substances against these mutations is now given through in a new system of chemical groups and sub-groups issued by the UK Rodenticide Resistance Action Group (RRAG) (Annex 8).[55]

Leucine120Glutamine (L120Q)

This is the most severe mutation conferring substantial resistance to all FGARs and among the SGARs, also to bromadiolone and difenacoum. First discovered on the borders of Hampshire and Berkshire in the 1970s, it is now widespread across much of central-southern England. The very high degree of homozygosity found across the focus shows that ineffective active substances have been used extensively, and for a long period, and have acted to select for this mutation. L120Q is so prevalent in those counties that practitioners are advised to treat all Norway rat infestations as if they carry this mutation. It has spread substantially into the neighbouring counties of Wiltshire, Somerset, Surrey and Sussex. It has not yet been found to have spread north into Oxfordshire and Buckinghamshire because no samples have been submitted from those counties. Outlier infestations carrying this mutation are now also widespread. It is not known if these are the result of *de novo* mutation events or are caused by transportation of

55 Buckle, A., Charlton, J., Meyer, A. and Prescott, C. 2021. Anticoagulant resistance in the Norway rat and guidelines for the management of resistant rat infestations in the UK. Rodenticide Resistance Action Group, UK. 11 pp. Available from: https://bpca.org.uk/about/partners/rrag. Date accessed: 26.02.21.

resistant rats from existing foci, or perhaps both. Whatever the cause, it is essential to use effective rodenticides in these areas to prevent the spread of this highly resistant strain.

Tyrosine139Cysteine (Y139C)

This is also a severe resistance mutation and one that is confers resistance to the FGARs and the same two SGARs as L120Q, bromadiolone and difenacoum. For more than 30 years these were the only SGARs that could be used against Norway rats in the UK. Y139C is the most widespread Norway rat resistance mutation and occurs over much of the length and breadth of the UK. It is the prevalent mutation present across much of Europe and, because many original Y139C foci were found in coastal areas, there is a suggestion that it was introduced as the result of trade and transportation. However, it can now occur almost anywhere in the UK.

Tyrosine139Phenylalanine (Y139F)

This is the third of the three severe mutations widespread in the UK, against which only the most potent anticoagulants brodifacoum, difethialone and flocoumafen are fully effective. This focus was first recorded in 1968, when it was already widespread in Kent and East Sussex. Apparently, there has been only limited spread and the mutation is now found in London and East Anglia, with a few outlier foci further away. It may not be a coincidence that this mutation is the most common in France and The Netherlands, given the long-established transport links across the English Channel with those countries.

Tyrosine139Serine (Y139S)

All SGARs retain some efficacy against Norway rats that possess this mutation, although vigilance is required when bromadiolone and difenacoum are used to ensure that treatments are fully effective. This focus was first discovered on the Anglo-Welsh border in 1959 and initially found widely over much of Wales. In spite of the fact that our new DNA studies show it only present in a small area around the towns of Oswestry and Welshpool it is unlikely that it had receded from a previously much wider scope. For decades it was apparently confined to the Welsh border but recently it has been found widely elsewhere in the north of England, especially in Lancashire, North Yorkshire and Durham. Once again, it is not known if these foci had lain long undetected or if they are only recently established.

Leucine128Glutamine (L128Q)

When discovered in the Scottish Central Belt in 1958, this was the world's first resistance focus. The L128Q mutation confers relatively low-level resistance against which all SGARs are effective. This mutation is now found more widely in the Scottish eastern lowlands and across much of northern England but has never been found south of a line joining the Humber and Mersey estuaries.

Hybrid resistance

In 2017, a rat tail tissue sample was received from near Edinburgh which carried two different genetical resistance mutations, L128Q and L120Q. This was the first record of 'hybrid resistance' (also called double resistance) in Norway rats in the UK, or anywhere else for that matter. No further incidence of hybrid resistance was recorded until 2020 when, in a small sample of only 54 tails, no fewer than eight animals were hybrid resistant.[56] There were four different combinations: L120Q/Y139C, L128Q/Y139C, L128Q/Y139S and, as mentioned before from Scotland, L128Q/L120Q. The apparent sudden proliferation of hybrid resistance and is its widespread nature (Figure 21) is remarkable, with hybrid resistant rats present from Scotland down to Dorset and East Sussex. In particular, the L128Q/Y139C hybrid is found across the north of England from the Humber estuary to Greater Manchester.

The reasons for this apparently sudden development remain unclear and, of course, hybrids may have gone unnoticed for some time. The obvious bio-geographical process that could explain this is the spread of individual resistance foci until their margins touch, the foci coalesce, and interbreeding occurs with consequent genetic recombination. Also unclear are the practical consequences for resistance

56 Buckle, A., Jones, C., Talavera, M. and Prescott, C. 2020. Anticoagulant Resistance in Rats and Mice in the UK – Summary Report with new data for 2019-20. University of Reading. Report Series VPU 20/002. 19 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 26.02.21.

management and public health. The most severe combination is probably L120Q/Y139C and this was found at three very widely dispersed locations, Dorset, Greater Manchester and East Sussex, probably the result of separate hybridisation events. So far, all the hybrid resistant animals have been heterozygous for both genetic mutations they possess and, therefore, may be no more resistant to anticoagulants than a homozygous L120Q animal. The practical impacts on pest management of animals that may be homozygous for more than one mutation are unknown. Laboratory breeding programmes and laboratory efficacy testing would be needed to elucidate this but many laboratory breeding stocks of resistant rats have recently been lost in the UK.

Susceptible Norway rats

Figure 21 also shows the locations of rat tissue samples from fully susceptible Norway rats. Although the incidence of susceptibility is very widespread, its frequency in resistance 'hot spots' is low, and this is especially the case in central southern England. Clearly, there are also significant zones of unknown resistance status, for example central and southern Midlands where we lack samples from several counties. The continued presence of susceptible rats at resistance foci is to be expected where a degree of heterozygosity remains, because when two heterozygous animals mate 25 % of offspring will be susceptible.

Resistance in the House mouse

Two resistance mutations are known to exist among house mice in the UK, Tyrosine139Cysteine (Y139C) and Leucine128Serine (L128S). A third house mouse resistance, found in Europe and known as the 'spretus group' strain, is not yet known in the UK.[57]

Our understanding of the practical effects of the two mutations differs. Much of the early SGAR development work was conducted using laboratory colonies of the Cambridge-resistant house mouse strain, named after the city where it was first found, and subsequently found to be L128S. Many published, conventional, cage and pen laboratory efficacy evaluations of brodifacoum, bromadiolone, difenacoum and flocoumafen are published. In contrast, the Reading-resistant house mouse strain, later found to be Y139C, has become the subject of extensive laboratory studies using mainly the blood clotting response test to derive resistance factors.[58] All the above-mentioned substances were tested in early field trials against house mice, prior to the development of DNA resistance testing. These showed that resistance to bromadiolone and difenacoum was present in house mouse populations at an early stage (i.e. 1981) and these substances are no longer recommended for use against them (Annex 8).[59]

The number of house mouse tissue samples received for DNA sequencing is limited and does not provide a detailed picture of the geographical distribution of the two mutations in the UK (Figure 22).[60] However, from the samples submitted it is clear that L128S is widely distributed across England, with Y139C more restricted to the south-east. There is also some hybrid resistance with animals carrying both mutations, especially in Greater London. So far, only animals heterozygous for each mutation have been found.

The incidence of resistance among house mouse populations in the UK is very high. A total of 97 samples have been sequenced and, of those, 87 (93.5 %) were found to be resistant. The recommendation of the RRAG is, therefore, that any house mouse infestation can be anticipated to contain resistant animals and should be treated accordingly.[61]

57 McGee, C.F., McGilloway, D.A. Buckle, A.P. 2020. Anticoagulant rodenticides and resistance development in rodent pest species - A comprehensive review. Journal of Stored Products Research 88: 101688.

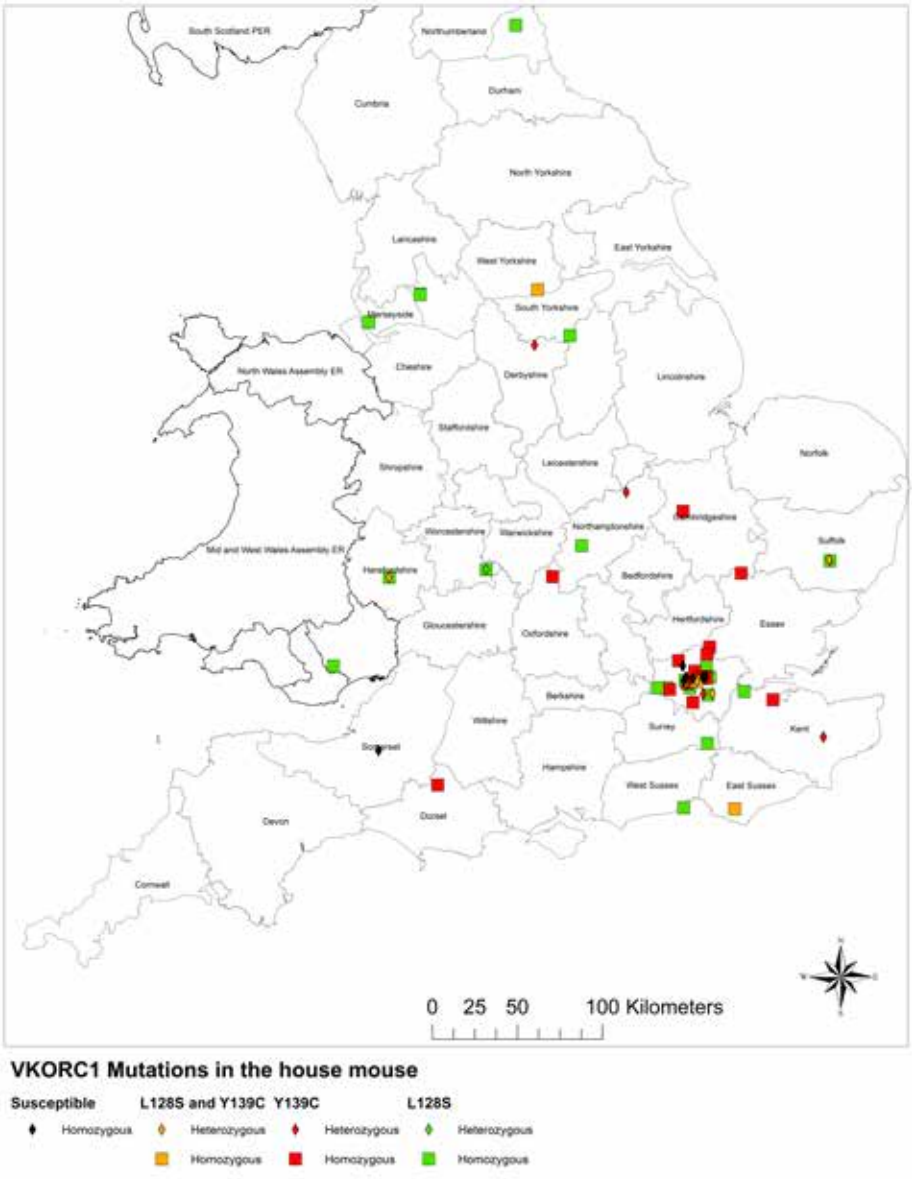
58 Prescott V, C, Buckle P, A, Hussain, I, Endepols, A. 2007. A standardised BCR resistance test for all anticoagulant rodenticides. International Journal of Pest Management 53: 265-272.

59 Rowe P, F, Plant J, C, Bradfield, A, 1981. Trials of the anticoagulant rodenticides bromadiolone and difenacoum against the house mouse (Mus musculus L.). Journal of Hygiene 87: 171-177.

60 Buckle, A., Jones, C., Talavera, M. and Prescott, C. 2020. Anticoagulant Resistance in Rats and Mice in the UK – Summary Report with new data for 2019-20. University of Reading. Report Series VPU 20/002. 19 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 26.02.21.

61 Buckle, A., Charlton, J., Meyer, A. and Prescott, C. 2021. RRAG House Mouse Resistance Guideline. Rodenticide Resistance Action Group, UK. 9 pp. Available from: https://bpca.org.uk/about/partners/rrag. Date accessed: 26.02.21.

Figure 22. Map showing all available data on the occurrence of resistance mutations among house mice in the UK.24



Anticoagulant resistance in other European Countries

HSE has requested a summary of resistance in other countries of the EU (Annex 2). The known occurrence of some of the major anticoagulant resistance mutations in Norway rats and house mice in European countries is shown in Table 11. Comprehensive surveys of both Norway rats and house mice have been conducted only in UK,[62] Ireland,[63] France[64] and Germany[65, 66] and, surprisingly given their geographical proximity, the situation is markedly different in each country.

62 Buckle, A., Jones, C., Talavera, M. and Prescott, C. 2020. Anticoagulant Resistance in Rats and Mice in the UK – Summary Report with new data for 2019-20. University of Reading. Report Series VPU 20/002. 19 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 26.02.21.

63 Mooney, J. Lynch, M.R., Prescott, C.V. et al. 2018. VKORC1 sequence variants associated with resistance to anticoagulant rodenticides in Irish populations of Rattus norvegicus and Mus musculus domesticus. Scientific Reports. 8: 4535. DOI:10.1038/s41598-018-22815-7

64 Grandemange, A., Lasseur, R., Longin-Sauvageon, C. et al. 2010. Distribution of VKORC1 single nucleotide polymorphism in wild Rattus norvegicus in France. Pest Management Science. 2010 Mar;66(3):270-6. doi: 10.1002/ps.1869.

65 Pelz, H-J., Rost, S. Müller, E. et al. 2011. Distribution and frequency of VKORC1 sequence variants conferring resistance to anticoagulants in Mus musculus.

66 Pelz, H-J. 2007. Spread of resistance to anticoagulant rodenticides in Germany. International Journal of Pest Management. 53: 299 – 302.

The occurrence of resistance in Norway rats in the UK has been described previously but it contrasts markedly with the situation in neighbouring Ireland. This is unexpected since the two countries are close neighbours and have shared intensive commercial and transportation links for many centuries. A recent survey of 65 Norway rat tissue samples, mainly from the eastern side of the island, showed a zero incidence of resistance. The absence of resistance in Ireland's Norway rats is difficult to explain and suggests little or no gene flow between the UK and Ireland. It might also suggest that any *de novo* mutation events leading to the development of resistance have been effectively suppressed, possibly because practitioners in Ireland have had available to them for Norway rat control the most effective resistance-breaking anticoagulants, brodifacoum, difethialone and flocoumafen; the latter substance being particularly widely used. The situation in France is more similar to that in the UK, with only the Y139S mutation absent in France among those present in the UK. This is in marked contrast to the position in Germany, where only the Y139C mutation has ever been found in Norway rats.[67]

Table 11. Occurrence of major resistance mutations in Norway rats and house mice in Europe. A number of other mutations which have been found only in one country or that are known to have little impact on the efficacy of rodenticides are omitted. * denotes the detected presence of the mutation. o denotes that a study has been conducted and the mutation was not found to be present.

	Norway rat					House Mouse		
Country	Y139C	L120Q	Y139F	Y139S	L128Q	L128S	Y139C	Spretus
UK	*	*	*	*	*	*	*	o
Ireland	o	o	o	o	o	*	*	o
France	*	*	*	o	*	*	*	*
Germany	*	o	o	o	o	*	*	*
Belgium	o	*	*	o	o			
Netherlands	*	*	*	o	o			
Denmark	*	o	o	o	o			
Italy						o	*	o
Switzerland						*	*	*
Serbia						*	*	o
Spain						o	o	*

The situation with resistance in house mice is more similar among the four countries. House mice in all of them possess both mutations, L128S and Y139C, which are present in the UK. There is, however, and third resistant strain present on the continent of Europe called the 'spretus group' resistance. This resistance is thought to have been caused by the introgression of a linked group of mutations supposedly after hybridisation with the Algerian mouse, *Mus spretus*.

Resistant management strategies

The 'golden rule' of resistance management is not to use substances where they are resisted. This rule was impossible to follow during the 30-year period when, uniquely in the UK, bromadiolone and difenacoum were the only SGAR substances permitted for use against Norway rat infestations in and around buildings. Fortunately, that situation is now changed and effective substances can be used to manage resistance in Norway rats and house mice. However, prolonged use of ineffective anticoagulants in resistance foci, particularly those of L120Q, Y139C and Y139F, will have contributed to the spread of resistance to the extent that we now see it across the UK (Figure 21).

KAP survey data provided some insights into the approach to resistance management taken by the three rodenticide user groups.

67 Pelz, H-J. 2007. Spread of resistance to anticoagulant rodenticides in Germany. International Journal of Pest Management. 53: 299 – 302.

At this point, there is no comprehensive strategy for anticoagulant resistance management in the UK, although product labels carry advice statements about resistance, such as:

- Do not use in areas where resistance to the active substance is suspected. Products shall not be used beyond 35 days without an evaluation of the state of the infestation and of the efficacy of the treatment.
- Do not rotate the use of different anticoagulants with comparable or weaker potency for resistance management purposes.
- For rotational use, consider using a non-anticoagulant rodenticide, if available, or a more potent anticoagulant.
- If after a treatment period of 35 days baits continue to be consumed and no decline in rodent activity is observed, the likely cause must be determined. Where other elements have been excluded, it is likely that there are resistant rodents so consider the use of a non-anticoagulant rodenticide, where available, or a more potent anticoagulant rodenticide. Also consider the use of traps as an alternative control measure.

Further advice is provided by the Rodenticide Resistance Action Group (RRAG) (https://bpca.org.uk/about/partners/rrag) and the Rodenticide Resistance Action Committee (RRAC) (https://rrac.info/). A difficulty when providing advice about resistance management is the complex nature of Norway rat resistance in the UK, with five mutations conferring different levels of resistance, and the highly fragmented geographical distribution of the different alleles. Some simplicity is offered by the scheme newly introduced by the RRAG and RRAC which allocates active substances into groupings according to their performances against anticoagulant resistance (Annex 8). It is to be hoped that wider knowledge and application of this simple framework, perhaps on product labels, our rapidly growing understanding of the distribution of resistance mutations, and availability of a resistance testing service free to practitioners operated by APHA (Figure 20), will lead to improved resistance management and reduced environmental contamination from the use of ineffective anticoagulants against resistant rodents.

3.7 Communications Work Group (Leader, Phil Christopher, Red Rock Services Ltd)

3.7.1 Purpose

The work on communication conducted by CRRU promotes all aspects of the stewardship regime, in particular a "*competent workforce*" and "*governance of the supply chain*". Press releases on CRRU monitoring programmes, for example, frequently generate considerable attention in publications serving the three CRRU user constituencies.

CRRU communications are intended to promote widespread awareness of the regime's principles and defined practices among users of stewardship-labelled rodenticides, people working in the supply chain, and stakeholders. As defined in original 2016 regime documentation, this is pursued by 'Dissemination of information from CRRU to external agencies about CRRU's co-ordination of the Stewardship Regime'.

Through its Communications function, CRRU is a provider of topical reader-centric editorial content for publication by organisations with memberships of, and/or outreach to, rodenticide users in professional pest control, farming and gamekeeping.

3.7.2 Content

In practice, this is enacted via CRRU-originated plain English narrative, distributed through multiple printed and online/digital information channels. These include independent publishers in farming, gamekeeping and professional pest control sectors; supply chain businesses and stakeholders; and relevant membership organisations (e.g. the four national farming unions, National Gamekeepers' Organisation, Scottish Gamekeepers' Association, Game and Wildlife Conservation Trust, Agriculture & Horticulture Development Board, British Pest Control Association, National Pest Technicians' Association) and CRRU Task Force members.

Recurring imperatives are disciplined supply chain governance; consistently responsible rodenticide

application (when such applications are justified) by a competent workforce; and that lower rodenticide residues in sentinel non-target species are the acid test of success.

The following themes are included wherever relevant in communication materials:

- Users and suppliers of stewardship-labelled rodenticides have personal and professional responsibility for consistent and constant best practice, as defined in regime documentation.
- Assessment of the stewardship regime's impact by GOG will include levels of rodenticide residues found in sentinel non-target species.
- If this assessment finds insufficient beneficial impact, future changes in rodenticide availability and application may be introduced.

3.7.3 Outputs

Each annual report since 2016 includes a list of that year's distributed items. Table 12 shows those produced since the 2019 report up to December 2020.

Table 12. Outputs from CRRU Communications during 2020.

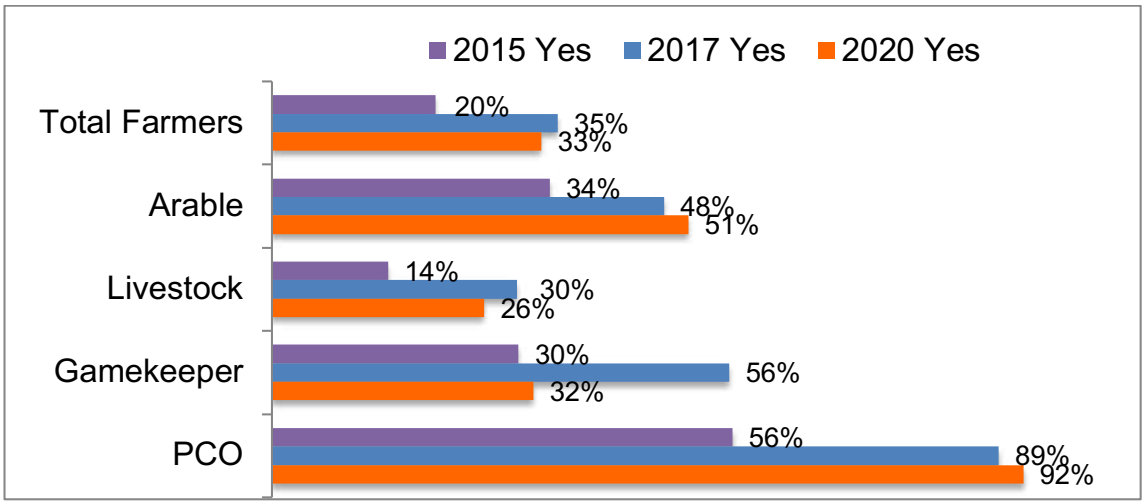
Timing	Title	Main message(s)
Dec 2019	Call to all for 'no-excuses' professionalism in rodenticide practice	Detectable anticoagulant rodenticide residues in 87 % of barn owls are highlighted by a new report... this is clearly unacceptable and demands consistent professionalism among all pest controllers, farmers and gamekeepers...
Feb 2020	Super-rat and mouse study appeals for tail tip samples	An appeal for farmers, gamekeepers and pest control technicians to collect tail samples from freshly killed rats and mice has been issued... to be analysed for rodenticide resistance genes...
Mar 2020	Rodenticide regime calls for no exceptions, bad apples or excuses	The first two years with all stewardship elements in place have seen "stubbornly intractable" rodenticide residues in barn owls... For success, "conscientious compliance" with stewardship principles by all rodenticide users is essential...
Apr 2020	Report-a-concern appeal for bad practice or illegal supply alerts	Commissioned by Pest Control News: At PPC Live in March, rogue practice and non-compliant product supply were frequent talking points with visitors... vigilant pest controllers can report concerns confidentially at thinkwildlife.org/stewardship-regime/report-a-concern/...
May 2020	Remote point of sale audits boost rodenticide review readiness	Amid COVID-19 disruption, users and sellers of professional-use-only rodenticides are reminded that formal review of the UK Rodenticide Stewardship Regime is imminent... the review may well have a significant bearing on future rodenticide availability and use.
Jun 2020	Rodenticide resistance testing halted by lab closure	Testing for rodenticide resistance has been suspended due to coronavirus-related closure of the laboratory where DNA analysis was being done... a new laboratory contractor is being sought.
Jul 2020	Free rodenticide resistance testing service resumes	Free DNA testing for rodenticide resistance in rats and mice has resumed... CRRU calls for tail samples of freshly killed rats and mice from pest controllers, farmers and gamekeepers...
Aug 2020	Call to all for professionalism in rodenticide practice	Commissioned by Pig World magazine: Detectable rodenticide residues in 87 % of barn owls have been highlighted by independent surveillance... this is clearly unacceptable and demands consistent professionalism from farmers, gamekeepers and pest controllers alike.

Sep 2020	Rodenticide alert prompts reminder of permitted target species	Users of rodenticides covered by the UK stewardship regime are reminded that no product is authorised for control of wood mice (Apodemus sylvaticus)... arises from an alert to the Campaign for Responsible Rodenticide Use complaints procedure.
Sep 2020	Additional biosecurity for rat and mouse tail samples	Additional biosecurity measures when sending rat and mouse tail samples for rodenticide resistance testing have been introduced... new packaging guidance... two main changes are to double-bag samples and include UN3373 label...
Oct 2020	Surprise resistance surveillance results prompt wake-up call	The spread of rats against which some rodenticides don't work has taken a "surprising and troubling" turn... 2019-2020 survey results show not only that 74 % of rat analysed carried a resistance gene but, of those studied, one-in-five had two different genes in widespread locations...
Oct 2020	Horrific roll call of human disease organisms worth shouting about	Commissioned by PEST magazine: Research has identified a number of human disease organisms carried by rats in a public park... Of rat bodies analysed, 88 % carried at least two such pathogens, and another 10 % carried one.
Nov 2020	Cholecalciferol rodenticides covered by stewardship regime	Rodenticides based on cholecalciferol are subject to conditions of the UK Rodenticide Stewardship Regime... prompted by new products coming to the UK market... pest controllers, farmers or gamekeepers considering the use of cholecalciferol should first read the product label carefully.
Dec 2020	New barn owl study finds improved breeding performance	Barn owl breeding success last year (2019) was four percent higher, at 2.66 fledglings per nest, than the preceding four-year average... On same basis, a 17 % increase was also found in the percentage of nests that produced fledglings.... Barn Owl Monitoring Scheme...
		-ends-

3.7.4 Key indicators from Knowledge, Attitudes and Practice Surveys and Policy Adjustments for 2021

In all three rodenticide user groups, overall awareness of the UK Rodenticide Stewardship regime saw marked increases from 2015 to 2017: Pest controllers, 56 % to 89 %; gamekeepers, 30 % to 50 %; and farmers, 20 % to 35 %. From 2017 to 2020 among pest controllers, awareness has held at 90 %+; in gamekeepers, receded to 32 %; and in farmers, held at 33 % (Figure 23).

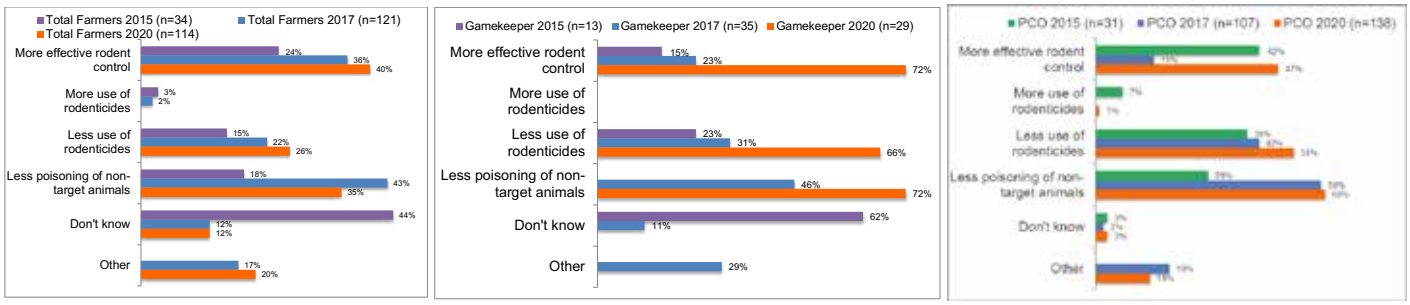
Figure 23. Responses to question F6. Have you heard of the: UK Rodenticide Stewardship Regime? Y/N. (Base: All respondents.)



Quoting from the KAP report: “The main thrust of understanding for people that know the campaign is clearly about better rodent control, using less rodenticide, whilst minimising the impact on non-targets.”

In all three user groups among those aware of the stewardship regime, there were substantial improvements 2015-2020 in knowledge about what stewardship is seeking to achieve (Figure 24).

Figure 24. KAP responses to question F7. What do you think that it is trying to achieve? (Base: all respondents in each main sector.)

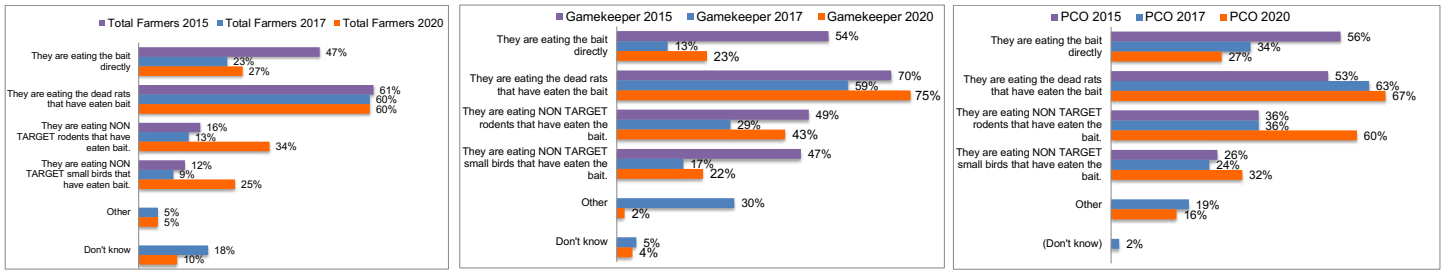


Among all participants, knowledge changed significantly for the better about:

(i) the main reasons for rodenticide presence in non-target wildlife (Figure 25).

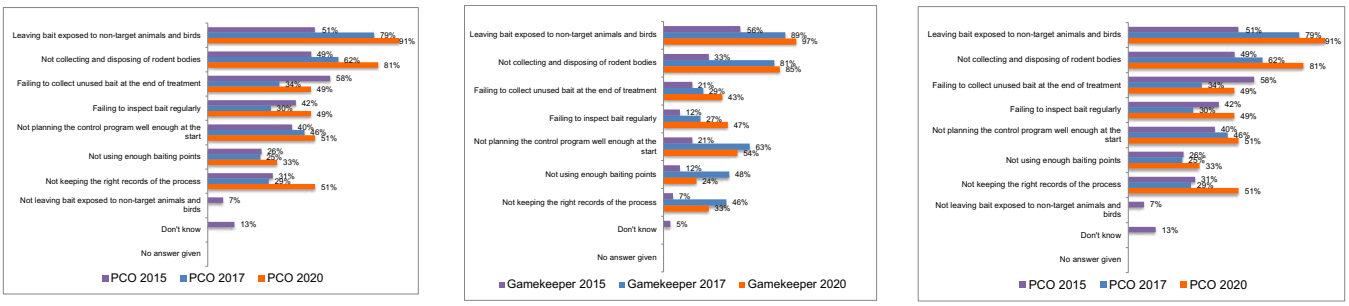
(ii) negative practices leading to the greatest risk to people and the environment (Figure 26).

Figure 25. E3. What, in your view are the main reasons why rodenticides are found in non-target wildlife (unprompted)? (Base: All respondents in each main sector.)



Looking beyond awareness and knowledge to rodenticide use in practice, a sentinel benchmark in the 2020 KAP report is this finding about the use of permanent baiting (Figure 17). Clearly, behavioural change like this comes about due to multi-factorial influences, including training and CPD, product labelling and point-of-sale guidance, as well as publications in all three user sectors generated by the CRRU communications programme.

Figure 26. F2. I’m going to read out a list of negative practices when using rodenticides, which of these do you think poses the greatest risk to people and the environment? (Base: All respondents in each main sector.)



3.7.5 Action in the Next Stages of the Regime

Guided by the KAP 2020 findings, a number of additions (with a corresponding budget increase) have been introduced to the 2021 communications programme. These include:

1. Consultation with gamekeepers' membership bodies (the main communications channel to this sector) about the 2017 to 2020 findings and plan with them a renewed impetus via their membership publications and, if available, their use of social media.

2. In farming, a commitment has been agreed recently with the publisher of Farmers Guardian (the leading weekly across all aspects of agriculture, farming and the countryside) for more frequent placements of stewardship editorial. The same publisher has monthly arable and dairy farming titles, which are also involved in this plan.

3. Also in farming, renewed consultation with membership organisations and farm assurance schemes to plan a renewed impetus.

4. In pest control, whose publishers give us consistently good support, maintenance of previous activity levels can be expected to keep stewardship awareness at 90 % and above.

5. An additional dimension across all three sectors is the @thinkwildlife presence on Twitter, with the same to follow imminently on Facebook. These two social media are regarded as the most effective by far for outreach to our target audience demographics.

4. CONCLUSIONS

4.1 General

The UK Rodenticide Stewardship Regime, developed by CRRU UK and initiated in 2016, has radically transformed the way that professional rodenticide products are purchased and applied by practitioners across a broad spectrum of user sectors, including farmers, gamekeepers and professional pest control technicians.

The regime has been under implementation for a period of five years. Previous sections of this report have described the operational framework, individual components and monitoring processes of the regime. The regime is evaluated by GOG according to the delivery of three key benefits: '*supply chain governance*', '*competent workforce*' and '*monitoring compliance*'.[68] The theme throughout this report has been the delivery of these benefits by the work of those engaged in implementing the stewardship programme, and foregoing sections provide detail of actions taken and results achieved. There is also explanation of forthcoming developments to the regime that will provide additional impacts in many aspects of stewardship, in particular in the important areas of best practice and training and certification, with an emphasis on agriculture.

Much has been achieved and the massive challenge of changing the behaviour of tens of thousands of rodenticide users, across three quite different user groups, has been firmly grasped but not yet completed. The CRRU Directors and CRRU Task Force will go into the next phase of the stewardship regime with determination to maintain the advances that have been achieved and to improve in areas where this is required.

In spite of the successful delivery of all aspects of the regime as it was envisaged at the outset,[69] the failure of the regime so far to deliver the limited objective of a reduction in the liver residues in barn owls must be addressed. An initial consideration was the inability of CRRU to apply all aspects of stewardship from its outset in 2016, due to the complexity of the exercise and high numbers of rodenticide users involved. Indeed, all the required elements did not fall into place until 2018. Therefore, any assessment of the success of the regime based on birds that were found dead in 2019 may be regarded somewhat premature.

Causing change to user behaviour and then finding the results of these changes in statistically significant differences in barn owl liver residues was acknowledged at the outset to be difficult.[70] The 'power analysis' study sought to determine the duration of regime implementation that would be required to result in significant differences in barn owl liver residues depending on sample size. The work showed that a sample size of 100 was close to optimal, because large increases in sample size did not bring about significant increases in statistical precision. With that sample size, it was found that for summed low (i.e. <100 ng/g w.w.) SGAR residues a 10 % change in concentration would be detected with statistical significance after three to nine years (upper and lower 95 % confidence intervals). A statistically significant 20 % change in residue concentration would be expected to be found in one to three years. For high summed SGAR residues (i.e. > ng/g w.w.) the 10 % change values are nine to 25 years, 20 % values three to seven years, and the 50 % values both one year. For detecting statistically significant change in the ratio of the numbers of owls with low and high residues, 10 % change would require seven to 88 years and 20 % change would require two to five years. All that can be drawn from this is, apparently, insufficient time has elapsed since the introduction of the regime to bring about changes of the magnitudes postulated in any of the metrics. Indeed, for some of them significant change is not yet anticipated.

4.2 Delivery of Stewardship against the Key Principles

The following sections will draw conclusions about the delivery and achievements of the regime during 2016-2020 in line with the 'Principles and Monitoring Requirements' set out by the GOG.[71]

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68 HSE. 2020. Report on the Rodenticides Stewardship Regime, Assessment of Implementation – January 2020. An information paper by the Rodenticides Stewardship Regime Government Oversight Group. 11 pp. Available at: https://www.hse.gov.uk/biocides/rodenticides.htm. Date accessed: 01.03.21.

69 HSE. 2015. UK Anticoagulant Rodenticide Product Authorisation and the CRRU Stewardship Scheme. Information document, January 2015. Health and Safety Executive. 12 pp.

70 Shore, R.F., Henrys, P.A. & Walker, L.A. 2014. Power analysis of liver second generation anticoagulant rodenticide (SGAR) residue data in barn owls from Britain: a Predatory Bird Monitoring Scheme (PBMS) report. CEH contract report to the Health & Safety Executive. 45pp. https://wiki.ceh.ac.uk/x/DAIDC.

71 HSE. 2021. Rodenticides. UK rodenticide stewardship regimes. Regime principles. Available at: https://www.hse.gov.

a. Use of Integrated Pest Management, including the use of rodenticides, involving a hierarchy of risk controls for rodents

The primary purpose of the regime was to apply controls to the purchase and use of rodenticides. Considerable effort has gone into those aspects. However, the use of Integrated Pest Management (IPM) is a well-established concept that is understood by the majority of those who undertake rodent pest management. The principle of IPM is introduced in the CRRU UK Code of Best Practice (COBP) and the many different available elements of an IPM approach are described, together with their strengths and weaknesses. Knowledge of IPM is one of the necessary training elements required in all CRRU-approved training courses.[72] Through the relationship with the COBP, the IPM concept is also integral to the enhanced farm assurance scheme standards and must be mentioned in them explicitly for the standard to be CRRU-approved. The understanding and application of IPM is examined in a section of the Knowledge, Attitudes and Practice (KAP) survey and its results show, across all user groups, a willingness to employ a wider range of management interventions.[73]

The concept of risk hierarchy, when introduced to users by the regime, was much less well-understood. It is a more complex concept, with several aspects that require detailed explanation. Rodenticide users were uncertain what risks were referred to, whether just environmental or a broader range such as risks to the applicator, bystanders and domestic animals; and if the latter which might take precedence. When only environmental risk is mentioned, many practitioners are quick to mention these other risks. Furthermore, there was uncertainty as to whether interventions needed to be applied sequentially, along the spectrum of ascending risk. After a question about the risk hierarchy concept was introduced into the KAP survey in 2017, it became apparent that a high proportion of respondents have heard of the term and understand the relationship between risk and treatment efficacy. The forthcoming revision of the COBP will seek to clarify any uncertainties about the interpretation of the risk hierarchy concept and its practical application.

b. Responsible use of rodenticides, when demonstrated they are needed, because of their potential threat to humans, animal health and the environment

CRRU was established to foster responsible rodenticide use in the UK some time prior to the requirement for stewardship. It is well-recognised by those who regulate rodenticides that, although some non-chemical methods are efficient preventative measures, they are inadequate to provide effective control of existing substantial rodent infestations.[74]

An important word in this heading is 'potential'. These potential threats to humans, animal health and the environment are well-know because of the nature of rodenticides as necessarily potent vertebrate poisons. A wide range of effective risk mitigation measures is applied and these have the desirable effect to reduce risk in most cases to an acceptable minimum. However, available measures are, apparently, either ineffective in preventing wildlife exposure or their application so far has been insufficiently comprehensive.[75]

It is the task of the regime to promote best practice in the effective application of all available and appropriate risk mitigation measures and, once again, the data obtained from the KAP surveys have shown important advances made in this respect.

c) Applicability to all suppliers, handlers and professional users of rodenticides approved under stewardship to address these risks

The decision by HSE to make the provision of stewardship, meeting the high level principles, a condition of authorisation resulted in all UK authorisation-holders choosing to join the CRRU stewardship regime. This, in turn, resulted in the requirement that a condition of authorisation for proof of competence was passed down

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uk/biocides/rodenticides.htm. Date accessed: 28.02.21.

72 CRRU. 2015. Proposals for Development of Courses in Rodent Pest Management and Associated Approved Certifications. Campaign for Responsible Rodenticide Use. April 2015. 4 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 28.02.21.

73 Research Engine. 2020. Rodenticide Knowledge, Attitudes and Practices: Survey: August 2020 Re-run. 35-37 Ludgate Hill, London. 171 pp.

74 HSE. 2015. UK Anticoagulant Rodenticide Product Authorisation and the CRRU Stewardship Scheme. Information document, January 2015. Health and Safety Executive. 12 pp.

75 Buckle, A. and Prescott, C. 2018. Anticoagulants and Risk Mitigation. Chapter 12 in Anticoagulant Rodenticides and Wildlife. (van den Brink et al., eds). Springer International Publishing AG, Switzerland. pp. 319-355.

the supply chain to any outlet selling professional rodenticides. This results in a requirement to show proof of competence at every transaction and therefore makes this stewardship condition applicable to all suppliers and to all purchasers. BASIS (Registration) Limited conducts an independent audit of compliance (see section 4.5). Through the acquisition of proof of competence certification, based on a broad range of CRRU best practice guidance, stewardship seeks to instil understanding of risks and all appropriate risk mitigation measures among all professional rodenticide users.

A further important factor in promoting effective risk mitigation is the more detailed requirements for its application that are set out on product labels, including the necessity to follow CRRU guidance.

d. The need for the regime to be robust, effective and workable, while remaining as simple as possible

It is the position of CRRU that all elements of the regime are robust, effective and workable. All aspects of the regime are under the direction of the CRRU UK Task Force, which comprises representatives from all user constituencies. Plans are discussed and refined within the CRRU TF. Issues that may impact certain users are raised by their representatives and resolved at an early stage.

Although delivery of stewardship is done through the six Work Groups, much of the regime relies on close co-operation between them. An example is proof of competence certification. This is determined for some by a training certificate, provided through a framework established by the Training and Certification Work Group, and for others by membership of a farm assurance scheme and compliance with its standards. The latter are overseen by the Best Practice Work Group. Both routes to certification are validated at point-of-sale by procedures designed by the Point-of-Sale Work Group. This cross-work group collaboration is generated by frequent meetings, and other informal interactions, and by the goodwill that exists among work group members who are competitors in other circumstances.

Where elements of the regime have not yet met a requirement to be robust, effective and workable they have been modified. However, effective implementation of the regime is entirely dependent on clear communication with a very large user base and, once decisions are made and implemented, they are difficult to reverse.

e. The need for the regime to cover the whole life-cycle of the rodenticide products: manufacture, supply chain, end-use, disposal and environmental fate

Participation of a broad range of stakeholders within the CRRU TF facilitates coverage of the manufacture, supply chain and end use components of this principle (Annex 4). Indeed, stewardship requirements fall upon authorisation-holders, the entire supply chain and down to users in all professional user groups. The foregoing sections of this report demonstrate that the supply chain, from manufacturer to user, is fully engaged in stewardship.

The disposal of rodent bodies and spent bait has, until recently, lacked definitive advice and often relied on statements such as "Dispose of dead rodents in accordance with local requirements", with an additional requirement to refer to other agencies for advice. Advice on burial previously published by the Environment Agency has been withdrawn and apparently not replaced. Similar guidance from the Scottish Environment Protection Agency[76] and the Northern Ireland Environment Agency[77] is extant but overly proscriptive and unlikely to promote safe disposal. However, most rodenticide labels now offer more detailed instructions and leave users in little doubt about safe disposal routes, although sources of further information are also offered as follows: "*Poisoned rodents may be disposed of by the waste producer at an incinerator or landfill permitted to accept that type of waste, or collected by a registered waste carrier and taken for disposal at a suitably permitted site. For further information on disposal contact the Environment Agency (http://www.environment-agency.gov.uk/) or SEPA (http://www.sepa.org.uk/). Rodents can be disease carriers. Do not touch dead rodents with bare hands, use gloves or use tools such as tongs when disposing of them.*"

76 SEPA. 2009. SEPA Position Statement - Burial of small quantities of rodent carcasses poisoned on farmland. Scottish Environment Protection Agency. 2 pp. Available at: https://www.sepa.org.uk/media/156483/wst_ps_burial_poisoned_rodents_farmland.pdf. Date accessed: 01.03.21.

77 DAERA. 2018. Regulatory Position Statement The Burial of Rodents Poisoned on Farmland - February 2017. Department of Agriculture, Environment and Rural Affairs, Northern Ireland. 1 pp. Available at: https://www.daera-ni.gov.uk/sites/default/files/publications/daera/RPS%20-%20Burial%20of%20rodents%20poisoned%20on%20farmland.pdf. Date accessed: 01.02.21.

The requirement for stewardship to cover 'environmental fate' is a very broad one. Most environmental concerns about anticoagulant rodenticides centre on exposure of vertebrate wildlife.[78] Therefore, the stewardship regime has focussed upon this aspect of the environmental fate of rodenticides. Required mitigation measures on product labels and published in guidance documents and codes of best practice also focus on the prevention of exposure to vertebrate non-target animals through primary and secondary exposure routes. It is, therefore, this risk that the main stewardship messages to users are designed to affect. The effectiveness of this approach is demonstrated by the metrics obtained by the KAP survey.[79] However, CRRU is aware of recent research in Germany that has demonstrated exposure of aquatic systems to SGARs probably (but not certainly) originating from sewer baiting programmes.[80] The National Pest Advisory Panel of the Chartered Institute of Environmental Health has issued a new guideline for those who conduct sewer baiting programmes in the UK to support a new phrase to be found on the labels of products authorised for application in sewers, as follows "*Baits must be applied in a way so that they do not come into contact with water and are not washed away*".[81] It is anticipated that the implementation of this label requirement, and wider application of best practice in sewer baiting, will result in a reduction in SGAR emissions to the aquatic environment.

f. The enabling of good practice in the control of rodent populations, as part of an Integrated Pest Management system, while minimising resistance build-up and secondary poisoning in non-target species.

The first phrases of this principle have been addressed above (sections a. and b.).

The most important long-term influence on the development of anticoagulant resistance in UK Norway rats was the policy to prevent the use of effective active substances against spreading rat infestations carrying the L120Q, Y139C and Y139F mutations. This policy was driven by a concern for the possible environmental effects of the use of brodifacoum, difethialone and flocoumafen.[82] That was supported, among other things, by reference to non-target impact field trials conducted to such questionable standards of risk mitigation that similar applications would now be illegal (and probably were when performed in the late-1980s).[83] Also, and unfortunately, the policy was not supported by any form of resistance monitoring, either by industry or government, for more than 20 years. The current situation is therefore probably irredeemable.[84] The situation with house mice is quite different and the ubiquitous nature of the phenomenon of anticoagulant resistance in that species is probably due to its high level of intrinsic natural resistance.[85]

There is an obvious requirement for improved resistance management for both species. This would have important advantages for public health and the environment: 1) rodent infestations are controlled more quickly and efficiently, 2) the spread and increases in severity of resistance are prevented, 3) unnecessary and often high emissions of ineffective rodenticide active substances to the environment are prevented. It is unlikely that resistance foci can now be removed, or even reduced significantly in size. However, an achievable objective is to reduce substantially the number of resistant infestations that are treated with substances to which they are resistant. New label phrases on professional rodenticides advocate effective measures to support resistance management and these must be advocated and implemented. Resistance testing, supported by a new

78 Smith, R.H. and Shore, R.F. 2015. Environmental Impacts of Rodenticides. Chapter 16 in Rodent Pests and their Control. CAB International, Wallingford, Oxon. pp 330-345.

79 Research Engine. 2020. Rodenticide Knowledge, Attitudes and Practices: Survey: August 2020 Re-run. 35-37 Ludgate Hill, London. 171 pp.

80 Regnery, J., Friesen, A., Geduhn, A. et al. 2018. Rating the risks of anticoagulant rodenticides in the aquatic environment: a review. Environmental Chemistry Letters https://doi.org/10.1007/s10311-018-0788-6.

81 CIEH. 2021. National Sewer Baiting Protocol. Best Practice & Guidance Document, Chartered Institute of Environmental Health. January 2021. 24 pages. Available at: https://www.urbanpestsbook.com/download/national-sewer-baiting-protocol-best-practice-guidance-document/. Date accessed: 02.03.21.

82 HSE. 2012b. Environmental Risk Mitigation Measures for Second Generation Anticoagulant Rodenticides Proposed by the UK. Health and Safety Executive. 30 pp.

83 Butt, P. 2012. A review of field trials to assess the primary and secondary poisoning hazards to non-target species involving the use of brodifacoum and flocoumafen to control Norway rats on farms. Produced for the National Pest Advisory Panel, Chartered Institute of Environmental Health, Natural England. July 2012. 20 pp.

84 Buckle, A., Jones, C., Talavera, M. and Prescott, C. 2020. Anticoagulant Resistance in Rats and Mice in the UK – Summary Report with new data for 2019-20. University of Reading. Report Series VPU 20/002. 19 pp. Available at: https://www.thinkwildlife.org/downloads/. Date accessed: 26.02.21.

85 McGee, C.F., McGilloway, D.A. Buckle, A.P. 2020. Anticoagulant rodenticides and resistance development in rodent pest species - A comprehensive review. Journal of Stored Products Research 88: 101688.

collaboration between CRRU and the Animal and Plant Health Agency (APHA), will provide fine-detail mapping of rat and mouse resistant foci to allow effective rodenticides to be used where they are needed. This service will also permit practitioners to obtain 'real-time' information on the resistance status of infestations where they work (Figure 27).

Figure 27. Screen-shot from the interactive resistance mapping tool provided by the Rodenticide Resistance Action Committee based on information from the University of Reading (https://rrac.info/). Users can modify search parameters based on rodent species, resistance mutations and their own location. Information provided shows, within a radius determined by the user, which resistance mutations are present. Exact locations are disguised so that precise identification of infested sites is impossible.

Clear messages on correct active substances to use against different UK resistance mutations are needed. A new system of active substance classification for resistance management efficacy has been developed and will be widely advocated (Annex 8). Consideration should be given to the use of this simple classification system on product labels.

Specifically for house mice, an anachronism has arisen as a result of rules required by European Commission biocide policy. Resistance to bromadiolone and difenacoum among UK house mouse populations means that these two active substances are not recommended for use against them.[86] An important procedure for the effective management of mouse infestations is indoor permanent baiting, and this is considered to carry limited environmental risk. However, only the two resisted SGARs are permitted for use in permanent baiting in the UK. This clearly promotes the use of resisted substances against resistant infestations. Consideration is required for indoor-only authorisation of some effective SGAR products for use in permanent baiting against house mice, where this is required for public health.

The rapid and thorough implementation of these measures will have a significant impact on improved public health, reduced resistance incidence and lower rodenticide environmental emissions.

CRRU is unequivocal in that all users of professional rodenticides should apply all appropriate and available risk mitigation measures to prevent, as far as possible, any emissions to the environment, in particular to avoid primary and secondary poisoning of non-target animals. Ever since CRRU's inception in 2004, much of its work has been aimed at this objective. Available information on environmental risks for the SGARs, was summarised by HSE prior to the initiation of stewardship, mainly relying on laboratory evaluation and the outcomes of hypothetical risk assessments.[87]

86 Buckle, A., Charlton, J., Meyer, A. and Prescott, C. 2021. RRAG House Mouse Resistance Guideline. Rodenticide Resistance Action Group, UK. 9 pp. Available at: https://bpca.org.uk/about/partners/rrag. Date accessed: 02.03.21.

87 HSE. 2012a. Consideration of the environmental risk from the use of brodifacoum, flocoumafen, difethialone, difenacoum and bromadiolone. Health and Safety Executive. 23 pp.

Several studies conducted in the UK provide information on practical environmental impacts of rodenticides. One of these, the Wildlife Incident Investigation Scheme (WIIS), is the most comprehensive and long-running government post-registration surveillance scheme for pesticides and biocides world-wide, running from 1985 to date. Incidents are reported by members of the public and, where the involvement of a pesticide or rodenticide is suspected, investigated by government scientists. Annual Reports were provided until 2006 and, thereafter, results were made available online (https://www.hse.gov.uk/pesticides/reducing-environmental-impact/wildlife/summary-of-quarterly-reports.pdf). No review is available of WIIS data since that published in 2012.[88] Another was undertaken by the University of Reading and covered the years of the scheme 1993 to 2011.[89] Both reviews showed that WIIS incidents involving vertebrate casualties caused by rodenticides when used according to the label recommendations, and therefore with the application of appropriate risk mitigation, are exceedingly rare. This supports the approach to stewardship adopted by CRRU to promote best practice. Examination of more up-to-date WIIS online records supports the same conclusion. Some concern has been expressed about WIIS data regarding under-reporting,[86] and there is no doubt that this must occur. However, for the scheme to be funded by government over a continuous period of 35 years, it may be assumed that some value is placed on data the WIIS provides. Furthermore, aimed as it is at the discovery of wildlife casualties as a result of both primary and secondary poisoning we must also assume that, with such a long span of reliable government data, any severe acute non-target impacts of rodenticides would have become apparent. Further and more detailed analysis of WIIS data would be of undoubted value.

A significant concern is the widespread distribution of rodenticide residues in UK wildlife.[90] With extensive contamination comes a justifiable concern about low-level residues and possible undetected so-called sub-lethal or chronic effects. An analogy has been drawn with the adverse impacts of the organochlorine (OC) insecticides on predatory bird populations, and indeed the chemical similarities of these substances with SGARs, being lipophilic and persistent in biological systems, are apparent. However, some important differences exist. Unlike OC insecticides, whose initial effects went largely unsuspected and unreported, surveys of the residues of SGARs in raptors have been conducted in the UK since their introduction to the market.[91] This is thanks to the pioneering work on barn owls by C. R. Shawyer[92] and the long-term studies conducted by UKCEH.[93] Furthermore, an increasing understanding of the effects of OC insecticides on predatory birds was accompanied by a growing understanding of their contributory effects on very serious population declines seen in exposed species, such as the sparrowhawk (*Accipiter nisus*).[94] In marked contrast to this situation, populations of some of the most exposed species of raptors in the UK, for example barn owl, buzzard and red kite, have been increasing dramatically, both in terms of population size and geographical distribution; this during a period of extensive SGAR use and exposure (Annex 9 and 10).

The reasons for these increases are different in each case. Barn owl populations were limited by a shortage of suitable nesting sites.[95] When this became apparent, numerous projects were operated to provide artificial nest boxes and now these are occupied by barn owls across the UK.[96] It is also likely that agricultural set-aside schemes, supported by government policy, and other changes in land use have provided increased habitats for the small rodents that barn owls prey upon. For buzzards, the massive and intensive persecution the species endured for more than a century finally abated and permitted populations rapidly to expand into areas from which they

88 HSE. 2012b. Environmental Risk Mitigation Measures for Second Generation Anticoagulant Rodenticides Proposed by the UK. Health and Safety Executive. 30 pp.

89 Buckle, A. and Prescott, C. 2012. Monitoring Impacts of Vertebrate Pesticides in the UK: 1993 to 2007. Extended Abstract. 6th SETAC World Congress/SETAC Europe 22nd Annual Meeting, Estrel Hotel, 20-24 May 2012. Berlin. 2 pp. Available at: https://www.setac.org/store/viewproduct.aspx?id=1509762. Date accessed: 02.03.21.

90 Smith, R.H. and Shore, R.F. 2015. Environmental Impacts of Rodenticides. Chapter 16 in Rodent Pests and their Control. CAB International, Wallingford, Oxon. pp 330-345.

91 Shore, R.F., Pereira, M.G., Potter, E.D. and Walker, L.A. 2015. Monitoring Rodenticide Residues in Wildlife. Chapter 17 in Rodent Pests and their Control. CAB International, Wallingford, Oxon. pp 346-365.

92 Shawyer, C.R. 1987. The Barn Owl in the British Isles. The Hawk and Owl Trust, London. 113 pp.

93 Shore, R.F., Henrys, P.A. & Walker, L.A. 2014. Power analysis of liver second generation anticoagulant rodenticide (SGAR) residue data in barn owls from Britain: a Predatory Bird Monitoring Scheme (PBMS) report. CEH contract report to the Health & Safety Executive. 45pp. https://wiki.ceh.ac.uk/x/DAIDC.

94 Newton, I. 2017. Farming and Birds. The New Naturalist Library, Volume 135. HarperCollins, London. 628pp.

95 Shawyer, C.R. 2019. Barn Owls in 2019. Available at: https://www.bto.org/news-events/news/2018- 04/barn-owls-2018-update-colin-shawyer. Date accessed: 03.09.2019.

96 Barn Owl Trust. 2020. State of the UK Barn Owl population – 2019. Available at: https://www.barnowltrust.org.uk/wp-content/uploads/State-of-the-UK-Barn-Owl-Population-2019-V2.pdf. Date accessed: 25.06.2020.

had been extirpated. The recovery of the rabbit (*Oryctolagus cuniculus*) populations, a preferred prey of buzzards, may also have been contributory.[97] Finally, re-introduction of captive-bred red kites in programmes all over the country has led to the massive growth in populations of this species.[98]

Although substantial population increases of some raptor populations which carry residues of rodenticides cannot be denied (Annex 9 and 10), it might be that the very steep growth curves that we see in the red kite, for example, might have been even more accelerated without the influence of some unknown, sub-lethal effects of rodenticide residues. This would be very difficult either to prove or to disprove using scientific study. What can be said with confidence, however, is that we know of no exposed population that has declined because of exposure to rodenticides.[99]

In spite of the foregoing, it is important to reiterate that stewardship is designed to ensure that users of professional rodenticides apply all necessary risk mitigation to avoid so far as possible poisoning of non-target animals. All casualties must be avoided if possible and all residues are unwanted and largely unnecessary. The work of the stewardship regime will continue to deliver these requirements.

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97 Walls, s. and Kenward, R. 2020. The Common Buzzard. Poyser Monographs. T & AD Poyser Ltd (A & C Black), London. 304 pp.

98 Carter, I. 2001. The Red Kite. Arlequin Press, Chelmsford. 187 pp.

99 Smith, R.H. and Shore, R.F. 2015. Environmental Impacts of Rodenticides. Chapter 16 in Rodent Pests and their Control. CAB International, Wallingford, Oxon. pp 330-345.

NB. Throughout this document, where the acronym CRRU is used for the Campaign for Responsible Rodenticide Use, it refers to CRRU UK.

Annex 1. Participants in the CRRU UK Task Force at 01.03.21.

		Affiliation
1	Ton Abel (D)	Zapi
2	Helen Ainsworth (D)	BASF
3	Steve Bailey (SR)	Barrettine
4	Claire Barber (SR)	AHDB
5	Damien Barrau (D)	LiphaTech
6	Rupert Broome (D&WGL)	Killgerm
7	Alan Buckle (D&TA)	Chair
8	Sarah Bull (WGL)	BASF
9	Karen Byram (Sec./Trea.)	CRRU Treasurer
10	Chris Calow (SR)	RSPB
11	Javier Calzada (I)	Quimunsa
12	Steve Campbell (I)	SASA
13	Gareth Capel-Williams (D)	PelGar
14	Nigel Cheeseright (D)	Rentokil
15	Paul Charlson (SR)	NPAP
16	Phil Christopher (WGL)	Red Rock
17	Mark Clook (TA)	HSE
18	Gabrielle Cor (I)	LiphaTech
19	Matthew Davies (WGL)	Killgerm
20	Patricia Erwin (I)	UFU
21	Glynn Evans (SR)	BASC
22	Kristina Graner (D)	Babolna
23	Bernard Griffiths (I)	FUW
24	Jonathan Hall (SR)	NFUS
25	John Hope (SR)	NPTA
26	Anthony Hopkins (SR)	NFU
27	Jon Howells (D)	Pelsis
28	Stephen Jacob (I)	BASIS
29	Lisa Jaggar	CRRU Secretary
30	Maja Juvan (I)	Unichem
31	Dawn Kirby (I)	Rentokil-Initial
32	Zita Kövér (I)	Babolna
33	Daniel Lightfoot (D)	Syngenta
34	Alan Morris (D)	Bayer
35	Richard Moseley (WGL)	Bayer
36	Charles Nodder (I)	NGO
37	Tim Peeling (I)	Pelsis
38	Colin Prescott (TA)	Reading Uni.
38	Charles Philips (SR)	Barrettine
40	Igor Rajic (I)	Unichem
41	Colin Shawyer (TA)	WCP
42	Michael Sims (D)	Bell Labs
43	Roger Simpson (D)	LODI UK
44	Lindsay Smith (I)	BASIS
45	Maria Eugenia Sisniega (D)	Quimunsa
46	Matija Sorc (I)	Unichem
47	Dee Ward-Thompson (WGL)	BPCA
48	Maja Vasiljević (I)	Unichem
50	Lee Walker (TA)	UKCEH
51	Liz Webb (I)	Lodi
Key:		Names in bold are nominated CRRU UK TF members Names in italics are on the email distribution list for information D = Director, SR = Sector Representative, TA = Technical Advisor, WGL = Work Group Leader,

Annex 2. Overview of CRRU evaluation data to be provided to the GOG.

Required data		Data to be provided
1	Environmental Impacts (Monitoring Compliance)	1. CEH annual survey of residues in livers of 100 barn owls
		2. Annual survey of barn owl breeding performance
		3. Annual review of WIIS incidents*
2	Whether the rodenticides are effective (Competent Workforce)	1. Annual report of training uptake and award of certification/ qualification by CRRU-approved awarding bodies
		2. Annual report of number of members of CRRU-approved farm assurance schemes
		3. Provision of up to date, relevant best practice guidance documents
		4. Promotion of regime objectives and raising awareness by stakeholder organisations
3	Resistance monitoring (Competent Workforce)	1. Annual report of status of resistance monitoring in UK and elsewhere in EU
4	Awareness using the Knowledge, Attitude and Practice (KAP) survey (Competent Workforce/Monitoring Compliance)	1. KAP survey baseline study (published)
		2. Repeated KAP surveys in 2017 and 2019
5	Point of sale information (Supply Chain Governance)	1. Output from the Point of Sale Audit. Interim results provided by June 2018.
6	Training (Competent Workforce)	(see point 2 above)
* Government is currently examining the feasibility of using data on several species from a variety of sources (PBMS and WIIS) as a further qualitative, or possibly quantitative, assessment of changes in the environmental impact of anticoagulant rodenticides.		

Annex 3. Objectives of the CRRU UK Point-of-Sale Work Group

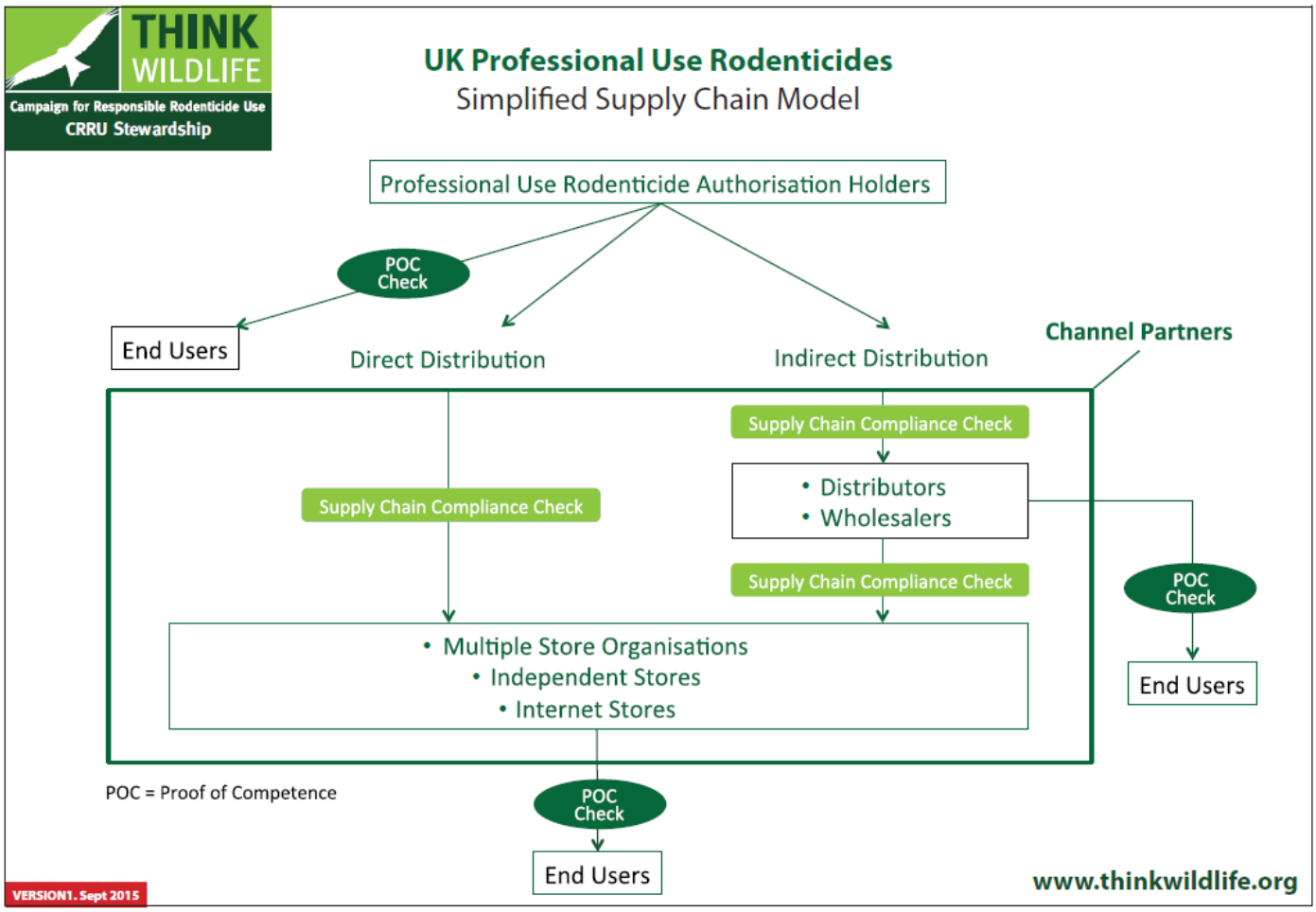
"The Point-of-Sale Work Group will lead actions to implement the requirement for proof of professional competence at point of sale which is to appear on labels as follows:

- To be used only by professional users holding certification demonstrating compliance with UK rodenticide stewardship regime requirements.
- ead the label before use. Using this product in a manner that is inconsistent with the label may be an offence. Refer to the CRRU UK Code of Best Practice (or equivalent) for guidance.
- When this product is supplied to a user for the control of rodents, it shall only be supplied to a professional user holding certification demonstrating compliance with UK rodenticide stewardship regime requirements.

It will work with all members of the distribution network, in all user sectors, to ensure that necessary mechanisms are operated at point-of-sale so that appropriate qualifications are held by all professional SGAR users. The issue of the purchase of products by company central purchasing functions, and their subsequent use by qualified field operatives, will be addressed.

The WG will, as far as possible, develop equivalent mechanisms for demonstration of qualification for internet purchase transactions for professional users of SGARs."

Annex 4. Simplified Supply Chain



Annex 5. Simplified Supply Chain

DOCUMENT 1: FOR SUPPLY CHAIN PARTNERS

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UK Rodenticide Stewardship Regime

Supply Chain Compliance Declaration

declares it will only supply Rodenticides with Stewardship conditions to End Users or Supply Chain Partners as follows :

End Users

- End Users who hold certification demonstrating that they have been trained in the UK Rodenticide Stewardship Regime as approved by the CRRU Training & Certification Work Group (see CRRU website for current list), and as set out in the guidance "CRRU Approved Certification Declaration" (see "Document 2 : For Certificated Users") or :

- Employees of businesses which are current members of a CRRU aligned Farm Assurance Scheme (see CRRU website for current list), and as set out in the guidance "CRRU Aligned Farm Assurance Scheme Declaration" (see "Document 3 : For Farm Assurance Schemes")

Supply Chain Partners

- Supply chain partners who also complete an equivalent "Supply Chain Compliance Declaration", ie "Document 1 : For Supply Chain Partners".

acknowledge that failure to adhere to the requirements above, and failure to demonstrate compliance when reasonably required, may result in the withdrawal of supply of Rodenticide with products Stewardship conditions.

Company: _____

Signed: _____

Print Name: _____

Position: _____

Date: _____

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Annex 6. Point-of-Sale Declaration Templates

DOCUMENT 2: FOR CERTIFICATED USERS

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UK Rodenticide Stewardship Regime

CRRU Approved Certification Declaration

I as senior person in authority at
declare that only Certificated User(s) will use the Rodenticide products with Stewardship conditions.

Listed below are the designated delivery addresses for and the name of at least one Certificated User at each designated delivery address and I have provided copies of the Proof of Competence (PoC) Certificate(s) to the Supplier Company.

	Address	Certificated User(s) Name
Registered / Invoice Address		
Additional Delivery Address		
Additional Delivery Address		
Additional Delivery Address		

Should require to collect Rodenticide with Stewardship conditions from the Supplier Company or to deliver to a new additional delivery address, then I give permission for the below named person(s) to purchase/collect with the understanding that only the Certificated User(s) will use the Rodenticide with Stewardship conditions.

Named Purchaser / Collector

I also recognise that it is the responsibility of to immediately notify the Supplier Company of any changes to named Certificated Users, eg if they leave the company

Signed: _____

Print Name: _____

Position: _____

Date: _____

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DOCUMENT 3: FOR FARM ASSURANCE SCHEMES

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Campaign for Responsible Rodenticide Use

UK Rodenticide Stewardship Regime

CRRU Aligned Farm Assurance Scheme Declaration

I as the named Farm Assurance Scheme contact at
declare that all Rodenticides with Stewardship conditions will only be applied by myself and my staff in full compliance with the current Farm Assurance Scheme Standards relating to the control of rodents.

Name & Address of Farm	Farm Assurance Scheme & Membership Number

I hereby give permission for the below named person(s) to purchase/collect only on behalf of the above Farm Assured business, and on the explicit understanding that these products will only be used at the above business while it remains a member of a CRRU Aligned Farm Assurance Scheme .

Named Purchaser / Collector

I also recognise that it is the responsibility of to immediately notify the supplier company of any changes to its Farm Assurance Scheme Membership status.

Signed: _____

Print Name: _____

Position: _____

Date: _____

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Annex 7. Point-of-Sale Question & Answer Guidance

CRRU Point of Sale Work Group

Proof of Competence Documents : Question & Answer

General

Q 1	Why are these documents necessary?
A 1	Effective proof of competence controls at the point of sale is a central requirement from the UK Regulatory Authority, CRD/HSE, for the implementation of a Stewardship Regime for Professional Use Rodenticides. Without these controls in place, Stewardship, and hence the authorisation, sale and use of these products, could not proceed.

Q 2	When do these documents come into force?
A 2	Professional Use Rodenticides which have Stewardship conditions attached to them will start to become available for sale to the market from 1st April 2016 onwards, and point of sale checks & controls must be in place by then for these products.

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Annex 8. Rodenticide Resistance Action Group: Classification of Active Substances for Resistance Management

The use of ONLY effective active substances against resistant infestations of house mice and Norway rats has important benefits:

(1) Rodent infestations are controlled quickly and efficiently.

(2) The spread and increases in severity of resistance are prevented.

(3) Unnecessary and often high emissions to the environment of rodenticide active substance are avoided.

The classification of rodenticide active substances that are authorised in the UK given below will help users to decide which active substances to use when they encounter resistant rodent infestations.

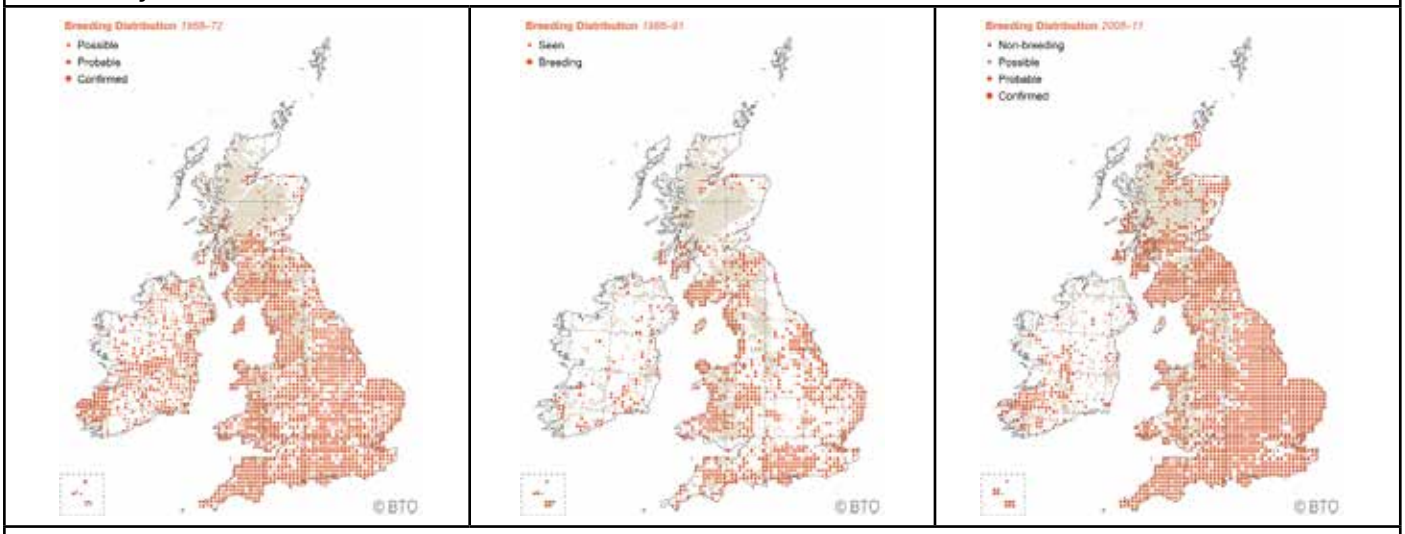
Group		Sub-Group		Compounds	Recommended uses
1	Anticoagu-lants	A	FGAR	warfarin, coumatetralyl	For use against Norway rats when there is no resistance to anticoagulants.
		B	SGAR	bromadiolone, difenacoum	For use against Norway rats when there is no resistance to anticoagulants, and against rats carrying mutations (L128Q and Y139S).
		C	SGAR	brodifacoum, difethialone, flocoumafen	For use against house mice, and all strains of resistant rats (L128Q, Y139S, L120Q, Y139C, Y139F).
2	Calciferols	-	-	cholecalciferol	Recommended against house mice, and all strains of rats.
3	Narcotics	-	-	alphachloralose	Recommended for control of all strains of house mouse.
4	Gases	-	-	carbon dioxide, aluminium phosphide, hydrogen cyanide	Specific applications by trained professionals only. Species restrictions may apply.

General guidance:

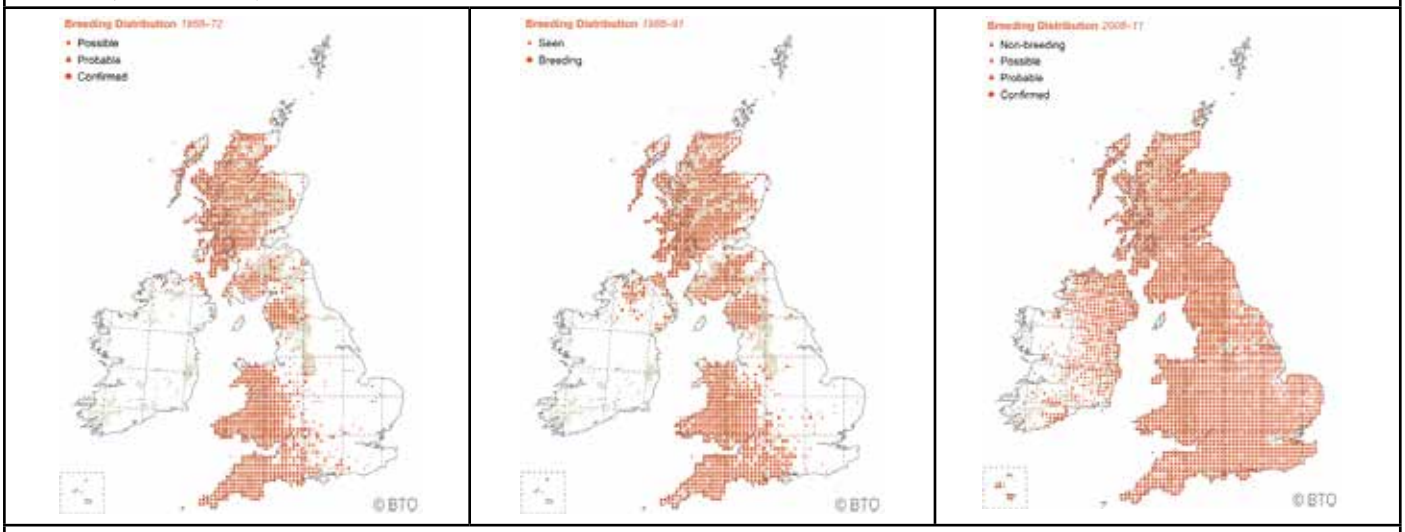
- Always know the name of the active substance you are using and follow the instructions on the product label.
- The use of full-strength baits (i.e. containing 50 ppm if it is a Group 1B and 1C active ingredient) will ensure that treatments are conducted quickly and efficiently, and the risk of partial treatment failure will not increase the severity of resistance and promote its spread.

Annex 9. The geographical distribution of populations of barn owl, buzzard and red kite as shown by three consecutive surveys by the British Trust for Ornithology. Source: *https://www.bto.org/our-science/publications/birdtrends/2020*

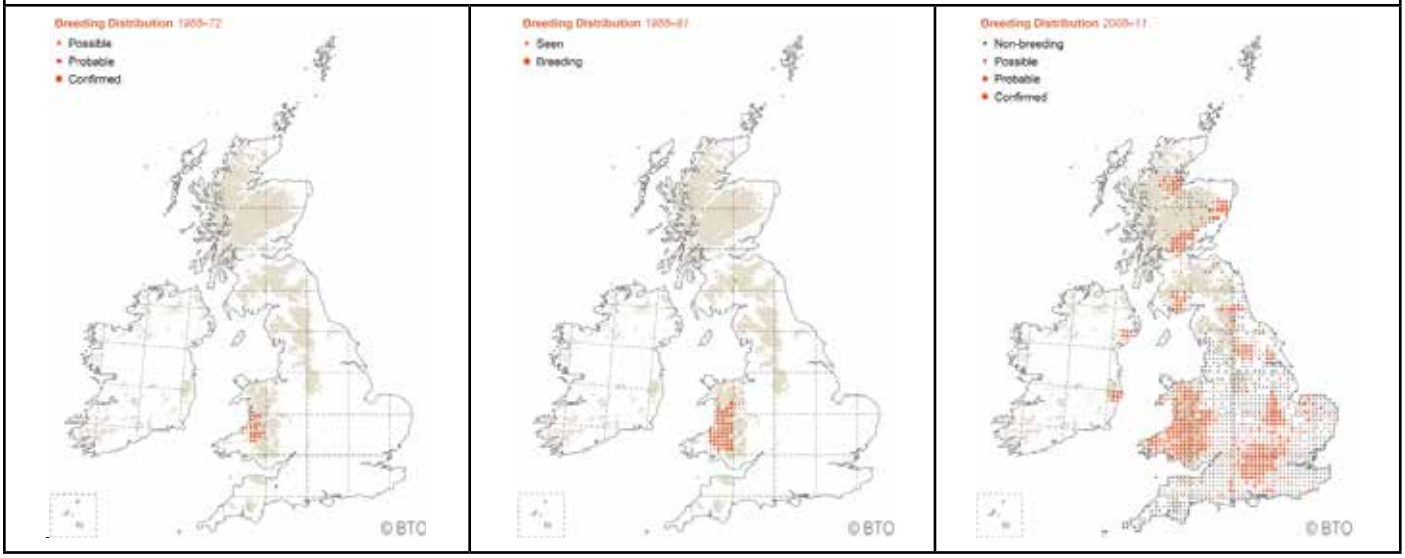
Barn owl (Tyto alba)



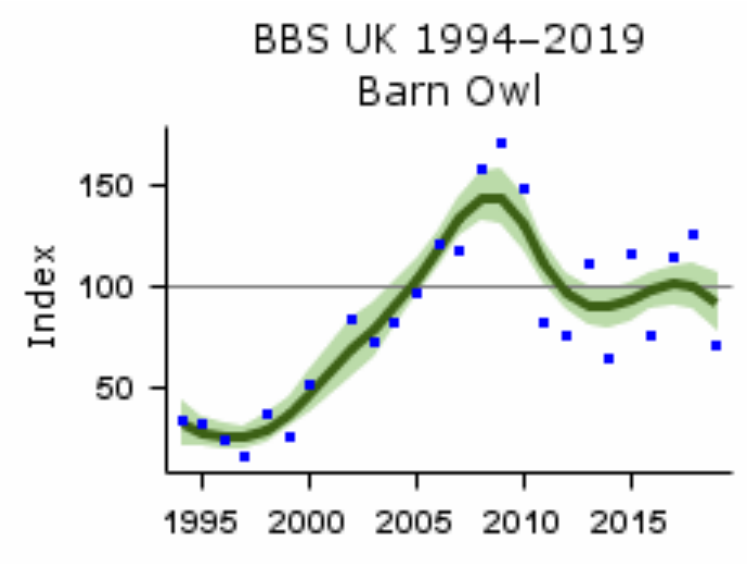
Buzzard (Buteo buteo)

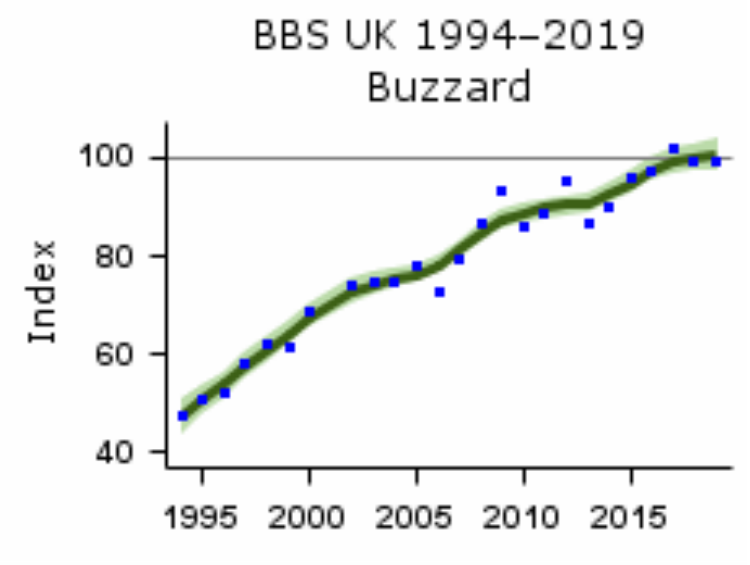


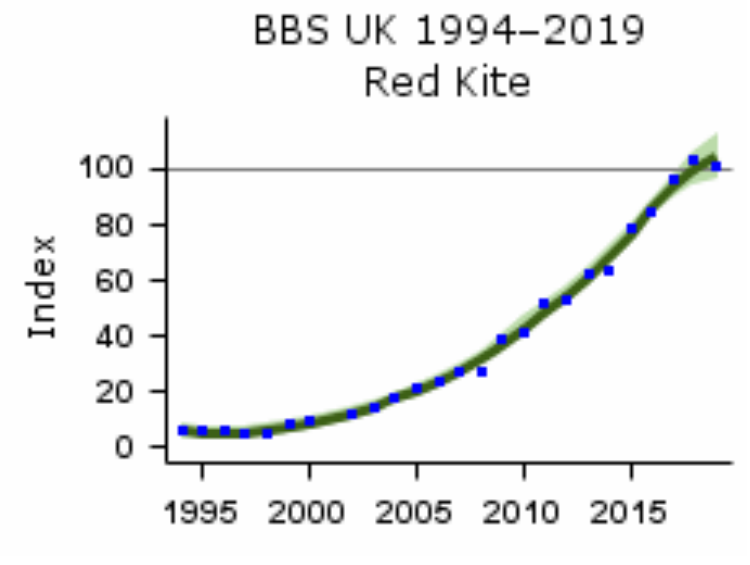
Red kite (Milvus milvus)



Annex 10. UK Population trends for barn owl, buzzard and red kite, 1994-2019. It is acknowledged that the Breeding Bird Survey (BBS), operated by the British Trust for Ornithology through a network of volunteers, is not optimal for recording population trends in a nocturnal species. However, procedures are repeated in the same manner year to year and, therefore, records of relative abundance should be reasonably reliable.







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