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Evidence Project Final Report

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Project identification

1. Defra Project code: SE4302

2. Project title:
   Development of a generic approach to evaluate animal health surveillance systems in Great Britain.

3. Contractor organisation(s):
   Animal Health and Veterinary Laboratories Agency (AHVLA)
   Royal Veterinary College (RVC)

4. Total Defra project costs (agreed fixed price): £ 525,779

5. Project: start date 01/07/2010
   end date 30/06/2012

6. It is Defra's intention to publish this form.

   Please confirm your agreement to do so..... **YES** ☐ **NO X**

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Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

Government invests in animal health surveillance in the UK to mitigate the impact of animal disease on public health, animal welfare and the rural economy by provision of evidence to optimise decisions on disease control. The purpose of this project was to develop an evaluation framework for animal health surveillance systems in Great Britain so that their current effectiveness and efficiency can be assessed. A second objective was to identify and apply a range of additional tools to enhance surveillance systems. The outputs from this project are highly relevant to current initiatives to re-structure animal health surveillance in GB following the Report from the Surveillance Advisory Group[1] the Kinnaird Review in Scotland[2] and the ongoing surveillance reviews by livestock sector.

This project delivered a SuRveillance EVALuation framework (**SERVAL**), which is intended to enable a comparable evaluation of different surveillance systems as well as reproducible assessments of a particular system were it to be repeated by different competent evaluators. The development of SERVAL was based on a **systematic review** of the current literature on the evaluation of veterinary or medical surveillance systems. This review revealed that there was no standardised approach or evidence of widely-accepted best practice. Surveillance objectives were seldom stated and economic analysis was rarely undertaken. Based on these findings, and informed by a technical workshop with international surveillance experts, SERVAL was developed. There are five sections to the framework that are presented in a tabular format: 1. Define the scope of the evaluation, 2. Characterise the surveillance system to be evaluated, 3. Design the evaluation, 4. Conduct the evaluation, 5. Reporting and communication.

The SERVAL framework was tested by applying it to case studies in existing surveillance programmes in GB. The case studies encompassed a range of surveillance objectives, including: (i) surveillance to demonstrate freedom from infection (a serological survey for *Brucella melitensis* in sheep and goats); (ii) surveillance for endemic disease (pre-movement testing for tuberculosis in cattle); and (iii) surveillance for early detection of an exotic disease (classical swine fever in pigs). The case studies confirmed that the framework was robust, complete and user-friendly and could provide comprehensive qualitative evaluations of current surveillance systems with recommendations for obtaining additional information to complete more detailed evaluations of specific attributes.

One of the main advantages of the SERVAL framework is the flexibility resulting from the ability to select the evaluation attributes included in an evaluation depending on the purpose of the evaluation and the objectives of the surveillance system being evaluated. In addition the framework could be adapted to assist with the design of proposed new surveillance models or the implementation of changes to existing systems.

In addition, the process for developing **Performance indicators** (PIs) was reviewed. These PIs can complement evaluation by enabling continuous monitoring of surveillance systems to assure quality and ensure that performance is sustained. The process of developing PIs was illustrated by the identification and application of 8 performance indicators in a case study of surveillance for *Brucella melitensis*.

A high-level **inventory** of the existing surveillance programme in GB was produced and used to map resource use and identify potential synergies between current livestock health surveillance activities. A comprehensive database was developed to capture activity-specific information. It was also noted that information on the economics of individual programmes was scarce and difficult to access. The results suggested that livestock health surveillance funding in GB was mostly associated with cattle, probably reflecting current strategic priorities. Of the diseases under surveillance the majority of money spent was on tuberculosis in cattle. The private sector was found to contribute around 10% of the surveillance budget across all species although there was marked variation between species.

The project also investigated the gaps in available evidence on the coverage of and stakeholder perceptions and attitudes to surveillance based an analysis of eighteen sources of available/emerging evidence. The highest ranking gap was: Investigation of **drivers and barriers for stakeholders** deciding to

[1] SAG (2012). Surveillance Advisory Group final report. http://vla.defra.gov.uk/reports/docs/rep_assp_report1211.pdf

[2] Scottish Government (2011). The review of veterinary surveillance. http://www.scotland.gov.uk/Publications/2011/11/09091744/0

use AHVLA/SAC diagnostic laboratories. The next most important gaps were scored as: the structure, sequence of events, pathways and players for effective surveillance; consequences of observed differences in coverage; actual and/or predicted coverage of diagnostic laboratory submissions and analyses of alternative data sources.

Farmers' and veterinarians' **perception of surveillance** and their roles/responsibilities for monitoring and managing animal health was elicited in the English sheep industry. Information was collected through short, structured interviews. Questions concerned how farmers and vets monitor and manage the health of their flocks; their perception of surveillance at the national level and their own role in and benefit from it. This task identified the importance of collecting data directly from sheep farmers and the requirement for identifying incentives and maintaining confidentiality.

The use of **capture-Recapture** (CRC) analysis to assess surveillance coverage was investigated by calculating the proportion of affected holdings that submitted samples to AHVLA regional laboratories (RL). The statistical method was enhanced to take into account covariate information and thus deliver a more precise estimate, which may improve sensitivity by enabling detection of smaller changes in reported incidence of syndromic animal health events. The application of sophisticated analysis enables greater value to be derived from surveillance data and identifying opportunities for the use of these methods should be included within an evaluation exercise.

In **conclusion**, this project demonstrated the feasibility and benefit of structured evaluation and performance monitoring of both existing and future surveillance programmes and developed tools to facilitate this. Areas identified for future work include

- Application of the SERVAL framework to address real evaluation questions about existing and proposed surveillance systems with provision of feedback to the framework development team to allow further development of the framework
- Application of the process for the development of PIs to both existing and new surveillance systems
- Clarification of costs and therefore the value of surveillance which is currently difficult to assess due to lack of data. This would allow both a better assessment of resource allocation within the current surveillance programme and facilitate economic analysis of individual surveillance components using the SERVAL framework
- Validation of the CRC method for assessing coverage and inclusion of this and other analytical methods in surveillance evaluations
- Further application of socio-economic methods to understand the barriers and incentives for farmer and veterinary practitioner participation in surveillance

Surveillance methods are evolving. Programme protocols should therefore be regularly reviewed and adapted to provide a cost-effective service for the farming industry and the public. The tools developed in this project will facilitate these reviews. More information on the project's results is available in the report and related scientific publications.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
   - the objectives as set out in the contract;
   - the extent to which the objectives set out in the contract have been met;
   - details of methods used and the results obtained, including statistical analysis (if appropriate);
   - a discussion of the results and their reliability;
   - the main implications of the findings;
   - possible future work; and
   - any action resulting from the research (e.g. IP, Knowledge Exchange).

Introduction

The principal aim of the project was to develop and apply a novel evaluation framework for animal health surveillance systems and their components. This project also sought to examine and develop methods to enhance veterinary surveillance. For clarity, project tasks have been grouped into these two streams: Section A describes the development and application of the framework and section B presents work on enhancing animal health surveillance. The final section (C) of this report provides discussion on the key outputs of the project, dissemination activities and the potential for future work. Table 1 outlines where each of the proposal objectives have been addressed in the final report:

Table 1 Objectives of project SE4302, how they were met by individual tasks and the layout of the final report

Objective	***Where addressed***
1) To review existing evaluation frameworks used in public health and related fields	Literature review (WP1), presented in Section A and Annex A.
2) To develop a framework for the evaluation of surveillance systems that defines criteria to assess the value of the system and identifies surveillance performance indicators	Tasks 2.1, 2.2 and 2.3 (Section A) describe the development of the evaluation framework. Work on the development of performance indicators was conducted in task 2.4 (Section B)
3) To describe existing surveillance systems and map the resource relationships between their different components	Task 3.1 (Section B) mapped and explored the distribution of resources for animal health surveillance in GB.
4) To investigate and explain sources of heterogeneity in surveillance processes across GB that may impact on the interpretation and use of surveillance data for decision-making	Task 3.2 (Section B, Annex H) summarised recent work to highlight gaps in our understanding of surveillance. Task 3.3 (Section B) examined the participation of English sheep farmers and veterinarians in surveillance.
5) To develop specific, novel evaluation tools	Task 2.3 (Section A) – contributing to the framework – developed guidance for evaluating surveillance. Tasks 2.4 and 3.4 (Section B) developed methods for analysing and evaluating surveillance systems and their outputs.
6) To apply the framework from (2) in 3-5 case studies to existing surveillance activities to assess the validity and practicality of the approach	Work package 4 (Section A and Annex D), applied the evaluation framework to 3 case studies.
7) To make recommendations for routine evaluation of surveillance systems	The final section (C) of this report discusses the key findings, implications and future applications of this work.

Our work focussed upon Great Britain, but we believe our results will also be of interest to the wider international community. It is expected that outputs from this project will guide animal health policy makers on decisions regarding investments to improve and refine veterinary surveillance systems in Great Britain.

Section A: Development of an evaluation framework for animal health surveillance

Work package 1: Systematic Review

A range of evaluation frameworks are available with a special focus on surveillance programmes. RVC with input from AHVLA conducted a systematic review of the literature on evaluation of surveillance systems in public and animal health contexts as well as the use of performance indicators (PIs) in the context of surveillance.

The aim of this systematic review was to identify and examine existing frameworks for surveillance evaluation in animal health, public health and allied disciplines, and to discover which techniques are currently being used for evaluation of these surveillance systems across the globe and to assess the strengths and weaknesses of the evaluation techniques that are currently being used.

The outcome of this work package was a comprehensive review of available frameworks and current

evaluation methods, which was published as a scientific paper in a peer-reviewed journal (Annex A, Drewe *et al.* 2012). This review provided the basis for developing an evaluation framework tailored to the needs of this project.

The abstract of this review appears below:

Disease surveillance programmes ought to be evaluated regularly to ensure they provide valuable information in an efficient manner. Evaluation of human and animal health surveillance programmes around the world is currently not standardized and therefore inconsistent. The aim of this systematic review was to review surveillance system attributes and the methods used for their assessment, together with the strengths and weaknesses of existing frameworks for evaluating surveillance in animal health, public health and allied disciplines. Information from 99 articles describing the evaluation of 101 surveillance systems was examined. A wide range of approaches for assessing 23 different system attributes was identified although most evaluations addressed only one or two attributes and comprehensive evaluations were uncommon. A distinct lack of standardization exists regarding the best approach for evaluating surveillance systems in order to facilitate decision-making in the fields of animal or public health. Surveillance objectives were often not stated in the articles reviewed and so the reasons for choosing certain attributes for assessment were not always apparent. This has the potential to introduce misleading results in surveillance evaluation. Due to the wide range of system attributes that may be assessed, methods should be explored which collapse these down into a small number of grouped characteristics by focusing on the relationships between attributes and their links to the objectives of the surveillance system and the evaluation. A generic and comprehensive evaluation framework could then be developed consisting of a limited number of common attributes together with several sets of secondary attributes which could be selected depending on the disease or range of diseases under surveillance and the purpose of the surveillance. Economic evaluation should be an integral part of the surveillance evaluation process. This would provide a significant benefit to decision-makers who often need to make choices based on limited or diminishing resources.

Tasks 2.1, 2.2, 2.3 and Work Package 4: Development, consultation and trialling of the framework

A three-stage process was used to develop the SERVAL (SuRveillance EVALuation) framework: (i) technical workshop of international surveillance experts (Task 2.1, Annex B); (ii) consultation process involving providers and user of surveillance and evaluation data (Task 2.2, Annex C); and (iii) application of the new framework to selected animal health surveillance components as case studies (Work Package 4, Annex D). Task 2.3 (Additional evaluation tools) was used to develop brief guidance notes on the assessment of each of the 22 attributes identified and defined during the development of the SERVAL framework. The framework was revised at each step of the way by the project team based on experiences and feedback from those involved in each stage of development.

Technical workshop (Annex B)

A two-day technical workshop was held in January 2011, attended by 16 surveillance experts from seven European countries. The experts were selected based on their expertise in the design and implementation of surveillance programmes as well as their background in evaluation. Experts represented professionals from academia, government and the industry. The workshop objective was to gather and discuss ideas for the development of a generic and comprehensive framework and to debate and agree the relevance of criteria and performance indicators that could be used to assess the performance of surveillance systems in GB. During the workshop, the following definition of a generic framework was adopted: "A structured approach to the evaluation of animal health surveillance systems which can be adapted for use in different situations in GB." It was agreed that whilst this framework would be developed for use in GB, it should aspire to be applicable to other EU members, and potentially worldwide use.

During the workshop, the importance of clarifying the goal of an evaluation before embarking was emphasised, to enable the evaluation purpose to drive the evaluation process. The definitions of criterion, attribute, threshold, performance measure and target were discussed in detail but with little

agreement between delegates. There was reasonable agreement that the focus of the framework should be on attributes. In this context "attributes" is taken to refer to the many quantifiable characteristics of surveillance systems that can be used to evaluate a system: examples would be representativeness, sensitivity, and timeliness. A take-home message from delegates' experiences of surveillance evaluation was that evaluations must be simple to conduct, ideally low-cost, have clear start and end points, and a clear idea of what will be done with outputs, if they are to be useful. Further, the framework should include an identification of the degree of uncertainty related to its findings. By the end of the workshop, two draft evaluation frameworks had been developed by two working groups and the two versions were later consolidated into a single framework by the project team. The framework was described in a detailed protocol consisting of five sections accompanied by a detailed table of attributes and their definitions.

Consultation process (Annex C)

The aim of the consultation was to draw opinion on the clarity, practicality and perceived utility of the draft evaluation framework and then to use this feedback to make improvements. Fourteen surveillance experts (three providers of surveillance data, five direct users of surveillance and evaluation information, and six members of the scientific community with special interest or experience in surveillance evaluation) were asked for their opinions on the draft evaluation framework using structured interviews by telephone or in face-to-face interviews.

The general view was that the SERVAL framework is easy to follow and mostly clear. The framework was considered to be thorough but rather long. Most people thought that an evaluation described by the draft framework was likely to be practically achievable within reasonable resource and time constraints. The outputs of the evaluation process were easily envisaged. Several people commented that the economic evaluation section was likely to prove the most difficult part to complete. All those consulted agreed that the outputs would be of high value to those funding, designing and implementing animal health surveillance. Overall, people were very positive about the framework and thought it was definitely needed. A series of 36 revisions was identified and these changes were subsequently made to the draft framework as a result of this consultation.

Two experts emphasised that in order to be useful, the output of an evaluation must lead to an action or a conscious decision otherwise the evaluation is a waste of resources. We have designed SERVAL to make it straightforward for the outputs to lead to actions, which may include influencing funders' and policymakers' decisions. To assist this, SERVAL incorporates a traffic-light system whereby each attribute is allocated a colour to indicate how well the system is performing: green (excellent or very good); amber (good, though with some room for improvement); and red (poor, in need of attention). Recommendations can then be developed to improve whichever areas are considered to be most important based on the specified objectives of that evaluation. The framework prompts users to identify relevant ways for follow-up by the funder and to measure what effect the evaluation had, for example by re-evaluating the surveillance system after a defined period of time.

The SERVAL framework has been designed to be thorough without unnecessarily long and so evaluations are straightforward and efficient, aided by the prompting notes. During the consultation no-one identified any aspects of the framework as redundant, although most conceded that some parts might be more important than others according to the situation in which it is applied. Crucially, SERVAL allows the evaluation to be scaled according to needs and resources so that even a small scale evaluation will provide value.

Format of SERVAL framework

The SERVAL framework is organised in an easy-to-follow table format containing five sections each with detailed guidance notes and examples to assist the evaluator (Figure 1). Themes within each section are cross-referenced to avoid duplication of information and to enable evaluation findings to be easily made into recommendations for improvements.

Assessment of surveillance system attributes

A major difference between SERVAL and existing frameworks is the high number of attributes (up to 22)

from which evaluators are encouraged to select a shortlist of those most appropriate to each evaluation. Guidance is offered in the choice of attributes but no prescription is made. This allows the evaluation to be easily tailored to any evaluation objective and any surveillance purpose. This flexibility in choice of attributes was highlighted as a very positive development in the consultation process from people with experience of being restricted to assessing the same 10 or so attributes by previous evaluation tools. The SERVAL attribute selection matrix has been designed to assist evaluators in choosing and prioritising attributes without unduly restricting choice for those situations where it may be appropriate to assess more or fewer attributes. See Hoinville (2011) for more information on and definitions of surveillance attributes and other terms used in animal health surveillance.

Task 2.3 (Additional evaluation tools) was used to develop brief guidance notes on the assessment of each of the 22 attributes identified and defined during the development of the SERVAL framework. The purpose of the guidance notes was to improve the clarity and utility of sections 3 and 4 of the SERVAL framework. The guidance notes extend the definition of the attributes and, where appropriate, references are given to publications describing or demonstrating qualitative or quantitative methods for the assessment of these attributes. The guidance notes are included with the definitions of the attributes in the appendix to the SERVAL framework (Annex D).

Development of SERVAL took 15 months. It has been designed to assist in the comprehensive evaluation of single surveillance components (activities) or entire surveillance programmes. For surveillance systems already in operation, the evaluation should focus on how they are actually implemented which may differ from how they were designed to be implemented. Anyone familiar with epidemiological concepts and with a reasonable knowledge of the disease under surveillance should be able to use this framework to conduct an evaluation. The evaluation process is likely to require input from people who work on the surveillance system being evaluated but may be conducted by an independent evaluator. The output of using the framework is expected to be a written evaluation report that includes details under standardised headings along with a series of recommendations for improvements to the surveillance system being evaluated. The contents and weighting of each section can be tailored to the needs of each surveillance system and so will vary from evaluation to evaluation. The evaluation report should be circulated in an appropriately accessible format to affected parties including both those implementing the surveillance activities and those using the outputs.

The aim of this project was to develop and trial a generic evaluation framework for animal health surveillance systems. The result is the SERVAL framework which has been developed primarily for use in GB, but its flexible and generic nature mean it should be also applicable to other EU members and potentially worldwide use.

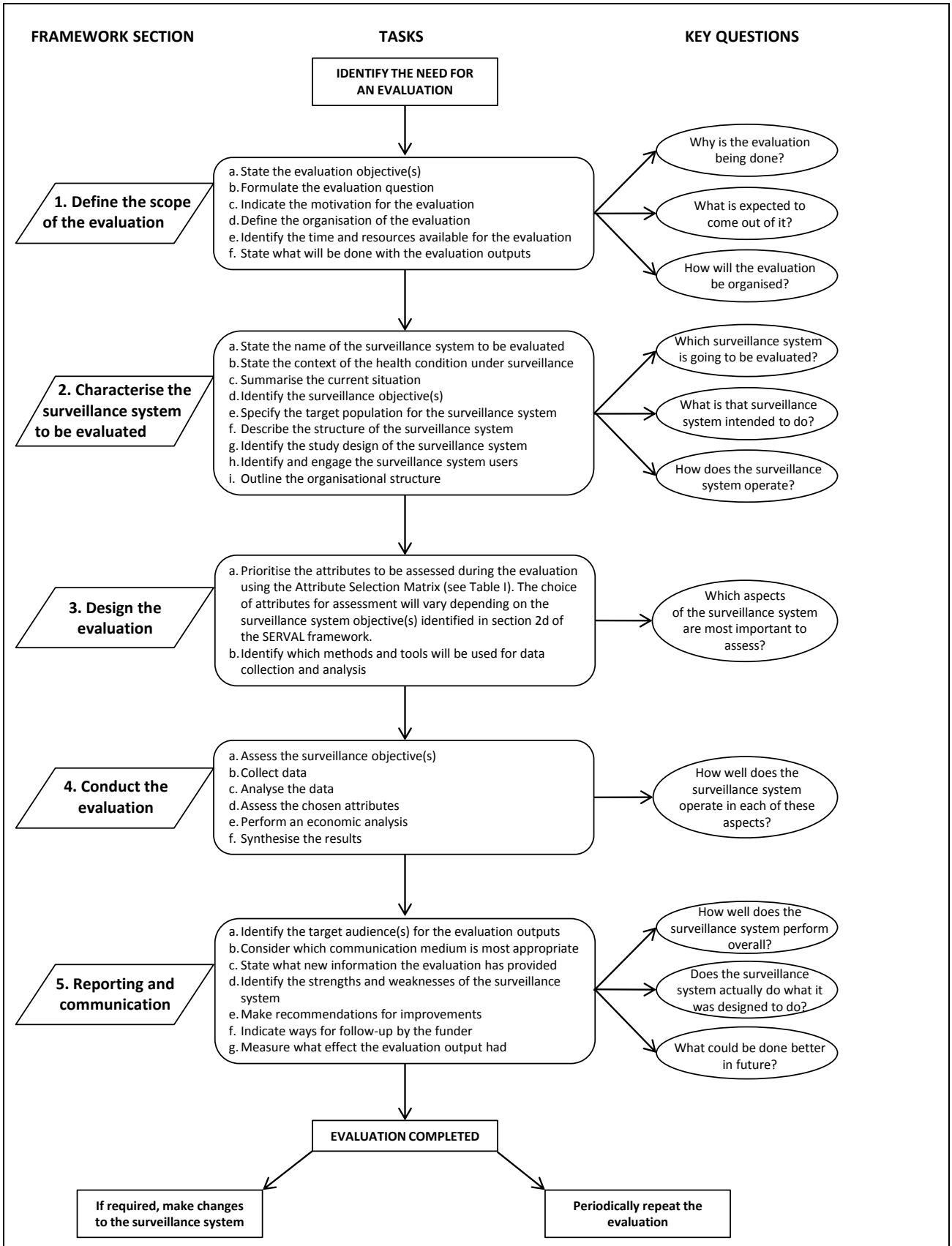

Figure 1 Overview of the SERVAL framework, a generic tool for evaluating any animal health surveillance system. Detailed guidance notes are included in the framework to assist with the completion of each section.

Work package 4: Case study evaluations (Annex D)

The draft SERVAL framework was tested by applying it to several case studies using existing surveillance programmes in GB. The case studies encompassed a range of surveillance and evaluation objectives, including: (i) surveillance to demonstrate freedom from infection (a serological survey for *Brucella melitensis* in sheep and goats); (ii) surveillance for endemic disease (tuberculosis in cattle); and (iii)

surveillance for early detection of an exotic disease (classical swine fever in pigs). Each case study was led by a different team member who solicited input from other team members and staff at the Department for Environment, Food and Rural Affairs (Defra) and the Animal Health and Veterinary Laboratories Agency (AHVLA) as necessary. These examples confirmed the flexibility of the framework because a different selection of attributes was assessed in each case study. As a result of the case studies, further minor amendments and clarifications were made to the framework leading to the current version.

Table 2 illustrates how to use the SERVAL framework to conduct an evaluation of a surveillance system. The last column of the framework contains a worked example of an evaluation using the case study of serological surveillance for *B. melitensis* in sheep and goats in GB. This is included to illustrate how each section of the framework is intended to be used. In addition, it provides an indication of the minimum amount of text that is expected in response to each question in the framework. See the case study report (Annex D) for the full versions of all three case studies.

Table 2 Example demonstrating how to use the SERVAL framework to conduct an evaluation of a surveillance system. Only the first section (defining the scope of the evaluation) is shown to illustrate the process, using a case study of serological surveillance for *B melitensis* in Britain.

Framework section	Guidance notes	Case study 1: Annual survey for *B. melitensis*
1a. State the evaluation objective(s)	Choose from the following list of six evaluation objectives: 1 To ascertain if a surveillance system is meeting its objectives. 2 To ascertain if a foreign surveillance system is reliable enough to accept imports from that country, or if a domestic surveillance system is good enough to support the export of animals or their products. 3 To ascertain if a surveillance system is providing value for money to the funder. 4 To determine how much benefit (monetary or otherwise) a surveillance system is providing to each of its user groups. 5 To identify the strengths and deficiencies of a surveillance system. 6 To identify potential measures that could improve the performance, efficiency and productivity of a surveillance system. This list aims to cover all possible evaluation objectives but excludes higher level strategic decisions, for example "to determine if a surveillance system, or a component of it, should be stopped", which would be based on the output of the evaluation. One or more of the objectives listed here could inform such a decision and the most relevant one(s) should be chosen.	*This evaluation has five objectives:* *1 To ascertain if the* B. melitensis *serological surveillance system in GB is meeting its objectives.* *2 To ascertain if this surveillance system is good enough to support the export of animals or their products.* *3 To ascertain if a surveillance system is providing value for money to the funder.* *4 To identify the strengths and deficiencies of this surveillance system.* *5 To identify potential measures that could improve the performance, efficiency and productivity of this surveillance system.*
1b. Formulate the evaluation question	Phrase the evaluation objective as a specific question in a format that the evaluation can seek to address.	*Does the* B. melitensis *serological surveillance system in GB meet its objectives to demonstrate freedom from infection and provide sufficient evidence to support the export of animals or their products? Further, which aspects could be improved and how should any improvements be made?*
1c. Indicate the	State what prompted the evaluation to be undertaken.	*This evaluation is being conducted to test out the draft evaluation framework and to identify*

motivation for the evaluation		*improvements to be made to the framework.*
1d. Define the organisation of the evaluation	Identify the people involved in the evaluation. In some cases a single body may be responsible for requesting, commissioning and funding the evaluation. In other cases, the body who requests the evaluation may be different to the body who commissions it who in turn may be different to the body that funds it. Consider: - Who requested the evaluation? - Who commissioned the evaluation? - Who is funding the evaluation? - Who will do the evaluation? - What other personnel support and administration will be required? - Who will be responsible for communication and reporting? - Who will benefit from the evaluation outputs? Indicate how the engagement of each of these people will be secured.	*This evaluation was requested, commissioned and funded by the UK government Department of Environment, Food and Rural Affairs (Defra) as part of the development of this generic surveillance evaluation framework. The outputs will benefit several bodies including: Defra, via improved evaluation of surveillance systems in general and efficiency savings to the* B. melitensis *surveillance system in particular; sheep and goat farmers, via reduced risk of infection entering their herds/flocks; and the project team developing the framework and performing the evaluation, via better understanding and expertise in surveillance evaluation. Defra and the project team are already engaged directly in this project. Sheep and goat farmers will be engaged indirectly through compulsory participation in the* B. melitensis *serological surveillance programme.*
1e. Identify the time and resources available for the evaluation	Indicate the staff, funds and time available for the evaluation. Identify the evaluation timeframe, including the start date, delivery date and any interim deadlines.	*This evaluation was led by one person with assistance in data collection and interpretation from four others. The work was fully funded by Defra contract SE4302. Up to two person-months were allocated for this case study which in the end took 10 person-days to complete. The evaluation was conducted in December 2011 – January 2012.*
1f. State what will be done with the evaluation outputs	This should be linked with the evaluation objective(s) stated in section 1a and indicate the purposes to which the evaluation results could be put. Thought should be given to how the findings of the evaluation will be reported. Reporting of the evaluation outputs is covered later in the framework (section 5e).	*This evaluation's outputs will be included in the SERVAL manual and will be presented to Defra in June 2012. Other information dissemination activities that are planned include presentation of results at ISVEE conference 2012 and publication in a peer reviewed journal. The results will also be provided to those commissioning and implementing the brucellosis surveillance system to facilitate improvement to the system as required.*

We used data and information that was already available when undertaking these case studies. We did not set out to collect data to assess the performance against any of the selected attributes: a process which would typically be part of a more detailed evaluation which could include quantitative assessment of individual attributes. The objective of these case-studies was to provide a proof of concept approach which shows that the framework appears robust, complete and user-friendly. These evaluations provide a comprehensive evaluation of the selected systems using available data. Recommendations for obtaining additional information to complete more detailed evaluations of specific attributes are provided, for example: holding meetings with stakeholders to assess awareness and engagement with surveillance for CSF. The evaluations carried out did not result in recommendations for substantial improvements in the surveillance for *Brucella melitensis* or pre movement testing for bovine TB but suggested that some improvement in the surveillance for early detection of CSF may be required.

Our case studies indicate that a complete qualitative evaluation will require at least 6-8 person-days, and the exact amount of time is likely to vary depending on the system being evaluated, availability of expertise and information, and the depth of evaluation required. If data need to be collected for specific indicators, or if broader interviewing of stakeholders involved in a surveillance programme is conducted, considerably more time will be required. A longer period would also be needed in order to conduct a

more detailed evaluation involving rigorous quantitative approaches.

Additionally, these case study evaluations provide an indication of approximately how much text is expected in response to each question in the framework. Responses are expected to be detailed but brief. Figures that summarise the findings of the evaluation – for example colour-coding the attribute assessments (Figure 2) – are likely to be an effective way of communicating the results.

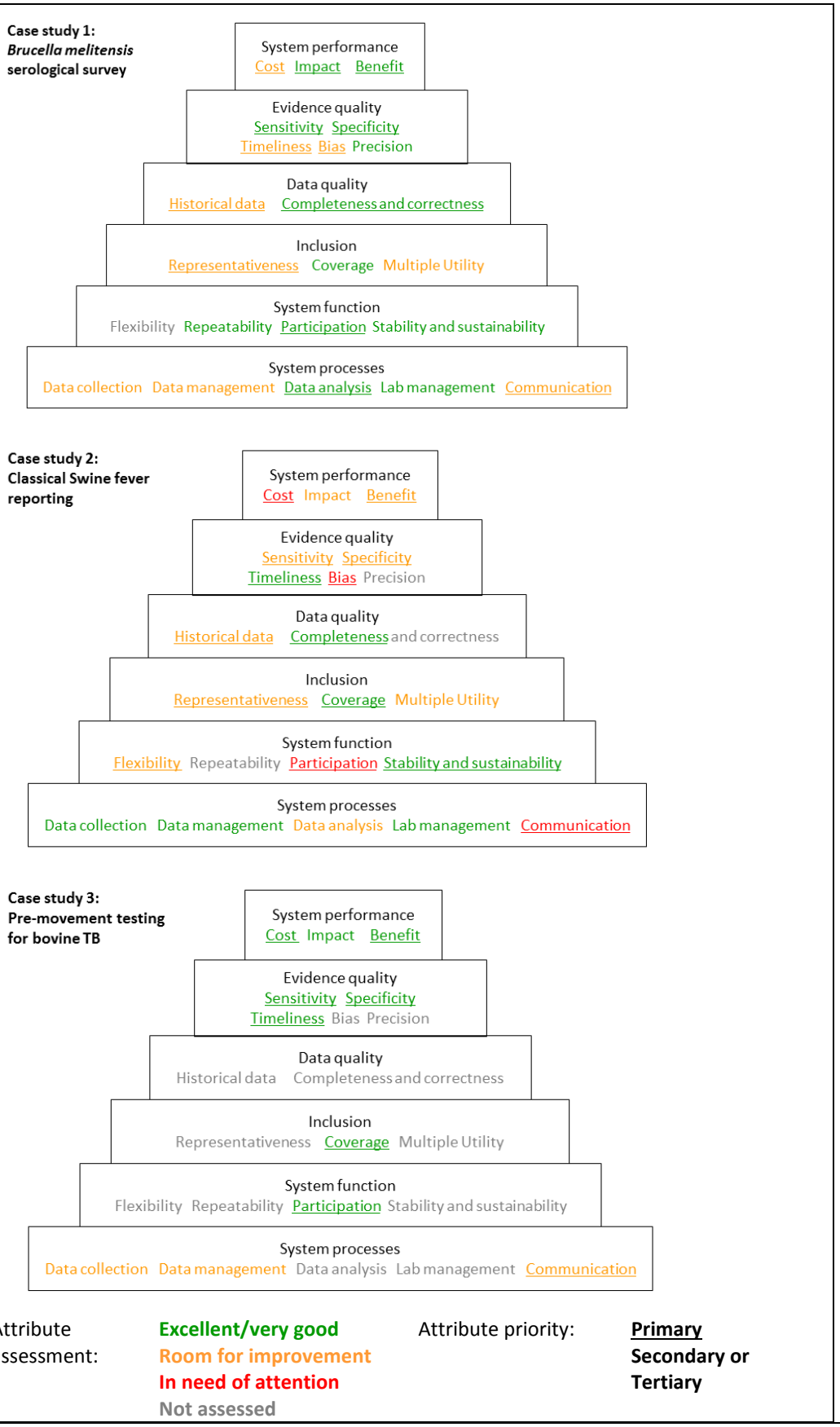

Figure 2 Summaries of attribute assessment outcomes from the three case studies.

Economic evaluation is an important part of the SERVAL framework, through estimating the costs of obtaining surveillance information and comparing these with the benefits derived from that information. Economic evaluation proved difficult in the three case studies. For example for the surveillance programmes for *B. melitensis* and classical swine fever the disease-specific costs were difficult to obtain as elements of both programmes were funded from a general exotic diseases budget, which did not collect specific activity costs. It is suggested that if a surveillance system is not collecting such data then it does not have a system in place for economic evaluation of the surveillance components and this limits the potential for evaluation of the surveillance overall.

Estimating benefit streams from surveillance can also be difficult and is reliant on technical information around changes in disease prevalence, estimating responses to detection of disease and comparing a baseline scenario without the surveillance being in place. This often leads to a significant number of assumptions being used to obtain an estimate of the benefits. If these figures are very sensitive to small changes in parameters such as prevalence of disease or time to detection then it is recommended that these could be used as the outcome measure and cost-effectiveness analysis would be preferable to cost-benefit analysis.

During the case study research a critical question was raised on whether assessing 'To ascertain if a surveillance system is providing value for money to the funder' should be considered an objective of all evaluations carried out for Defra. As outlined above the specific disease surveillance programmes did not always have monitoring and evaluation systems that collected cost data, which means that even a cost-effectiveness analysis could not be performed within the research carried out. This indicates a clear area for improvement in surveillance at a time when governments are looking to identify efficiency gains.

If a surveillance system is funded by a central body such as the government but with benefits generated across other groups such as the farming sector then the evaluation should be realised by both the funder and the beneficiaries (stakeholders). The SERVAL framework would be a useful foundation in this regard as the livestock sector are increasingly being asked to fund aspects of surveillance and in order for them to make decisions on such investments they will need to understand the benefits they gain from surveillance. The output from an evaluation, such as the case studies presented in this report, could be a useful tool for communicating to such parties how an animal health surveillance system operates and the information that it provides. In addition, because SERVAL provides a logical, clear and structured approach, the output could become a source of assurance and credibility for the system examined. Finally, the SERVAL framework could be used to communicate the design and performance of animal health surveillance systems with international bodies such as the OIE and the EU to influence decisions made by these bodies on legislation for animal health surveillance.

In addition to the three case-studies conducted by the project team, a veterinary student on placement at Defra/AHVLA used the draft SERVAL framework to conduct a case-study evaluation of surveillance for avian influenza in wild birds. This work demonstrated further the practicality and user-friendliness of the SERVAL framework, and the outputs were well received by those guiding policy development and surveillance design in this area. Whilst the lack of availability of data on the wild bird target populations made assessment of some attributes difficult (notably coverage and representativeness), this case-study demonstrated that the framework can be successfully applied to surveillance in wildlife populations, thereby validating further the flexibility of SERVAL.

In conclusion, undertaking these case studies has shown the SERVAL framework to be a comprehensive and generic framework for the evaluation of animal health surveillance. It is straightforward to use and flexible enough to accommodate a range of surveillance and evaluation objectives. SERVAL will shortly be made freely available on the internet. We encourage its use by those involved in animal health surveillance and would be delighted to receive feedback on users' experiences.

Section B: Methods to evaluate and enhance animal health surveillance

Task 2.4: Development of performance indicators (Annex F)

This task considered the theory of performance indicators (PI) and their application to animal health surveillance.

PIs provide a method of continuous monitoring to define target and observed performance that can be used to support confidence or guide changes in policy. This is of increasing importance in animal health surveillance, where increasing pressure on resource availability forces changes to surveillance programs and activities.

The development of PIs for monitoring surveillance performance should follow a logical process of:

1. Define the surveillance program, system and component(s) to be measured
2. Describe the activities within the surveillance program, system or component(s) being measured
3. For each activity, identify the objective or expected outcome and if necessary select priority objectives for development as indicators
4. Use attributes to define each indicator
5. Pilot and evaluate the indicators before implementation, and
6. Implement the use of PIs and disseminate easily understood outputs

In this task we explored the development of PIs for a surveillance system for *Brucella melitensis* in small ruminants. We identified three surveillance components and developed PIs for two of these:

A. The testing of laboratory submissions from sheep and goats presenting with abortion, and
B. An annual on-farm serological survey

We identified 27 activities (13 for the abortion submissions and 14 for the serological survey). From these, eight indicators were developed to inform an overall performance value. For each indicator, we defined the data (e.g. numerator and denominator), calculation frequency (e.g. quarterly), weight (i.e. relative importance or contribution to overall performance value), target (i.e. expected performance level) and quantitative targets (i.e. lower and upper cut offs to enable each performance indicator to be comparable). Real data were used where possible and the degree of performance was calculated for each PI and then aggregated for an overall performance value.

The case study in this task looked at two components of one surveillance system and as such, was relatively straightforward to design. However, within the constraint of the task, the PIs were not evaluated and the performance values were not challenged. It would be expected that the aggregation of PIs from multiple surveillance components brings with it a complexity and increasing resource requirement in terms of planning, measurement and evaluation.

Task 3.1: Inventory and resource mapping of animal health surveillance systems (Annex G)

Animal health surveillance in Great Britain is conducted through a range of public and private initiatives, yet there is no consolidated information on these activities and the outcomes. The aims of this task were, therefore, to:

1 Develop a high-level inventory of existing surveillance programmes relevant to the scope of this project. This inventory developed includes key characteristics of each programme as used previously (Stärk and Nevel 2009) and including some characteristics identified in an international workshop to discuss surveillance terminology (Hoinville, 2011). Information was collected from relevant literature and reports as well as from current programme managers and industry to illustrate the use of the inventory.

2 Explore the information in the inventory to identify gaps and potential synergies between current livestock health surveillance programmes in GB. Relevant surveillance programmes were mapped to identify overlaps and potential synergies. The intention was to highlight links to improve resource allocation that may impact on performance. Overlaps and synergies were identified in

order to make suggestions on possible redundancies and where some additional collaboration could add value. The current distribution of financial resources between programmes was considered as part of this objective.

An inventory of all known surveillance components (activities) of livestock, horses and wildlife in GB was developed through team discussions and web searches. Four criteria were used for inclusion of current surveillance activities in the inventory:

1 Surveillance components (rather than programmes) each constituted an individual record in the inventory.
2 Surveillance components that were current in GB as of June 2011 or were active in the preceding 12 months were included (i.e. cross-sectional inventory).
3 Whilst an initial list containing livestock, horses and wildlife was made, focus for the inventory was restricted to schemes of domesticated food producing animals (excluding horses).
4 A broad spectrum of study designs was included: ongoing or repeated, descriptive and action linked activities plus others which may not fit the usual definition of a surveillance activity (for example, control programmes and surveys) that provide information which contributes to achieving surveillance objectives.

The outcome was a comprehensive database covering 36 livestock disease surveillance components each described by 51 surveillance characteristics.

Analysis of the inventory data revealed that livestock health surveillance funding in GB is unevenly distributed between species. The vast majority (94%) of livestock surveillance expenditure in GB is spent on diseases of cattle, 2% is spent on pigs, 2% on sheep and goats, and 1% on poultry. The remaining 1% is spent on surveillance for antimicrobial resistance across all species. It should be noted that most of the cattle expenditure is for tuberculosis surveillance (UK national control programme required by legislation) of which infection control is an integral part and a large cost. It was not possible to separate out control costs from pure surveillance costs in this analysis. Such an analysis should be considered in the future for all species, in order to compare surveillance costs without control costs. Clearly separated expenditure data would be required and this might not be available.

Standardised Livestock Units were used to take into account the metabolic weights of each species (a reflection of energy consumption), and still the marked skew towards spending on cattle remained. The amount spent on disease surveillance per livestock unit was found to be positively correlated with economic value of livestock sector.

Analysis of public versus private expenditure suggests that private sector expenditure makes a small contribution to the total estimated surveillance spend (approximately 10% across all species, although the exact figure is likely to be a little higher because not all private funding was disclosed). The balance of funding of surveillance activities varied across the species groups, with approximately equal cost sharing between public and private sources in the pig sector but a greater proportion of public funding in the cattle and sheep sectors. The study recognises that there are gaps in the data particularly from the poultry sector and from the herd health schemes for all species. In addition we took no account of the costs in time and resources of the farmers in taking samples and regularly monitoring the health of their animals. For this reason we have not examined whether the current ratio of public: private funding (approximately 9:1) is in proportion to the amount of benefit gained by various parties from the surveillance. Further, it was not possible to accurately determine costs for all surveillance activities because they were often block funded and costs for each programme were not always separated. The proportion of spending on passive and active surveillance was not clear in some cases. We suggest that funders and deliverers of surveillance need to start characterising how money is spent in order to be able to estimate if each surveillance programme is providing value for money.

Common gaps in resource use across species were identified, for example multiple utility of surveillance programmes (sharing of samples) was not commonplace. Where the same sample collectors are used, it is not clear whether animals are sampled once and the resultant samples analysed for several diseases, or

whether multiple farm visits and sampling sessions are made (which would represent an overlap and therefore a potential waste of resources). Risk-based sampling is currently used in a minority of cases and its wider use could usefully be explored.

None of the industry-led cattle herd health schemes were willing to disclose financial information, sample sizes or geographical locations of farms sampled. The reason given was that this would give their competitors an advantage. As a result, this source of surveillance information is not publically available and the usefulness of such schemes is severely limited. This represents a potentially large waste because of the similar nature of several of these schemes conducting surveillance on the same diseases.

Task 3.2: Investigation of determinants of heterogeneity (Annex H)

The original aims for this task were:

1 To explore the heterogeneity that exists in currently utilised and alternative sources of surveillance data (e.g. health schemes) with a particular emphasis on coverage, and
2 To assess the likely consequences [of surveillance systems that produce heterogeneous results] on the performance of disease control. It was envisaged that this would [possibly] be assessed within a qualitative to semi-quantitative risk analysis framework.

Rather than duplicate completed, current, or ongoing work it was agreed to revise the Task: eighteen recent or emerging sources of available research evidence about the coverage of, and stakeholder perceptions and attitudes to, animal health surveillance in Great Britain (GB) were identified by the project team, reviewed and summarised (Annex H). Twenty-eight immediate gaps were identified and assigned a possible priority for future work. The preliminary report formed a basis for a workshop involving the customer to identify what research activity would best inform the overall aim of the project i.e. the development of a generic approach to evaluate animal health surveillance systems in GB. The project team discussed each of the 10 gaps prioritised as 'HIGH' and any other gaps that they thought should be prioritised as 'HIGH'. Where gaps addressed similar areas they were clustered and a relative ranking imposed. The relative importance of each of these areas, the feasibility of completing relevant work within the time and resources available for both this task and within the overall remit of the project were considered.

The final ranking produced was as follows (most important first). There is a lack of evidence about the:

1 Perception of roles in and engagement of players at 'entry' level to any surveillance component; particularly farmers for surveillance based on diagnostic submission to AHVLA or SAC laboratories and, subsequently, motivating and influencing factors and barriers for stake-holders;
2 Identification of the structure, sequence of events, pathways & players for any surveillance components other than that based on diagnostic submission to AHVLA or SAC laboratories
3 Impact of observed differences in coverage of diagnostic laboratory submissions – What do observed differences mean? What risk does it present?
4 Actual and/or predicted coverage of diagnostic laboratory submissions – there are a lack of analyses for Wales (actual) or Scotland (actual and predictions) and no work that takes cross-border effects into account.
5 Aspects to do with alternative data sources – from identification, through access issues, to assessment of coverage and engagement.

These gaps should form the basis of recommendations for the direction of future work.

Task 3.3: Perceptions of surveillance (Annex I)

Where animal diseases pose a threat to public health, animal welfare, international trade and farming businesses, there is a need to monitor health trends in our livestock populations and respond to changes. Passive surveillance – where surveillance is initiated by farmers and private veterinarians through observation, investigation and reporting of suspect disease – relies on the farmer's ability to detect signs of disease and farmers' and private veterinarians' motivation to investigate and report the findings. In particular, the relationship between public and private veterinary services and the sheep industry in Britain is poorly understood. So in task 3.3, perceptions of roles and responsibilities in monitoring sheep health, and attitudes towards animal health surveillance at the national level were investigated with

sheep farmers and private veterinarians.

Information was collected through short, structured interviews with ten farmers and nine veterinarians from the North East and South West of England. All but one of the veterinarians interviewed had been practicing for at least five years. All farms kept commercial sheep flocks, however four of the five northern farmers also kept pedigree sheep. Only three farmers (all from the southern region) considered their sheep flock to be their main source of income.

One of the key findings from the interviews was that sheep health was chiefly monitored at farm level by the farmer, with only occasional input from the veterinarian; and information on the health of the flock, if recorded, was not widely disseminated as a rule. Farmers generally felt they had sufficient expertise to manage most health issues on their farm and tended to request a visit from their vet only under exceptional circumstances (eg high levels of abortions or sudden deaths) or when blood or faecal sampling was required. Farmers more often sought advice from their vet through telephone contact.

Veterinarians believed that often farmers do not contact them soon enough and can underestimate the impact of disease. It was believed that underreporting results in a biased view of the health status of the national sheep flock. Abattoirs and knacker's yards were identified as potentially useful alternative sources of information on diseases in sheep, but utilising these sources would require the co-operation of processors and might necessitate some operational changes. Preventive health visits to sheep farms were not a regular practice but veterinarians strived to keep in touch with their farmers through various other activities, including evening meetings, visits at the farm for other purposes (eg when treating other stock) and by promoting health plans and talking to farmers when they came to the surgery to buy drugs.

Both farmers and veterinarians believed they played a primary role in the monitoring of sheep health; however, the farmers interviewed did not perceive the communication of such information centrally to be part of their role currently. Both groups thought they could potentially contribute to a formal system of reporting diseases to the regional veterinary laboratories and neither indicated a strong resistance to sharing information on sheep health. However, a lack of time, organised systems for data collection and financial recognition or incentive were considered to be deterrents to their collaborating in surveillance efforts. Effective communication of the value of surveillance information – both to industry and the individual farmers and vets – assurances of data protection and compensation for time and effort are likely to facilitate participation in surveillance.

This task has provided valuable insight to how sheep health is monitored and managed in the British sheep industry. The survey highlights several key considerations in improving passive surveillance of sheep health, from the collection of data (from farmers and private vets), through to better use of the data and communication of the knowledge generated.

Task 3.4: Capture-recapture methodology in analysis of submission data (Annex K)

One-list capture re-capture (CRC) methods use the counts of individual units (e.g. animals or farms) that have been identified multiple times by the surveillance system to infer the total number of truly infected units. The ratio of the detected individuals to the estimate of truly infected individuals is then termed the completeness of the surveillance system (or sensitivity, as it measures the likelihood that an infected/affected farm is captured by the surveillance). A capture re-capture (CRC) estimator (Chao, 1987) was enhanced to take into account covariate information (e.g. farm size, type, and distance from AHVLA RL) (Bohnning et al., submitted, Annex K) and used to estimate the completeness of FarmFile with respect to the number of farms making (i) any submissions and (ii) carcass submissions. The CRC estimator gave an estimate of 56% completeness for all submissions, and 24% for carcass submissions. It was found that both farm size ($p<0.001$) and farm type ($p<0.05$) had a significant influence on the likelihood of submission for all submissions, whereas distance from an RL was important for carcass submissions ($p<0.1$).

The new CRC estimator was also applied to Farm File data on a syndrome level, and used to estimate the completeness of animal health submissions for each syndrome. Results are shown in Table 3 and Annex J.

Table 3 Estimates of the completeness of farmfile data by syndrome according to the capture re-capture estimator with covariates. (See Appendix for results for 2009, comparison with other estimators, and statistical significance of covariates)

Syndrome	No of farms that submitted to farm file (2010)	CRC estimate of total affected farms	Estimate of completeness of farm file
Circulatory	*180*	855	0.21
Enteric	*7212*	18,002	0.40
Mastitis	*978*	2487	0.39
Musculo-skeletal	*271*	3436	0.08
Nervous	*254*	3874	0.07
Reproductive	*2978*	6433	0.46
Respiratory	*1658*	4903	0.34
Skin	*189*	1924	0.10
Systemic Misc	*3982*	13,433	0.30
Unknown	*1297*	7312	0.18
Urinary	*76*	12,776	0.01

Results were fairly consistent for those syndromes with greater than 300 cases, with completeness ranging from 18% (circulatory) to 40% (enteric). For syndromes with fewer than 300 cases, the estimates of completeness were less than or equal to 10%, suggesting a possible underestimate in these cases. It is acknowledged that further work to validate these results by comparison with an independent data source would be useful to assess whether the assumptions made in carrying out these analyses are valid.

Section C: Discussion of key findings, future work and dissemination activities (work package 5)

The delivery of veterinary surveillance in the UK has recently been subject to detailed scrutiny and review. Three reports (ASSP 2011, SAG 2012, and Scottish Government 2011) have been published highlighting the need to ensure that animal health surveillance provides sufficient evidence to meet the purposes of decision-makers effectively and efficiently. This project developed a generic framework (SERVAL) for the periodic evaluation of animal health surveillance systems to ensure that they are meeting their objectives. The process of developing performance indicators which can be used to continuously monitor the performance of surveillance systems was also reviewed. In addition a high level evaluation of the current animal health surveillance programme for livestock in England and an analysis of the gaps in the evidence available about surveillance coverage and the perceptions of stakeholders were carried out. Finally tools for the assessment of specific attributes were developed and applied including capture-recapture analysis for the assessment of coverage and socio-economic methods for the assessment of participation.

The **SERVAL** evaluation framework developed in this project addressed the absence of a standardised approach for the evaluation of animal health surveillance systems identified by our initial systematic literature review**.** The design of this framework was informed by a technical workshop with international surveillance experts. Revisions were incorporated following consultation with providers and users of surveillance and application to three case studies. Each of these case studies evaluated an existing GB surveillance system component with a different surveillance objective. SERVAL can be adapted to consider the performance of a surveillance activity for different purposes – for example, the use of laboratory diagnosis for the detection of new threats or for changes in the frequency of endemic disease. This is especially relevant to current projects, eg Surveillance 2014, since it is recognised that Government and industry may have different priorities. The SERVAL framework could also be adapted to consider how surveillance systems might contribute to other policy drivers – eg food security or support of the rural economy. This could be achieved by framing the evaluation purpose accordingly and appropriate selection of attributes – or indeed inclusion of new attributes.

The case studies indicated that the **SERVAL** framework was robust, complete and user-friendly. The consultation process concluded that the framework would definitely prove valuable and that it was thorough, easy to follow and generally clear. Comparison with another recently developed animal health surveillance evaluation framework (Hendricx *et al* 2011) suggested that the **SERVAL** framework is more

flexible and that the outputs may be easier to interpret. The case studies suggested that a rapid qualitative evaluation of a surveillance system will require approximately 6-8 person-days, although the exact amount of time is likely to vary depending on the system being evaluated, availability of expertise and information, and the depth of evaluation required. The evaluations carried out within this project allowed the development of recommendations for obtaining additional information to complete more detailed evaluations of specific attributes are provided, for example: holding meetings with stakeholders to assess awareness and engagement with surveillance.

The documentation provided with the framework, including detailed guidance notes on the methods available for the evaluation of each attribute, should make SERVAL easily applicable by surveillance professionals not involved in its development. A manuscript has been submitted for peer-review publication (World Organisation for Animal Health's *Scientific and Technical Revue*) and presentations are planned at an international conference (The 13th Conference of the International Society for Veterinary Epidemiology and Economics, Maastricht, August 2012) and a workshop (The 2nd Conference of the Scottish Government's Centre for Expertise on Animal Disease Outbreaks, Edinburgh, September 2012) to facilitate dissemination of information about the framework and encourage its use. Finally, the SERVAL framework, with appendices and illustrated by the case-study evaluations as appropriate, will be published on the websites of the three collaborating institutions; promoting its dissemination and use both within and outside the UK. Wider application of the SERVAL framework to real evaluation questions will build on the experience gained by application to the case studies and feedback from users will be encouraged to facilitate further development of this framework.

The SERVAL framework could also be used to evaluate the design of new surveillance to enable any issues impacting on attributes – eg timeliness or sensitivity – to be identified at an early stage. We recommend that all existing surveillance systems, proposed new systems or proposed changes in existing systems should have an evaluation process built in to their design and the selection of performance indicators to monitor delivery should be considered. The outputs of such evaluations will also be useful for conveying the process and value of surveillance to the various stakeholders (eg industry and the public) other than the funders of these systems.

Output from the systematic review of literature conducted in work package 1 was presented at the *1st International Conference on Animal Health Surveillance*, in Lyon, May 2011. The literature review was also subsequently published in the journal *Epidemiology and Infection* (Annex A, Drewe *et al* 2012).

Development and implementation of performance indicators for the continuous monitoring of animal health surveillance systems could be used to support confidence in current activities, identify changes in expected performance and to guide changes in policy. The knowledge gained from this task will be directly used to develop performance indicators for AHVLA early warning surveillance. A brief summary of the work conducted was presented to the Independent Surveillance Advisory Group, chaired by Professor Dirk Pfeiffer (SAG 2012).

A high-level **inventory** of existing surveillance programmes was established and used to identify gaps in resource use and potential synergies of current livestock health surveillance programmes. Such a compilation of surveillance systems across species was provided for the first time and revealed that information on surveillance costs, particularly for private herd health schemes, were not always available or accessible. The results of this work suggested that surveillance funding was focused on cattle, with the majority of this being spent on bovine tuberculosis; although, it should be noted that most of the cattle expenditure is for tuberculosis surveillance (UK national control programme required by legislation) of which infection control is an integral part and a large cost The contribution of private schemes to surveillance was hard to quantify due to limited data sharing but was estimated to be about 10%. Since surveillance essentially delivers evidence to inform action, there is scope to increase work in this area to understand the value and benefits of investment in surveillance and in particular to enhance data sharing, clarify costs and identify who pays and who gains.

The project also investigated gaps in the evidence available about surveillance coverage and stakeholder perceptions and attitudes based on eighteen sources of evidence. This work identified gaps in our current

understanding of surveillance coverage and understanding of stakeholder perceptions, most importantly the perception of roles in and engagement of farmers and their vets. A specific assessment of **farmers' and veterinarians' understanding of surveillance and their roles/responsibilities** for monitoring and managing animal health in the English sheep industry was conducted. Incentives to encourage participation and ensured confidentiality were found to be critical. The application of socio-economic approaches in understanding stakeholder perception and behaviour with respect to animal health is a relatively under-researched area. Since surveillance systems ultimately rely on the relationships between primary producers, their veterinary consultants and providers of services including laboratory diagnosis, benefit is to be realised from a multi-disciplinary collaboration.

Capture-Recapture (CRC) analysis was used to assess coverage by calculating the proportion of affected holdings that submit samples to AHVLA regional laboratories in order to assess the coverage of this system. The statistical method was enhanced to take into account other information (e.g. farm size, type, and distance from AHVLA RL) and thus deliver a more precise estimate. Further work on the validity of the estimates is required as it appears that for syndromes with very few cases, the estimator may underestimate the proportion of holdings detected. It is also suspected that the estimator will perform less well for conditions where, having submitted one case, the farmer is unlikely to make a second submission. This validation is complicated by the scarcity of prevalence estimates for conditions and syndromes recorded in FarmFile, a review of the data available to allow validation would be useful. A manuscript (Annex K) on the enhanced capture-recapture methodology has been offered for publication in a peer-reviewed journal (*Biometrics*).

Conclusion

This project has delivered a range of outcomes that will contribute to more effective and efficient veterinary surveillance in the UK. In order to benefit from this work, results need to be disseminated to relevant groups and individuals involved in surveillance design, implementation and use of surveillance information as a basis for decision making. To achieve this, the project has used a range of dissemination channels including publications in scientific and non-scientific journals, consultation and a seminar. The results will continue to be available through a manual and dedicated web site. In addition, targeted dissemination within the veterinary service and key organisations such as AHVLA, SAC and Defra will be beneficial.

Due to the dynamic surveillance landscape and several reviews being conducted in parallel to this research, there is a need to integrate our findings with results of other activities to consolidate future developments. Those developing and implementing surveillance systems should be aware of and able to use the tools and methods developed in this project. The publications and the planned workshop will contribute to this objective.

Annexes to final report

Annex A – Literature review (WP1) published in Epidemiology and Infection

A Literature review (published).pdf

Annex B – Report on the technical workshop (task 2.1)

B Report on technical workshop.pdf

Annex C – Report on the consultation of experts and stakeholders of animal health surveillance (task 2.2)

C Report on framework consultatic

Annex D – Report on the evaluation case studies (WP4), presenting the SERVAL framework with guidance on the assessment of attributes (task 2.3)

D Report on WP4 case studies 21jun12.

Annex E – Manuscript on the development of SERVAL submitted to Revue Scientifique et Technique (PROTECT)

E Manuscript for Rev Sci Tech (submitted).

Annex F – Report on the development and application of performance indicators for animal health surveillance (task 2.4)

F Report on development of perfc

Annex G – Report on the development and use of an inventory of animal health surveillance programmes in GB to understand resource allocation (task 3.1)

G Report on inventory of surveillar

Annex H – Report summarising the output of recent reviews of animal health surveillance in GB (task 3.2)

H Summary of recent reviews of surveillanc

Annex I –Report on a survey of the perceptions of surveillance among English sheep farmers and veterinarians (task 3.3)

I Report on perceptions of surveil

Annex J – Results of application of capture-recapture methodology to diagnostic submission data for cattle (task 3.4)

J Results of CRC method on cattle subi

Annex K – Manuscript on the generalisation of Chao's estimator for covariate information, submitted to Biometrics (PROTECT)

K Manusccript for Biometrics (submitted

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

ASSP (2011). Sustainable scanning surveillance in England and Wales: A report from the AHVLA Sustainable Surveillance Project. http://vla.defra.gov.uk/reports/docs/rep_assp_report1211.pdf

Bohnning, D., Lerdsuwranski, R., Vidal-Diez, A., Vivatwongkasum C., Arnold, M.E. A generalization of Chao's estimator for covariate information. Submitted to Biometrics.

Chao, A. (1987) Estimating the population size for capture re-capture data with unequal catchability. Biometrics 43, 783-791.

Drewe, J.A., Hoinville, L.J., Cook, A.J.C., Floyd, T. and Stärk, K.D.C. (2012) Evaluations of animal and public health surveillance systems: a systematic review. Epidemiology and Infection **140**: 575-590.

Hendricx P, Gay E, Chazel M, Moutout F, Danan C, Richomme C, Boue F, Souillard R, Gauchard F, Dufour B. (2011). OASIS: an assessment tool of epidemiological surveillance systems in animal health and food safety. *Epidemiology and Infection*. 139(10): 1486

Hoinville, L.J. (2011) Animal Health Surveillance Terminology Final Report from Pre-ICAHS Workshop. http://vla.defra.gov.uk/reports/rep_ahsurv_term.htm

SAG (2012). Surveillance Advisory Group final report. http://vla.defra.gov.uk/reports/docs/rep_assp_report1211.pdf

Scottish Government (2011). The review of veterinary surveillance, final report: How information on animal disease is gathered, analysed and disseminated in Scotland. http://www.scotland.gov.uk/Publications/2011/11/09091744/0

Staerk and Nevel (2009). Strengths, weaknesses, opportunities and threats of the pig health monitoring systems used in England. *Veterinary Record*. 165: 416-465.