Department
for Environment
Food & Rural Affairs

www.gov.uk/defra

Making the most of our evidence:
A strategy for Defra and its network

June 2014

Department for Environment Food & Rural Affairs

Forestry Commission

Cyfoeth Naturiol Cymru Natural Resources Wales

Centre for Environment Fisheries & Aquaculture Science

VMD Veterinary Medicines Directorate

The Food & Environment Research Agency

Llywodraeth Cymru Welsh Government

JNCC Joint Nature Conservation Committee

Animal Health & Veterinary Laboratories Agency

Environment Agency

Kew Royal Botanic Gardens

Marine Management Organisation

Natural England

Rural Payments Agency

dwi

© Crown copyright 2014

You may re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence v.2. To view this licence visit www.nationalarchives.gov.uk/doc/open-government-licence/version/2/ or e-mail: psi@nationalarchives.gsi.gov.uk

Contains Environment Agency information © Environment Agency and database right

This publication is available at: www.gov.uk/government/publications

Any enquiries regarding this publication should be sent to us at:

strategicevidence@defra.gsi.gov.uk

PB 14175

Contents

Ministerial foreword 4

Welsh Government's Ministerial foreword 5

Introduction from Defra's Chief Scientific Adviser 6

1 Integration of evidence with policy and operations 8

1.1 Purpose of the strategy 8

1.2 Defra and its network operating as 'one business' 10

1.3 The importance of evidence to Defra and its network 12

1.4 Defra and its network as part of a wider evidence community 14

2 Evidence priorities 16

2.1 Statutory obligations for evidence 18

2.2 Applied evidence priorities 20

2.3 Strategic evidence priorities 24

2.4 Developing and using innovative approaches to address evidence priorities 27

2.4.1 Systems thinking 27

2.4.2 Risk and opportunity 28

2.4.3 Effective use of data and existing research 29

2.4.4 People and place-based thinking 29

2.4.5 Effective policy, regulatory and operations evaluation 30

2.4.6 Modelling and decision support 31

3 Improving evidence delivery 32

3.1 Building a balanced and flexible programme of evidence 33

3.2 Promoting co-ownership, co-design and co-funding of evidence activities 34

3.3 Driving innovation and quality in the ways we access and use evidence 35

3.4 Sustaining critical evidence capacity and capabilities 36

3.5 Promoting and supporting the development of a competitive research market 37

3.6 Next steps 39

Annex A Applied evidence priorities 40

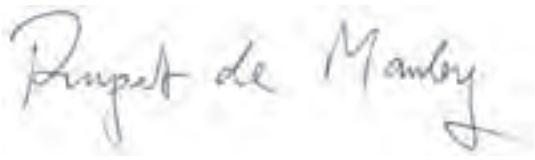
Annex B Strategic evidence priority areas 46

Ministerial foreword

I am delighted to present this new Evidence Strategy. Defra and its associated agencies and non-departmental public bodies are committed to providing focused, high-quality scientific evidence to help deliver our priorities to grow the rural economy, improve the environment and safeguard animal and plant health. This evidence is vital in supporting government to make important decisions on how to manage the country's natural resources, promote sustainable growth in the environment, food and rural sectors, and in the management of risk.

This Government is making great strides in working more efficiently across the public sector and producing 'more for less' whilst making the most of evidence, skills and capabilities. As we continue to improve these efficiencies it will be vital to coordinate all our evidence activities by working in a more joined-up way. That means working better within government and with our partners across a range of organisations including the Research Councils, academia, industry, civil society and others – nationally, in the European Union and globally to make the most of our financial resources and people and look for innovative solutions. Our investment in evidence needs to support the delivery of effective and workable policies and operations today and ensure we are ready for the challenges of tomorrow.

This new Evidence Strategy lays out how Defra and its network bodies will address our applied and strategic evidence needs by working together as one business: prioritising needs, coordinating evidence activities, sharing best practice and improving the quality and management of information. We will keep building on how we work together, not only within Defra and its network but outside, nationally and internationally. By coordinating and prioritising more effectively we will produce better quality evidence that provides better value for money.



Lord de Mauley
Parliamentary Under Secretary
of State for Natural Environment and Science
Department for Environment, Food and
Rural Affairs

Welsh Government's Ministerial Foreword

I am pleased to support this Evidence Strategy which sets out a clear direction and commitment to providing robust and up-to-date evidence from our shared Wales and England budget.

I want to ensure that by working closely in partnership with Defra and its network that the Welsh Government will have the evidence to support our ambitious policy goals associated with: delivery of green growth, resource efficiency, enhanced resilience and diversity of our natural environment and to tackle poverty.

Collaboration is fundamental to helping us address the challenges we face through pooling expertise and working across the public, voluntary and private sector to maximise the impact and encourage innovation.

Alun Davies AM
Minister for Natural Resources and Food
Welsh Government

Introduction from Defra's Chief Scientific Adviser

This is the first evidence strategy to cover the whole of Defra and its network, setting out how evidence will help to deliver advice and support to policy and operations. Defra and its network already has a strong focus on the use of evidence to support current policies and to help define the policies of the future. Since Defra's previous Evidence Investment Strategy was published in April 2011 considerable progress has been made to work more effectively across Defra and its network of organisations, including all our executive agencies and non-departmental public bodies, and also with the Welsh Government and other partners to deliver the evidence we need.

This strategy is designed to encourage science and innovation with impact by ensuring there is a focus on building generic capabilities, harnessing the research talent in the UK and stimulating others in the research community to share in delivering new evidence that can be used in policy-making. The evidence for our policies and operations needs to be acquired more efficiently, which calls for Defra and its network to adopt new ways of working by building on what already works well. The strategy seeks to maximise the value from evidence by focusing our effort on key priorities, managing and making better use of the knowledge we already have and ensuring best value from our shared resources and expertise. This will require changes in the way we commission, collect and use evidence with greater participation from, and collaboration with, external partners and providers of evidence.

Some important principles are set out in this strategy. There will be rigorous prioritisation of investment in those activities, and critical capabilities, that have the greatest impact or are essential to manage emergencies. Defra and its network will also be conscious about how the science and research it sponsors can benefit society as a whole and the evidence generated from activities will be available for others to use. Promoting appropriate levels of competition among the suppliers of evidence will help to drive up quality both internally and externally and will also help to stimulate growth of the research market place. This will encourage innovation within the supplier community and give Defra and its network access to the breadth of expertise in that community. Finally we need to harness the abilities of our own experts by fostering a culture of innovation and commitment to quality.

Progress will be reviewed regularly and the strategy will be updated as the policy landscape changes. I look forward to working with colleagues across Defra, its network and crucially with external partners to deliver quality evidence that we can all value.

Professor Ian Boyd
Chief Scientific Adviser

1. Integration of evidence with policy and operations

1.1 Purpose of the strategy

Defra is responsible for policy and regulations on environmental, food and rural issues. Our priorities are to support growth in the rural economy, improve the environment and safeguard animal and plant health. We are making a significant contribution to the economic recovery and we are committed to encouraging innovation and reducing the regulatory burden on rural communities and businesses, while promoting growth through initiatives such as the UK Agricultural Technologies Strategy.

This Evidence Strategy sets out the collective evidence priorities of Defra and its network bodies, including the Forestry Commission (see figure 1, page 10). It sets out the new ways we will work to get the most from evidence in partnership with the rest of government, Research Councils, academia, industry, civil society and others – nationally, in the European Union and globally.

Defra delivers its priorities and statutory obligations through a range of executive agencies and non-departmental public bodies (NDPBs). We work closely with the devolved administrations in Wales, Scotland and Northern Ireland, and maintain responsibility for evidence delivery in some areas on behalf of the devolved administrations, along with our network.

Defra manages research budgets and programmes for England and Wales, except for a small element of delivery-related animal health and welfare surveillance which has been devolved. We also manage research budgets and programmes in some areas for the benefit of the whole of Great Britain and seek to ensure that evidence helps deliver the needs of the British Overseas Territories and Crown Dependencies.

Defra and the Welsh Government work closely together to ensure an appropriate evidence base for policy development, recognising that Defra and Welsh Government goals differ in some policy areas. This strategy therefore reflects both English and Welsh evidence needs. Welsh Government priorities are to drive green growth, use resources efficiently, tackle poverty, and enhance resilience and diversity of our natural environment.

Defra also has wider responsibilities across government to provide evidence to support policies on economic growth, sustainable development and adaptation to environmental change including climate change.

In delivering the policy priorities for Defra and its network we aim to:

- **maintain and improve access to the evidence required to meet our policy and operational needs,**
- **get the most from our investment in evidence, our specialists and strategic partnerships,**
- **drive up the quality of all the evidence we use and the advice it underpins, and**
- **step-up our preparedness and planning for risks and new and emerging priorities and potential threats.**

We will use our strategy **internally** as the high-level framework to guide our detailed planning, prioritisation and delivery of evidence; and **externally** as a statement of our principles and priorities and a basis for discussion and joint working with potential partners for co-designing and meeting our evidence needs.

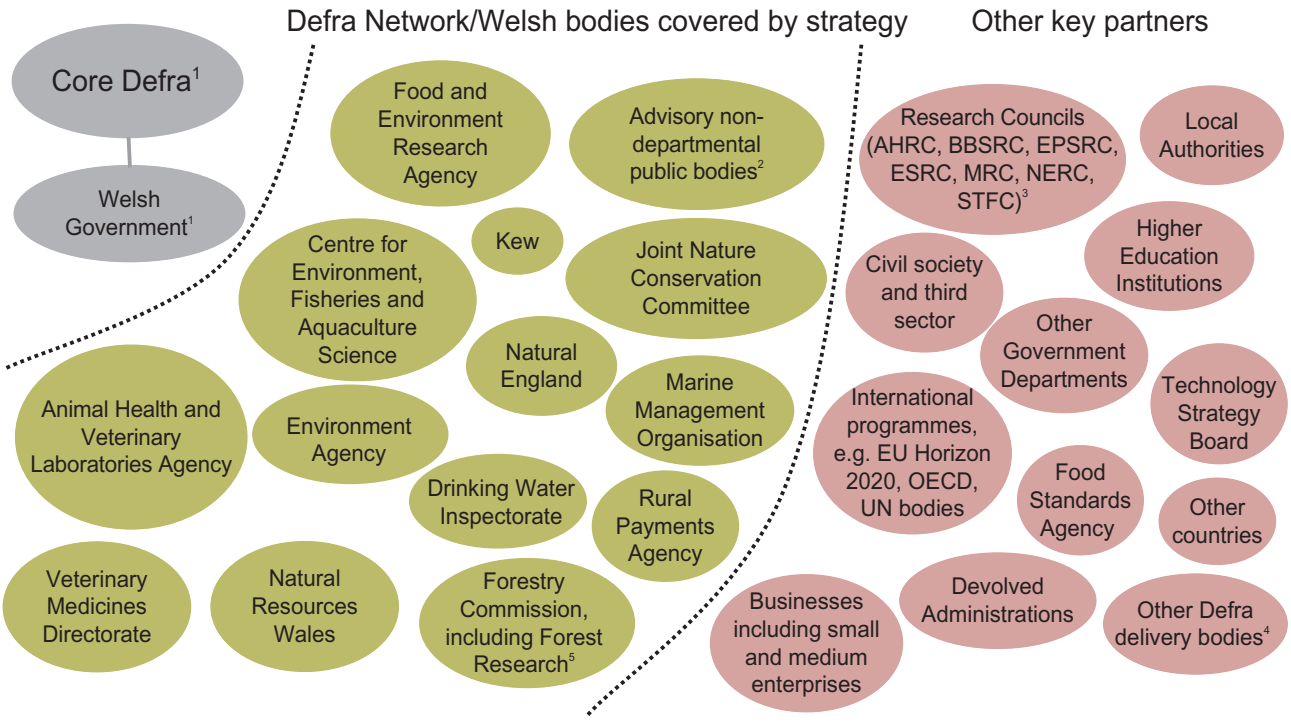
Image courtesy of Cefas

1.2 Defra and its network operating as 'one business'

Defra and the agencies, NDPBs and other public bodies that support it are collectively known as 'Defra and its network' (see figure 1 below).

Defra and its network will increasingly operate as 'one business'. This means developing a future business model that is even more joined-up, flexible and resilient, allowing us to deliver 'more for less' particularly across common evidence priorities. We will improve the connection between evidence, policy and delivery and make the most of skills and capabilities within and outside the network to deliver timely, robust and fit-for-purpose evidence.

Figure 1: Defra's evidence landscape



1 Defra holds the budget for the delivery of evidence on behalf of the Welsh Government.
2 Defra also has a number of expert committees which provide evidence and information to help inform policy.
3 Acronyms are: AHRC – Arts and Humanities Research Council; BBSRC – Biotechnology and Biological Sciences Research Council; EPSRC – Engineering and Physical Sciences Research Council; ESRC – Economic and Social Research Council; MRC – Medical Research Council; NERC – Natural Environment Research Council; STFC – Science & Technology Facilities Council.
4 e.g. Waste and Resources Action Programme, National Industrial Symbiosis Programme and the Carbon Trust.
5 Forest Research is a delivery body of the Forestry Commission, a ministerial Department.

Effective joined-up working across Defra and its network

The Joint Water Evidence Group

In 2011, the Joint Water Evidence Group (JWEG) was set up to bring together evidence teams working on land and water issues from Defra, the Environment Agency, Natural England and the Forestry Commission, with the aim of working in a more efficient and effective manner to 'help secure a healthy water and wetland environment in England which delivers the ecosystem services required by society and helps provide resilience to climate change and other pressures'. In order to achieve this aim JWEG seeks to better coordinate land and water research and development across Defra and its network; support collaboration with a range of partners (internal and external); and identify and promote innovative ways of working, including the promotion of Evidence Reviews.

1.3 The importance of evidence to Defra and its network

Evidence is information used to support decisions. Defra and its network use evidence to develop, implement and evaluate policy, to inform our operations and services, and to demonstrate the wider value of our investments.

Evidence covers a range of sciences including economics, social research, operational research, statistics, natural science, engineering and geography. It includes research and development, monitoring and surveillance, and secondary analysis and synthesis. In order to properly address our priorities, we work together across different policy areas and disciplines to take account of the multiple social, economic and environmental factors at play.

Evidence supports all stages of the policy cycle and is an essential component throughout the decision-making process in Defra and its network. We fund evidence to:

- identify and understand potential threats and opportunities,
- inform our policy, regulatory activity and operational development and delivery (see the case study opposite on Marine Monitoring and Assessment), and
- evaluate impact and value for money of those policies and operations.

We also fund evidence to contribute directly to policy delivery by stimulating innovation and growth.

Evidence is derived from a wide range of resources and activities including:

- our specialist staff in a range of disciplines,
- independent experts,
- external suppliers, and
- the national and international science community and intergovernmental organisations.

We anticipate that expenditure on evidence in 2014/15 will be around £200m[1] across Defra and its network. Approximately 35% of this total will be on activities to meet statutory obligations. Based on expenditure in previous years, we would expect to spend around 40% of our evidence budget with external suppliers.

[1] Whilst final budget allocations have yet to be agreed, the figure above represents an estimate of the total full economic cost for evidence across the Defra Network for the year 2014/15.

Evidence produced by Defra and its network has value for others and we are committed to making our data more accessible for others to use, helping deliver the Government's commitments on transparency and open data.

The impact of evidence on policy

Marine monitoring and assessment

The UK Marine Monitoring and Assessment Strategy (UKMMAS) provides a framework for the co-ordination of marine environmental monitoring between the key UK organisations.

The strategy brings together a network made up of more than 20 organisations with wider engagement of more than 250 stakeholders. Government departments are represented, with members from Defra, DECC, MoD, DfT, DfID, plus the devolved administrations and agencies such as Cefas. Scientific and technical bodies are closely involved, including the Joint Nature Conservation Committee (JNCC), National Oceanographic Centre (NOC) and Plymouth Marine Laboratory (PML), plus universities and other research institutes.

The aim of the network is to provide an integrated and flexible framework, delivered through a series of evidence working groups which bring together these organisations and coordinates monitoring to support policy, operational and marine management decision making in an efficient way.

A recent success was in delivery of the European Commission's initial assessment programme for the first phase of implementation of the Marine Strategy Framework Directive (2008/56/EC article 12) where the UK received the top rating (http://eur-lex.europa.eu/legal-content).

Image courtesy of Cefas

1.4 Defra and its network as part of a wider evidence community

Defra and its network have developed evidence partnerships in the UK, EU and internationally; across a range of organisations including other government departments, the devolved administrations, Research Councils, business, and with academia. We also work in partnership with EU member states, for instance on EU Research Frameworks. Such relationships will become even more important if we are to continue to ensure Defra's policies and operations are informed by quality evidence as budget pressures increase and new technologies develop. This strategy signals the value Defra and its network places on further improving these partnerships and in engaging partners early on in the commissioning of evidence.

Working in partnership

Contaminant monitoring: WILDCOMS is a collaborative network that monitors disease and contaminants in vertebrate wildlife. It is made up of the various UK surveillance agencies/schemes including the AHVLA, Cefas, the Wildlife Incident Investigation Scheme, and the Predatory Bird Monitoring Scheme (run by the Centre for Ecology & Hydrology (CEH)). The aim of the network is to create more effective and efficient monitoring by facilitating collaboration between partners. It provides a coherent view across the schemes and facilitates identification of disease and contaminants of emerging concern in the environment that may affect such issues as food production or ecosystem services. Some key results of the partnership have included: better identification and a holistic view of emerging issues described in quarterly bulletins disseminated to over 400 stakeholders; more cost effective sample collection for contaminant and disease surveillance enabled through common processes and sharing of data and samples; and a role as a non-regulatory indicator measure in the Health and Safety Executive's Chemicals Regulatory Directorate UK National Action Plan for the Sustainable Use of Pesticides.

Otter picture courtesy of Heather Lowther (CEH)

Insect Pollinators Initiative: Under the Insect Pollinators Initiative (IPI) innovative research projects were commissioned to provide a basis for reducing current declines and sustaining healthy and diverse populations of pollinating insects for the future. The IPI has played a key role in shaping the development of the forthcoming National Pollinator Strategy. IPI is a partnership between Defra and four other funders: the Biotechnology and Biological Sciences Research Council (BBSRC), the Natural Environment Research Council (NERC), the Wellcome Trust and the Scottish Government. Each organisation has a different mission and remit but agreed to work together on this shared objective to fund a total of nine projects, totalling approximately £10m over five years. The majority of the projects are now coming to a close and are being used to inform policy in a number of areas including agriculture, environmental stewardship, biodiversity, natural value (ecosystems), pesticides and bee health.

2. Evidence priorities

We will prioritise our investments in evidence to maximise its impact across the wide range of responsibilities exercised by Defra and its network. We will balance statutory, applied and strategic needs and sustain critical capabilities whilst also supporting the development of new capabilities for the future.

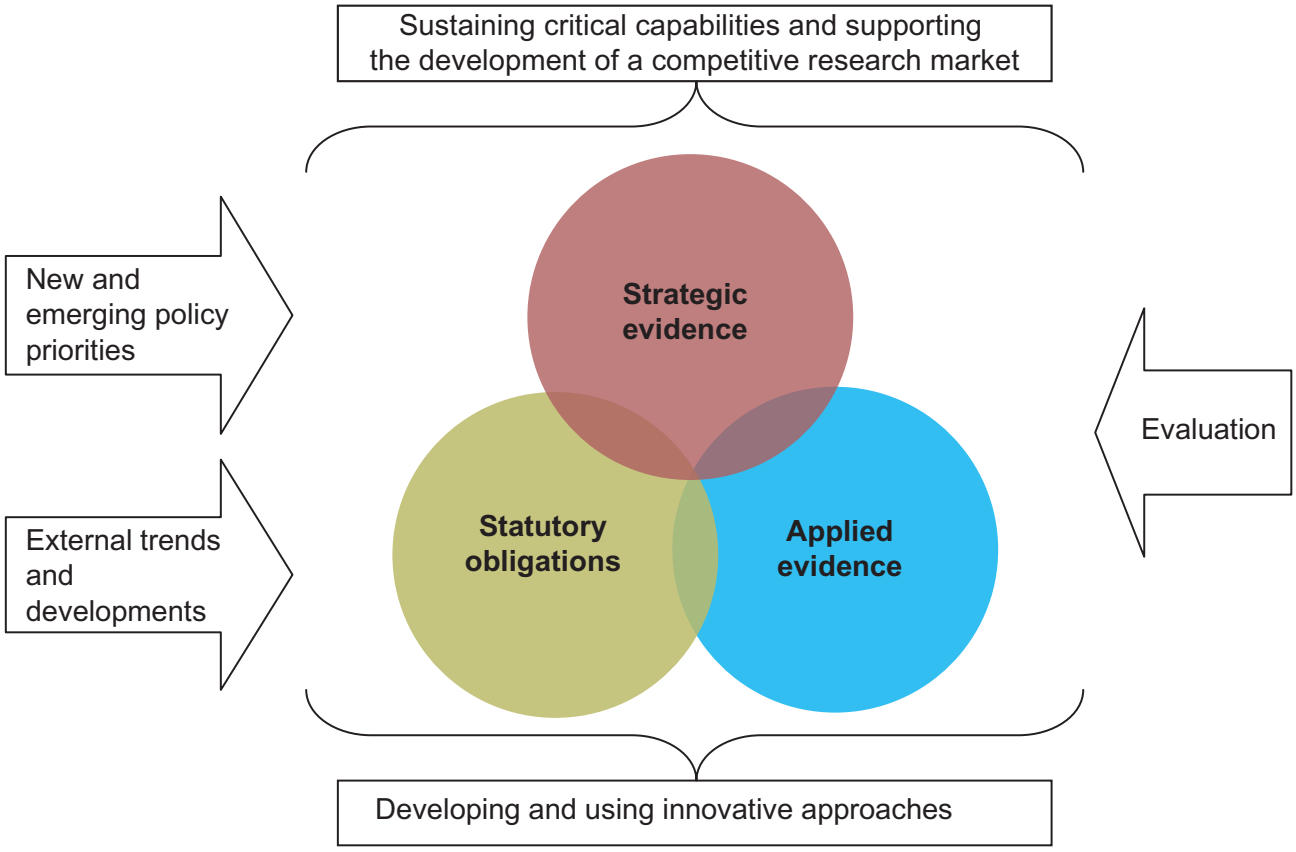
- **To maximise the value from our evidence investment, we will focus our resources on priority needs and on maintaining the critical capabilities upon which we rely** (see box opposite). We will manage our evidence work and influence others to ensure continued support for strategic activities over a longer timeframe. These will address cross-cutting or emerging issues alongside applied shorter-term activities which address policy and operational issues, and activities which deliver our statutory commitments. We will operate flexibly to identify and plan for risks and emerging issues and opportunities.
- **We have developed a new prioritisation framework which will allow us to decide where to invest in evidence, where it is for others to fund, or where we need to work in partnership. We will prioritise investments in evidence in the following ways:**
  - For **statutory obligations** – we will drive efficiencies and increase value for money in our statutory data collection. This will be achieved by seeking logistical efficiencies, applying technological and other innovative solutions, ensuring a focus on outcomes and also ensuring that, wherever possible, we use statutory data collection to add value to other activities.
  - For **applied evidence activities addressing policy and operational issues** – we will prioritise against policy and operational objectives, taking account of impact and critical capabilities. We will scrutinise the value of all potential research activities, especially the likelihood of delivering timely and useful outcomes.
  - For **strategic activities addressing longer-term, cross-cutting and emerging issues** – we will continue to support the strategic, longer-term evidence challenges that face Defra and the wider network and use external trends and developments, including the outputs from horizon scanning, to identify strategic research priorities to be pursued, especially with partners.

Prioritisation is a dynamic process with new evidence needs driven by new and emerging policy priorities and external trends and developments, including signals from horizon scanning (see figure 2 opposite). Policy evaluation can identify further gaps in our knowledge which need to be filled to improve the effectiveness of policy delivery.

Critical capabilities

Critical capacity and capabilities (e.g. expertise, infrastructure, networks and data) support Defra and its network's resilience and responsiveness to change. They can include the ability to immediately respond to emergencies; for instance in the area of animal and plant health diseases having the ability to work under high containment with dangerous pathogens, and to be able to respond to disease outbreaks of such pathogens if the circumstances arise. They can also include the ongoing production of monitoring data to meet legal obligations, or cross-cutting capabilities on which we rely to meet our policy and operational objectives. Defra needs to manage its relationship with different critical capabilities in different ways to ensure they are safeguarded but also able to improve and innovate. We will manage our critical capabilities in a strategic way through our prioritisation and commissioning process.

Figure 2: Prioritising our evidence needs



2.1 Statutory obligations for evidence

Across Defra and its network, evidence-related statutory commitments account for over one third of the evidence budget. This is mainly monitoring, surveillance and reporting requirements driven by domestic and EU legislation. **Whilst we will continue to deliver statutory commitments, we will aim to deliver them in more efficient and innovative ways, seeking to minimise activities where they do not add value.** We recognise the importance of stability to long-term data sets and will seek to optimise the overlap between statutory and other work (see case study below), maximising the value obtained from our statutory obligations including helping us spot potential emergency situations before they become critical.

Improving the efficiency of evidence utilisation

Seabed mapping

Image of *Lophelia pertusa*, copyright of JNCC

JNCC acts as the hub to bring together seabed habitat maps from across UK waters, and has developed mechanisms to utilise this evidence to meet multiple objectives. For example, for protected site identification and assessment of marine protected area networks, designing habitat monitoring programmes, assessing and reporting the environmental status of habitats, and spatial planning. This work involves UK coordination of: shared standards for data collection, analysis and interpretation; data management including agreed metadata and data formats; and development of IT solutions to create and distribute map products.

Some examples of our statutory evidence obligations are given in the boxes below.

Examples of some of our statutory evidence obligations:

Food and farming
- Monitoring of pesticide residues in food.

Sustainable economic growth in rural areas
- Monitoring and evaluation of the Rural Development Programme for England.

Marine
- Monitoring of marine protected areas, and of the wider marine environment under the Marine Strategy Framework Directive.

An enhanced natural environment
- Monitoring the state of the terrestrial and freshwater environment, its biodiversity, and water quality.

Managing our natural resources while delivering sustainable growth
- Monitoring air quality.

Greater resilience to environmental and other risks
- Work to support climate change adaptation and mitigation commitments under the Climate Change Act and UN Convention on Climate Change.

Animal and plant health
- Monitoring and surveillance of animal and plant pests and diseases.

Post-implementation reviews of regulations
- New or better applied evidence to inform how a wide range of regulations are used.

Statutory monitoring of water quality

The revised Bathing Waters Directive is designed to preserve, protect and improve the quality of bathing waters and to protect human health. In England the Environment Agency is the competent authority for implementing this Directive. Each year the Environment Agency delivers a comprehensive monitoring programme at each of the 416 designated bathing waters and reports the results to the European Commission through Defra. The results are also used to help plan and target actions to deliver improvements to bathing water quality, and make data publicly available so people can make informed decisions on where and when to bathe.

Image of bathing water sampling, copyright of the Environment Agency

2.2 Applied evidence priorities

Our applied evidence priorities are closely tied to the delivery of policy and operations and will evolve over time in response to emerging issues. Our aim is to reduce risks and maximise opportunities by bringing the most suitable evidence to bear on current priority problems and challenges. We will continue to require quality evidence across our policy and operational areas, but we will prioritise our needs to optimise their impact.

We will assess impact systematically as a function of:

- **the importance of the target policy or operational objective,**
- **the criticality of the evidence to meeting that need,**
- **the wider impacts of the evidence and the risks around evidence gaps, and**
- **the contribution of investments to maintaining critical capabilities.**

This process should help us to radically improve prioritisation across our applied evidence investments, making them better linked to policy and operational needs and giving us the flexibility to reprioritise as new issues emerge.

Our top non-statutory applied evidence priority areas are listed opposite. There is some overlap with the statutory obligations listed in section 2.1 where priorities have both a statutory element and an applied non-statutory need. Some of the applied priorities shown oppposite will contribute to more than one departmental priority, but they are shown under the main one to avoid duplication. An expanded description of these and other important applied evidence priorities is in annex A.

It is vital that our applied evidence work remains flexible and able to respond quickly to changing priorities. Whilst evidence can be important in the short-term to support operational work or policy development, the commissioning of evidence can also have an important role as a policy delivery mechanism to stimulate innovation in industry, for example through the Agri-Tech Strategy (see page 37).

Supporting growth and improving the environment are objectives we deliver in partnership with private businesses. Some evidence resource is therefore allocated to supporting innovation in the sectors which have a major impact on our objectives. We may fund this directly, in direct partnership with industry, through the Technology Strategy Board's various platforms and programmes, or working with other funders.

Table 1: Top non-statutory applied evidence priority areas grouped by current departmental priority

Growing the rural economy	Improving the environment
• Encouraging innovation and sustainable food production through the UK's Strategy for Agricultural Technologies. • Monitoring and evaluation of the Rural Development Programme for England. • Innovation in food authenticity testing to support enforcement of food labelling legislation and maintain confidence in the integrity of the food chain. • Modelling future scenarios for UK and EU agricultural markets.	• Assessing flood risk and river flow monitoring. • Supporting sustainable management of fisheries and implementation of the reformed Common Fisheries Policy. • Supporting implementation of the National Pollinator Strategy and monitoring bee health. • Valuing natural capital in order to improve future decision making – including identifying opportunities for business to develop green markets. • Integrated Water Resource Management to ensure secure, safe, sustainable and affordable water supplies and improve water quality. • Operational monitoring and R&D to assess and improve delivery of environmental resources, the state of protected sites and the wider environment. • Evaluating environmental stewardship schemes to develop sustainable land management approaches.
Safeguarding animal health	**Safeguarding plant health**
• Observation and investigation for new, re-emerging and zoonotic diseases. • Monitoring and investigation for exotic and notifiable diseases. • Surveillance and R&D to tackle Bovine Tuberculosis. • Research and surveillance activities to address antimicrobial resistance.	• Supporting implementation and evaluation of the Plant Biosecurity Strategy including development of a prioritised Plant Health Risk Register. • Informing current and future policy development on established and non-established tree pests. • Informing development and implementation of the Tree Health Management Plan. • Monitoring and surveillance for priority pests and diseases.

Applied research needs

Improving public trust in the food chain

Defra's food authenticity programme uses cutting edge science to develop robust detection methods to ensure the integrity of the UK's food supply. Some of the methods have been used to successfully identify high profile cases of fraud including detection of horse meat in meat products, added water to chicken, and fish substitution.

The programme supports a coherent set of research and surveillance activities, developing a unique 'analytical tool box' of methods for food fraud detection to help protect consumers and enable a level playing field for industry. It has developed techniques to check and verify the quality and composition of food and detect food mis-description. The programme increases consumer confidence in the food supply chain by supporting enforcement of food labelling and standards legislation and helps inform the development of policy in this area. It helps businesses comply with food law, protects honest traders from economic fraud and promotes competiveness, resilience and integrity of the supply chain.

The programme, through its collaborations both here and abroad, has ensured that the UK is a recognised world leader in the area of food authenticity and its work programme is a key contributor in the £20m EU Food Integrity project.

2.3 Strategic evidence priorities

- **Government investment in strategic evidence has an important role in helping society and business respond to current and long-term cross-cutting challenges, often in unexpected ways** (see the case study on Bluetongue below). Understanding long-term challenges is important in preparing Defra to play its role in meeting them effectively. Through `foresight' and consultation we have derived a set of key issues that we expect to confront Defra and its network.

- **We recognise the need for evidence to support the delivery of policy around the following high-level outcome areas if we are to respond to long-term challenges:**
  - **Enhanced competitiveness and environmental performance in the environmental, food and rural sectors.**
  - **Natural resources managed sustainably and equitably to promote economic growth, public health and healthy ecosystems.**
  - **Greater resilience through well managed risk, and better contingency planning and mitigation of risks associated with the natural environment.**

Against each of these outcomes we have identified a series of priority challenges where we need to work in partnership with others to define and deliver the new evidence. Interdisciplinary research across the natural and social sciences will be used to address these complex real-world problems. These areas are listed in figure 3 and a fuller description is provided in annex B.

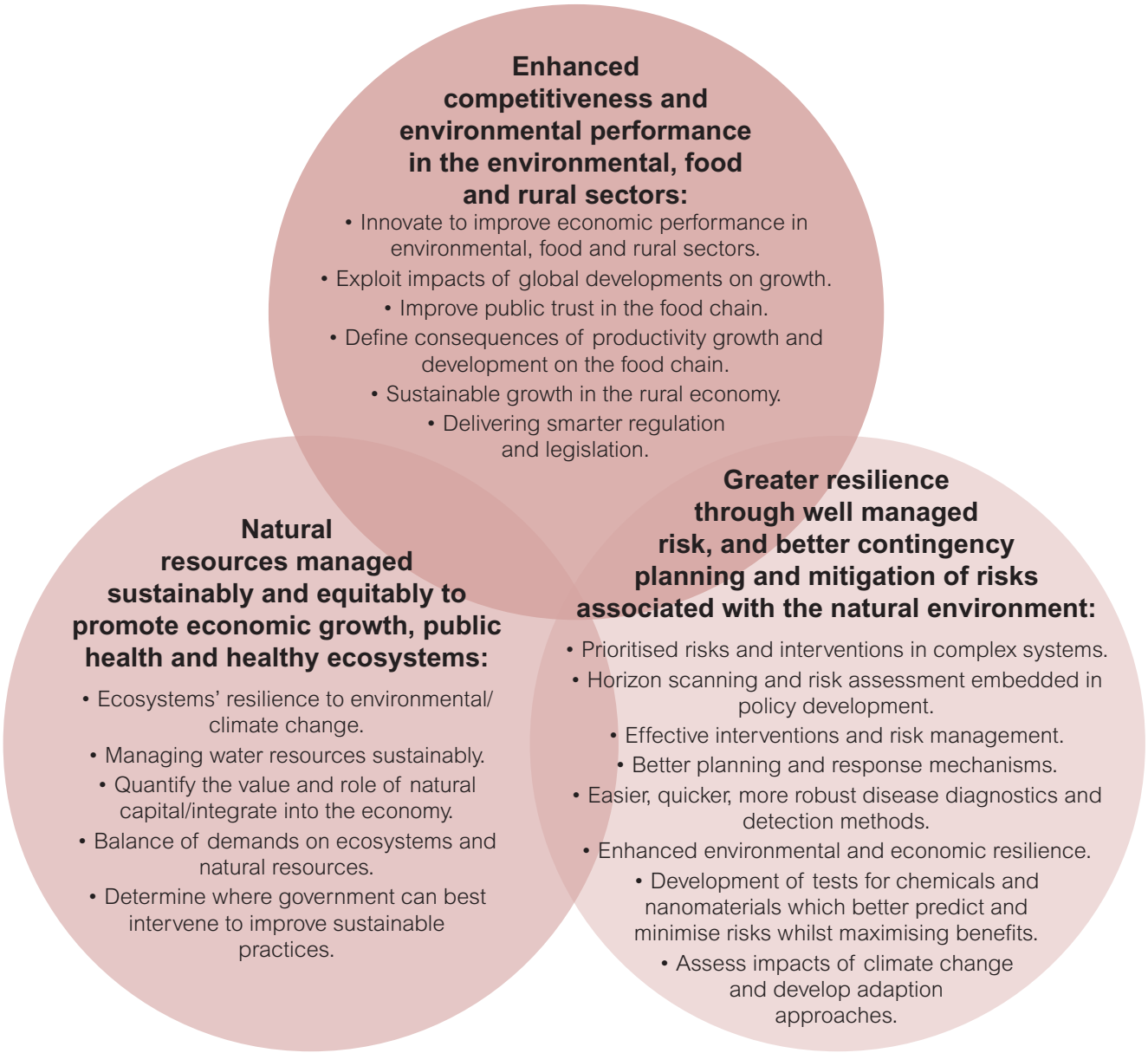
Use of strategic research to inform current policy decisions

Detecting Bluetongue outbreak risk

Livestock diseases can have a devastating impact on farmers, rural communities and the economy. Occasionally they are carried into the UK from infected areas of Europe by wind-borne midges. An early warning system has been developed which can provide a daily assessment of the risk of such disease transfer by incorporating experimental data on wind-borne transport of midges into an atmospheric dispersion model (Numeric Atmospheric-dispersion Modelling Environment or NAME). This system has successfully been used to provide advance warning of disease incursions (Bluetongue virus) as well as retrospective analysis of disease incursion (Schmallenberg virus) into the UK to predict areas where the delayed impacts would be seen and has potential application for other midge-borne diseases.

We will aim to increase the proportion of our investment in strategic evidence. Prioritisation will be used to create headroom, so that we are better prepared for the future.

Figure 3: Defra's strategic evidence outcomes and priority areas



The cross-over from applied to strategic research needs

Focus on flooding

Image copyright of the Environment Agency

The Joint Flood and Coastal Erosion Risk Management (FCERM) R&D programme conducts and promotes FCERM research and development on behalf of Defra, the Environment Agency, Natural Resources Wales and the Welsh Government. The programme is organised into three themes aligned to policy and operational responsibilities and which have Theme Advisory Groups (TAGs) containing strong representation from academics, practitioners, consultants and partner organisations. These TAGs debate and identify needs, help prioritise projects and ensure the programme remains integrated with wider national and international best practice and emerging research and analysis.

The programme contributes to meeting both applied and longer-term strategic research needs by commissioning operationally-focused studies and influencing and leveraging significant additional funding for FCERM research from Research Councils, the EU and beyond. For example in the Coastal Sediment Systems Research Programme NERC and the Joint FCERM programme members have agreed a set of shared objectives, with NERC funding the basic research elements through academic grant award, and the Joint FCERM programme members funding the subsequent translation of these outputs into user tools. The work of the Joint FCERM programme is closely aligned with the objectives of the Living With Environment Change (LWEC) partnership and its UK Flood and Coastal Erosion Management Research Strategy.

2.4 Developing and using innovative approaches to address evidence priorities

To deliver our evidence needs we foresee the need to increasingly draw on new approaches and capabilities that will help provide suitably robust answers to the policy questions and challenges of today and tomorrow. These will include cross-cutting approaches as follows:

2.4.1 Systems thinking – i.e. understanding complex environmental, economic and social systems – we need evidence to help develop new policy and operational options to address complex problems characterised by the interactions amongst social, natural and physical systems. We need to improve our ability to respond to unintended consequences on separate, but connected issues. This will be supported by operational research capability and improved use of analysis.

Embedding systems thinking and system dynamics modelling into policy design

Pilot on waste policy

In 2013, the Waste Evidence and Analysis Team led a research project to build internal capability and evaluate the use of systems thinking and system dynamics as techniques to support policy making. The project introduced these methods to a group of Defra staff, and produced systems models of the waste prevention and plastics packaging recycling systems. Systems thinking and system dynamics modelling provided a framework for structuring the problem and facilitating shared learning.

The waste prevention model consists of a qualitative system model comprising several sub-models: a stock and flow diagram representing the flow of products and materials in the economy, and seven sub-models that drive the rates of flows into and out of the stocks. The model was developed in collaboration with experts from government, industry and academia and was used to inform the first Waste Prevention Programme for England.

For packaging recycling, the visual capability of the model played an important role in facilitating the communication between policy experts and other stakeholders with the modelling team. A series of test policy scenarios were run to learn how to use it as a policy appraisal and evaluation tool. The modelling process provided a framework to collate and document data from a wide range of sources in a clear and structured way, as well as highlighting data and other evidence gaps.

2.4.2 Risk and opportunity – focused, high-quality evidence allows us to recognise emerging risks and to take the right decisions to deliver against our policy priorities. We will improve our ability to quantify, mitigate and plan for risks and explore different business models that create opportunities from them.

Climate Ready service to farmers and rural businesses

Image of farmland copyright of the Environment Agency

Climate Ready is a government programme helping businesses and public sector organisations build their resilience to extreme weather and plan for a changing climate. It does this by providing authoritative information, tools and resources to help them understand their climate risks and identify appropriate responses. The Environment Agency's Climate Ready Support Service is working with partners to raise awareness and share good practice within the agricultural and forestry sectors. For example the Environment Agency is embedding climate change advice into existing guidance for farmers and organising workshops and farm walks to make the case for action and demonstrate the benefits.

Identifying and managing the risk of plant and tree pests and diseases

Image of Citrus longhorn beetle (*Anoplophora chinensis*) courtesy of Fera

The EU plant health regime targets those pests and diseases identified as highest risk to the health of plants and trees. Defra has developed a plant health risk register which ensures we are directing risk management activity most effectively to the highest risks. The risk register is an open dynamic tool, which is updated in response to new developments by the UK-wide Plant Health Risk Group which undertakes a monthly review of threats. Potentially serious pests are subject to a detailed Pest Risk Analysis (PRA) following internationally agreed methodologies. Import inspections are based on risk-based EU targets and in addition inspections are carried out of other material focusing on those trades posing the greatest risk. Inland inspections and surveillance are also risk-based; using EU decisions, outcomes of PRA or targeting premises assessed as providing the greatest potential for distributing pests. Risk assessment feeds into the development of contingency plans and approaches to outbreak management to ensure that actions taken are correctly targeted, proportionate and effective.

2.4.3 Effective use of data and existing research – we will make better use of the data, information and knowledge we and others hold before we commission new work. We will take full advantage of "citizen science" and new social media, and make our data more accessible for others to use. We will also explore ways of handling and exploiting new large data sources or combining existing data sets to answer new questions. We will invest in knowledge exchange and brokering to ensure effective interaction between evidence providers and evidence users.

2.4.4 People and place-based thinking – we will work to ensure that our evidence is developed and presented in context, related to the relevant geographical scale and location, and the local people and relevant communities. To deliver Defra and its network's core business we need to understand the interactions between natural, social and economic factors to achieve our strategic objectives. People and place-based thinking contributes to this understanding and forms a core part of the evidence base for policy making and for operational delivery. Defra's Geography Strategy sets out how Defra and its network will share resources, specifically geographic information, data and skills to provide the best evidence for policy and delivery.

Copernicus – big data from space

Image of Sentinel-1 satellite copyright ESA/ATG medialab

In April 2014 Copernicus, the EU Environmental Monitoring Programme, entered its operational phase with the launch of the first satellite, Sentinel-1. Sentinel-1 will provide an all-weather, day-and-night supply of radar imagery of the Earth's surface. The volume of data and information produced by Copernicus will continually grow in the coming years as new satellites are progressively launched to monitor the land, the oceans and the atmosphere and the full set of the six Copernicus services become operational. Over the next two to three years, it is estimated that the satellites will deliver eight terabytes of data per day. Defra will be working closely with the UK Space Agency to ensure access to this 'Big Data' and turn it into tangible information and products in support of the delivery of our policies and operations.

Making use of geographical data to understand local impacts on communities

During the recent winter flooding, the Environment Agency's geographic data on flood extents was combined with land use data from the Rural Payments Agency (RPA), which underpins farming subsidies, agri-environment schemes and forestry schemes. This combined data was used to provide accurate and timely information on the impact and extent of flooding on agriculture and local communities.

2.4.5 Effective policy, regulatory and operations evaluation – whilst policies and operations undertaken across Defra and its network are challenging to evaluate, policy evaluation remains an integral part of our procedures and processes. The complex nature of some environmental policies, and the contexts in which they are implemented, can make it particularly difficult to identify whether environmental initiatives are being implemented as intended and having impact. We will meet this challenge by working in partnership with other government departments and academic organisations to build both internal and external evaluation capability and capacity, whilst identifying and promoting best practice in complex evaluation methodology.

Effective policy evaluation

The Catchment Sensitive Farming (CSF) Project

The CSF Project is run jointly by Natural England and the Environment Agency and aims to reduce water pollution from agriculture and help achieve EC Water Framework Directive objectives. Activities used to evaluate the project include: farmer engagement; farmer awareness and attitude; uptake of measures to reduce water pollution; pollutant losses; and water quality. Project evaluation, led by the Environment Agency, is based on data sets generated specifically for the project. It uses a combination of existing and new data analysis methods including: a database of farmer engagement and advice delivery activity; telephone surveys of specific farmers; follow-up farm visits to assess advice uptake; water quality monitoring and modelling; and case studies. Evaluation across these areas provides a clear 'weight of evidence' to demonstrate that the project is meeting its primary objectives and has helped to inform future business cases. This is reflected in the fact that whilst the CSF project was initially designed to run for two years, it is now in its eighth year.

2.4.6 Modelling and decision support – we will sustain and continually improve modelling through better model formulation and validation and invest in long-term modelling capabilities. We will ensure these deliver effective evidence which improves the value for money of public spending. We will improve our understanding of the capabilities and limits of available models, and will integrate monetary and non-monetary evidence into a holistic approach to decision making. In March 2013, the Macpherson review of analytical modelling across government made a series of recommendations. These included the need for business critical models to have robust quality assurance, effective management processes and clearly defined senior responsible owners. We have developed a plan for how we will implement these actions and have started to put measures into place, including providing appropriate resources and training.

Image of Ash Dieback *Chalara fraxinea*, *hymenoscyphus pseudoalbidus*, courtesy of Fera.

Effective modelling to inform policy and decision making

Chalara modelling

Chalara fraxinea is the fungus that causes Ash Dieback Disease. *Chalara* modelling work was conducted by Professor Chris Gilligan and his Epidemiology and Modelling Group at the University of Cambridge in 2012-13. This was designed to improve our scientific understanding of the potential spread and impact of *Chalara* and inform the development of the *Chalara* Management Plan 2013. The *Chalara* modelling work is the first time that stochastic models – which model the effects of a series of random variables – have been used in the management of an emerging disease in the plant health area. It shows the importance of strong interactions between stakeholders, biological experts, statisticians and modellers to build model-based evidence. The model outputs were discussed with stakeholders and scientists responsible for providing data and/or expertise about the disease. In addition, the model was also peer reviewed by a panel of experts to assess whether further improvements could be made. This process resulted in an open environment in which the strengths and weaknesses of the modelling work could be discussed and encouraged strong engagement of stakeholders in management decisions.

3. Improving evidence delivery

We will improve the quality, impact and value for money of evidence, whilst delivering savings, make a step change in planning and prioritisation across Defra and its network, and build closer relationships with partners and the wider evidence community.

Defra is establishing a new cross-network approach to the commissioning of evidence. Commissioning is the process by which evidence needs, and the best means of delivering them, are identified (see box on opposite page). Through this we aim to:

- **maintain and improve access to the evidence required to meet our policy and operational needs,**
- **get the most from our investment in evidence, our specialists and strategic partnerships,**
- **drive up the quality of all the evidence we use and the advice it underpins, and**
- **step up our preparedness and planning for risks and new and emerging priorities and potential threats.**

To achieve these aims we will:

- Build a balanced and flexible programme of evidence.
- Promote co-ownership, co-design and co-funding of evidence activities.
- Drive innovation and quality in the ways we access and use evidence.
- Sustain critical evidence capacity and capabilities.
- Promote and support the development of a competitive research market to drive up evidence quality and innovation and drive down costs.

3.1 Building a balanced and flexible programme of evidence

We will build a balanced and flexible proramme of evidence that responds to our changing policy and operational needs and helps identify and plan for new issues whilst supporting long-term policy development (see section 2).

The future evidence commissioning process:

The priorities set out in this strategy will be addressed through a new network-wide 'commissioning' approach to identify and meet our evidence needs. This approach will be based around a series of high-level 'Statements of Need' accompanied by a series of programme-level 'Network Evidence Action Plans'. Co-design among the network partners will be at the heart of this, bringing the network together with other funders and relevant experts. Statements of Need will provide a clear definition of needs and the Action Plans will lay out how these needs will be met. This will include:

- a prioritised set of proposed evidence activities (applied, strategic and statutory) to meet the evidence needs set out in the Statements of Need,
- a plan to manage relevant critical capabilities, and
- partner organisations who will contribute to the work, either through funding or through delivery activities.

3.2 Promoting co-ownership, co-design and co-funding of evidence activities

We will promote co-ownership, co-design and co-funding of evidence activities by working with partner organisations across the whole research community and with external experts on shared agendas, leveraging additional investment and developing smarter ways of working. We will focus on areas where Government is best placed to deliver evidence and give others the space to contribute.

Co-design

The Demonstration Test Catchments (DTCs)

Dealing with water pollution from agriculture requires an understanding of hydrology, geology, ecology, agronomy, soil science, social science and economics as well as a practical knowledge of farming systems. The interdisciplinary nature of policy questions in this area and the large-scale, long timeframe nature of the work needed to demonstrate the effectiveness of interventions has meant that policy-makers have had to work with a fragmented evidence base in the past.

Image copyright Eden DTC
(Flow gauging in the Eden DTC)

The DTCs research platform was set up in 2009 to address this. A set of large-scale 'outdoor laboratories' was established in four English river catchments to encourage researchers from different disciplines to collaborate by sharing study sites and data. DTC has brought together collaborators from around 40 organisations, multiple funders and a wide range of academic disciplines. The dialogue and partnerships established have helped researchers, policy-makers and other stakeholders to co-design a long-term interdisciplinary research agenda. At the same time, DTC has provided Defra with a sounding-board of leading academics to help rapidly answer emerging policy questions. The net result has been to provide policy-makers with more robust evidence, whilst helping researchers to identify more relevant research questions and communicate their findings more effectively.

3.3 Driving innovation and quality in the ways we access and use evidence

We will drive innovation and quality in the ways we access and use evidence by promoting innovative new ways of delivering evidence through our specialists and external experts. We will build on the many good practices across Defra and its network and our partners to encourage a culture of innovation and continuous improvement. A 'Quality Framework' for evidence across Defra and its network is currently being developed to join up the different elements of quality e.g. assurance, control, assessment, governance, corporate processes and communications. The new framework will improve accountability, visibility of quality for decision-makers and ensure consistent assessment of quality across the network through fit-for-purpose processes. The framework will launch in spring 2015 alongside a training package to build capacity and awareness of quality amongst specialists and decision-makers.

Continuous improvement and encouraging innovation

Action Based Research (ABR) Programme

Defra's ABR Programme is designed to help us understand how we can shape policy to promote sustainable innovation. The process of developing an ABR project starts with the specification of a broad set of outcome-focused research questions, for example 'how can we encourage businesses to make more sustainable products?'. The process is designed to encourage innovation by generating the broadest possible range of ideas for new projects – encouraging bids from the research community, business and civil society and promoting the development of new collaborations, for example between academics and businesses, to establish new ideas and concepts. The programme also seeks to encourage new and small enterprises to bid for projects. The projects employ a highly iterative approach based on an evaluation process that lets us identify new lessons early and feed them back into the project and directly into policy thinking. This ensures the delivery of on-going value throughout the lifetime of the project.

Continuous improvement and encouraging innovation

The Catchbox project

Catchbox is an innovative project piloting a Community Supported Fisheries model on the south coast. Under this project, communities in Brighton and Chichester formed co-operatives through which small-scale local fishermen have been able to supply weekly 'boxes' of fish directly to subscribing members. As well as testing the appetite for consumers to work with their local fishermen, and sharing both the risks and benefits faced by the fishermen, the project also provides a mechanism to create a market for under-utilised or discarded fish species. The project has improved our understanding of the technical and system-wide barriers faced by local communities and businesses wishing to adopt this type of model. The multi-disciplinary team, comprising evidence and policy specialists from across Defra, have worked closely with civil society organisations leading the work on the ground to ensure that relevant learning can be fed back directly into policy thinking. Following the research, the co-operatives have continued and new ones have begun, based on this work.

3.4 Sustaining critical evidence capacity and capabilities

We will sustain our critical evidence capacity and capabilities by mapping them to our policy and operational requirements and strategic risks, and planning for their management as part of the prioritisation and commissioning process.

Sustaining and drawing on critical capabilities

Since 2001, exotic notifiable disease outbreaks in Great Britain have included Foot and Mouth Disease, Avian Influenza and Bluetongue. By maintaining critical capability in these and other priority notifiable disease areas, we have been able to respond to these outbreaks promptly and proportionately. Value can also be seen from the recent occurrence of Schmallenberg virus, where existing capability for vector-borne diseases enabled effective and proactive advice and guidance to be given to farmers.

3.5 Promoting and supporting the development of a competitive research market

We will promote and support the development of a competitive research market to drive up evidence quality and innovation and drive down costs by opening up work to appropriate competition and streamlining and enabling innovative procurement practices. We will remain mindful of the risks of market failure (e.g. where there is only one supplier) and of the advantages of maintaining and developing in-house expertise for rapid response.

Encouraging innovation

The UK's Strategy for Agricultural Technologies

The UK's Agri-Tech strategy (a strand of the Government's Industrial Strategy) was published on 22nd July 2013. Its vision is: `that the UK becomes a world leader in agricultural technology, innovation and sustainability; exploits opportunities to develop and adopt new and existing technologies, products and services to increase productivity; and thereby contributes to global food security and international development.'

Through the strategy, the Government is investing £160 million over the next five years to improve the uptake of research into farming. This will support the establishment of:

- a £70m catalyst fund to help commercialise new agricultural technologies, co-funded with industry, and
- a £90m fund to establish world class Centres for Agricultural Innovation. Co-funded with industry, these will support wide-scale adoption of innovation and technology across key sectors, technologies and skills in the food and farming supply chain.

Defra is working with BIS, DfID, and the Technology Strategy Board to deliver these commitments in a way that supports sustainable intensification and growth in the food and farming sectors.

Encouraging innovation

The Sustainable Agriculture and Food Innovation Platform (SAF-IP)

Underpinning the Agri-Tech strategy, SAF-IP aims to stimulate the development and adoption of new technologies to help improve the productivity of the UK food and farming industries, while decreasing their impact on the environment. The innovation platform was launched in October 2009 by the Technology Strategy Board, in partnership with Defra, and the BBSRC. Over the five-year life of the innovation platform, £90m will have been invested in projects to develop new technologies. Investments are made jointly with industry and other funders in projects to develop innovative solutions to these challenges.

3.6 Next steps

This Evidence Strategy lays out what the evidence priorities for Defra and its network bodies are and the steps we will take to both improve how we deliver evidence for policy and operations and achieve better value and impact from our investment. It has been developed and co-designed with colleagues across Defra and its network, expert advisers and our strategic partners.

We greatly value the role that experts and partners have played in helping to shape this strategy. We will build on this as we implement the strategy and move to tackle the challenges we are facing by strengthening our partnerships and engaging experts and stakeholders in identifying and meeting our evidence needs and making best use of our collective resources.

We welcome further views on how we can work together to maximise the value of our collective evidence as the strategy is implemented. To discuss such opportunities and how you can get involved please e-mail: strategicevidence@defra.gsi.gov.uk.

Annexes

Annex A: Applied non-statutory evidence priorities

Applied evidence activities to meet current and emerging policy priorities have been grouped into eight priority delivery areas, under the four Departmental Priorities. These activities demonstrate the breadth of work for which Defra and its network is responsible and the link to business needs. Evidence activities often contribute to meeting the needs of more than one delivery area, but they are grouped under a headline theme for reference. We also support areas which are cross-cutting in nature, encourage partnership working or the maintenance of core capabilities on which Defra and the network may draw. The Government-wide climate information service is a good example of this. The Hadley Centre provides evidence to support cross-cutting work relevant to agriculture, marine, flooding, biodiversity, plant and animal health alongside obligations under the Climate Change Act and the provision of Climate Change Risk Assessments. Our analysis to support the Better Regulation programme also helps us to understand the impact of Defra's regulations, identify improved 'alternative' approaches, and support reform of regulation across our policy areas.

Under each theme we have given a flavour of some of the areas we will be concentrating on in the coming years and the new pressures we will be responding to. This information builds on the short list of top priorities outlined in Section 2 (figure 3) of the main strategy. It represents our higher-level priorities and may not include many activities judged essential for delivering legal obligations and operational duties. This does not mean that we will be stopping activities in areas that are not mentioned here.

Growing the rural economy – Champion a thriving, competitive British food and farming sector and drive growth in the wider rural economy

i) Supporting sustainable economic growth in the rural economy

We are responsible for supporting growth in the rural economy and do this through a number of mechanisms. One of the main initiatives is the Rural Development Programme for England (RDPE), an EU funded programme (part of the broader Common Agricultural Policy framework) for supporting delivery of rural economic growth and improving the agricultural environment. We will continue to monitor and evaluate the performance of the Programme over the next few years; both looking back at the phase that has just finished (2007-2013 Programme) and at the new programme when it starts in January 2015. Another key focus of our work will be monitoring and evaluating connectivity policies such as the Rural Communities Broadband Fund and broader roll-out of broadband in rural areas, including mobile infrastructure. We will also need to provide evidence on the drivers of rural tourism and its contribution to rural economic growth (Rural Growth Networks monitoring and evaluation).

ii) Supporting a thriving, sustainable and competitive British food and farming sector

Supporting and developing British farming and encouraging sustainable and innovative food production, will drive growth and ensure a secure, environmentally sustainable and healthy supply of food with improved standards of animal welfare. To promote sustained growth farmers, manufacturers, retailers and consumers all have a part to play in both developing new methods of production and reducing waste, reducing diffuse pollution and using resources effectively. At the same time, society needs to try to prevent the pressure being placed on the land from damaging the environment.

To achieve these aims we will work with the farming and food sector and use R&D to stimulate science, innovation and technology to drive change across the food chain to maintain a resilient and secure food supply that consumers can trust. We will support research into wider sustainable intensification practices to explore what sustainable intensification looks like, how it can be measured and how it can best be implemented across a range of agricultural systems and landscape scale catchments. In addition to supporting sustainable growth through analysis and research, we play a role in supporting innovation in the Agri-food sector. We are working in partnership with industry to deliver the UK Agri-Tech Strategy which aims to make the UK a world leader in agricultural technology, innovation and sustainability (see case study on page 37 in main strategy). To meet the objectives of the strategy we will continue to support the Technology Strategy Board's Sustainable Agriculture and Food Innovation Programme. We will ensure that genetic modification (GM) can play a part in contributing to economic growth by both arguing for a more effective and proportionate EU regulatory framework based on science and evidence, backed by strict safety controls and by promoting the UK as the leading EU bridgehead for investment in GM technology. Our research on crops to help farmers adapt to extreme weather and become more resource efficient will also contribute to this work.

We will continue to conduct annual farm surveys to provide evidence on the current and forecast economics of farming, the impact of policy proposals, and the sustainability of farming. We will provide analysis of the impacts of Common Agricultural Policy (CAP) reforms and build the knowledge base on food security, food chain resilience and sustainability. We will also fund R&D focused on environmental aspects of agriculture such as the development of new agri-environment schemes, as well as the monitoring and evaluation of the Environmental Stewardship scheme to develop sustainable land management options for the future. We will conduct R&D to support the regulatory system for pesticide manufacturers and users and will carry out monitoring and surveillance of the patterns and effects of pesticide use. This will enable us to ensure that the use of pesticides does not carry unacceptable risks and to inform the development of a proportionate regulatory regime. We will develop validated analytical methods to verify food labelling and detect food fraud to support food law enforcement to help to rebuild trust in the food sector.

Improving the environment – Manage our rural, urban and marine environments, ensuring greater resilience to environmental risks

iii) An enhanced natural environment with protection for our landscape, habitats and wildlife

We have a commitment to improve biodiversity and ecosystems. An important focus of our work is to access evidence that will help us develop new policy instruments to restore habitats, assess and maintain ecosystem services, improve the status of wildlife and address key threats such as the risk to habitats from invasive species. As part of this programme Defra and its network is leading work to develop a National Pollinator Strategy in 2014 which aims to understand and halt the decline of pollinators. This will include commitments on monitoring and other evidence needs in the coming years. We also promote international leadership on biodiversity issues through support for international initiatives and agreements on biodiversity and wildlife trade.

Defra, JNCC, Natural England, the Environment Agency and the voluntary sector monitor the terrestrial, freshwater and marine environment to understand changes within the living environment. We also have programmes looking at the state and trends of terrestrial biodiversity and protected sites. In addition, we monitor and evaluate access and engagement interventions, such as the Access to Nature Scheme to encourage more people to enjoy the outdoors and to understand how we rely on the natural environment for our wellbeing.

iv) A sustainably managed marine environment

We have a marine programme which promotes the sustainable management and use of marine resources. This aims to improve the state of the UK's marine environment and fisheries and achieve our vision for clean, healthy, safe, productive and biologically diverse oceans and seas. In addition our migratory and freshwater fisheries work aims to ensure the sustainability of freshwater fisheries through the more effective conservation of freshwater and migratory fish species and the more efficient management and regulation of activities affecting them.

One immediate and pressing evidence need within the marine environment is to support sustainable management of fisheries and the implementation of the reformed Common Fisheries Policy. This includes preparation for the introduction of the landing obligation, the achievement of Maximum Sustainable Yield and the development of an ecosystems approach to fisheries management. We are also conducting extensive work to support implementation of the Marine Strategy Framework Directive, including monitoring of the state of the marine environment, and understanding its response to both natural change and anthropogenic pressures.

Another important focus for our work in the coming years will be to provide evidence to support the development of new Marine Conservation Zones as part of our commitment to the UK's contribution to an international ecologically coherent network of Marine Protected Areas.

v) Managing our natural resources to deliver sustainable economic growth

We are working to help government and other organisations better understand and take account of the benefits we get from our natural capital in order to better manage these critical assets. We also have obligations to help to ensure that resources are used sustainably and not in a way that has a negative impact on the environment or human health.

Evidence activities we are investing in over the coming years to meet these needs include efforts to value natural capital in order to improve long-term decision making – including support for the Natural Capital Committee's identified research gaps and by identifying opportunities for business to develop green markets. We will also be investing in evidence to support activities on waste and materials resource efficiency and the move towards a more circular economy. This includes the identification and collation of data and evidence to encourage resource efficient behaviours amongst industry and the general public.

We are committed to continued monitoring and R&D programmes to assess the impacts of resource use on the environment, such as the assessment of air, water and soil quality. We will be conducting work to support implementation of the Water Framework Directive to ensure good ecological status of our waters and to better understand the fate and behaviour of chemicals in water and the environment, and study environmental aspects of new oil and gas industries including fracking. We will also support sustainable water resource management (for example through the deployment of the catchment-based approach) in order to maintain secure water supplies and the current high standards of drinking water quality. We are committed to conducting the National Forest Inventory to understand pressures on forest resources and funding ecotoxicology R&D, and chemical risk assessment and test development under the auspices of REACH (Registration, Evaluation, Authorisation and restriction of Chemicals) and the Organisation for Economic Co-operation and Development (OECD).

vi) Greater resilience to environmental and other risks

We are responsible for response to a range of environmental emergencies including flood and drought events and animal and plant health pest and disease incidences (the latter of which are covered in the next two sections). This involves maintaining response capabilities, developing rapid detection and control mechanisms, and building environmental resilience. We are also responsible for making sure that the UK is prepared for future emergencies, threats and hazards and producing evidence which underpins the threats and hazards identified in the National Risk Assessment.

One example of building and maintaining capabilities to respond to such emergencies and build resilience is our investment in the EA-Defra joint Flood Risk Management Programme - to model, map and manage flood risk on a national basis. We are also developing real time forecasting and warning methods, and helping to set construction best practice. In addition, the Environment Agency has an extensive water quantity monitoring programme to monitor river level, flow, groundwater level and rainfall for various flood and water resource management purposes.

Looking to future threats, we have a commitment to provide evidence to inform the UK's response to a changing climate by supporting the development of the national adaptation plan on a 5 yearly basis.

Safeguarding animal health – Minimise risks and increase preparedness for animal disease outbreaks, driving growth and competitiveness through high standards of animal health and welfare

vii) Assess and minimise the risks of animal diseases and prepare to manage outbreaks

We are responsible for maintaining emergency response capability for animal disease outbreaks (both terrestrial and aquatic), and building resilience within the system to avoid, protect against and react to such incidences. In the coming years we will continue to carry out monitoring and surveillance and supporting R&D to help to respond to disease threats from a range of exotic and notifiable diseases. We will also carry out monitoring for other high-risk diseases, including those that affect public health; and scanning surveillance activities for new, re-emerging and endemic diseases (including zoonotics). R&D associated with these areas will improve our preparedness and response to such threats and we will design innovative intervention and risk management approaches to pest/disease planning, management and control. These activities will include the provision of some National, European and World Organisation for Animal Health reference laboratories to support capabilities and horizon scanning of diseases of strategic importance.

Activities to support statutory surveillance activities on antibiotic resistance in bacteria isolated from animals are increasing in importance. Another main focus area in the coming years will be R&D on Bovine Tuberculosis (bTB) including oral badger vaccine development, continued development of cattle vaccines, diagnostics, and evidence to gain a better understanding of the wildlife reservoir. Work will also include epidemiology and socio-economics of bTB and control.

Safeguarding plant health – Strengthen capability to minimise and manage plant disease and pest outbreaks, with greater economic and environmental resilience to disease threats

viii) Reduced risk and impact of plant pest and disease outbreaks

We have commitments to safeguard against plant pest and disease outbreaks, and implement the recommendations of the Tree Health and Plant Biosecurity Expert Taskforce. The Plant Biosecurity Strategy sets out how we will achieve this, through the development of the prioritised Plant Health Risk Register, and supporting evidence to improve preparedness for dealing with outbreaks and build resilience into the natural environment. This work will include setting up a centre of excellence for Pest Risk Assessments - increasing our capacity to undertake the required monitoring and surveillance for plant health for priority pests and diseases and target surveillance activities at the early detection of known 'quarantine' pests. It will also include using new approaches to: detect pests through new detection and identification methods; integrate current knowledge and make pest predictions through advances in modelling; and improve sampling efficiency through the use of statistics. We will also continue to provide evidence input to inform current and future policy development on established and non-established tree pests, as well as evidence to inform development and implementation of Tree Health Management Plans, including management of Phytophthora, Ash Dieback and Oak Processionary Moth.

Annex B: Strategic evidence priority areas

Section 2 of the main strategy explained that we have worked with stakeholders to identify key drivers of change for long-term cross-cutting issues. Those drivers of change include:

- scientific and technological advances,
- economic growth and globalisation,
- increasing energy demand,
- changing governance at global and local scale,
- changes in behaviour/values and ethical stances,
- continuing environmental change including climate change and natural hazards,
- natural resource depletion,
- potential rise in invasive species, pests and disease,
- population growth and demographic change,
- innovative chemicals and materials,
- increasing pollution, and
- composite threats to food security.

We have used these drivers to identify three key outcome areas where we will focus our strategic evidence needs:

i) Enhanced competitiveness and environmental performance in environmental, food and rural sectors

A balanced and sustainable economic recovery needs all UK sectors and the wider rural economy to improve their competitiveness, to enhance their resilience to shocks, and to decouple their growth from environmental harm over the longer-term. It also requires all sectors to look for opportunities for growth from innovative efforts to enhance environmental performance and resource efficiency. Competitive, diverse and sustainable farming, fishing and food industries are particularly important to the social and economic sustainability of rural and coastal communities, which in turn also depend on sustainable tourism and other industry sectors such as water and waste. Industry needs to deliver growth that is sustainable and resilient despite a future of growing global populations, pressures on available land, water and other key resources, a changing climate and extreme weather. Other drivers include changing national and international trade patterns, geopolitical factors and demographic change. Addressing this challenge is going to need continued refinement of methods for management of our own limited land and water resources to reduce environmental impacts and waste. This can be achieved through new business models, changes to market structures, better management practices, development of skills within the sector and new technologies.

Enhanced competitiveness and environmental performance in environmental, food and rural sectors

Key evidence challenges are around the following priority issues:

- Innovate to improve economic performance in traditional and new environmental, food and rural sectors.
- Exploit the impact of global developments on UK competitiveness and growth.
- Develop approaches to predict and detect activity impacting on food chain security, resilience and integrity to maintain and improve public trust in the food chain.
- Define the consequences of productivity growth and development on competitiveness and environmental performance across the food chain.
- Target interventions to support sustainable growth in the rural economy, taking account of the impacts of societal and technological changes.
- Delivering smarter regulation and legislation.

ii) Natural resources managed sustainably and equitably to promote economic growth, public health and healthy ecosystems

Economic growth has historically been coupled with increased exploitation of natural assets as populations grow and develop, leading to the depletion and degradation of natural capital. These trends look likely to continue in the future across many natural assets unless action is taken to fully integrate natural capital into the economy.

As the Natural Environment White Paper made clear, we want to improve the quality of our natural environment across England and Wales, moving to a net gain in the value of nature. We aim to stop the decline in habitats and species and the degradation of landscapes. We will protect priority habitats and safeguard vulnerable non-renewable resources for future generations. We will support natural systems to function more effectively in towns, in the country and at sea. We will achieve this through joined-up action at local and national levels to create an ecological network which is resilient to changing pressures. Government has a role in ensuring that natural resources are managed in a way that maximises our wider wellbeing and promotes sustained economic growth, moving towards a more circular economy. We need to be able to promote technologies that support sustainable production or consumption. We will need a good understanding of consumer and business behaviours, looking at how they respond to different interventions. Correspondingly, we need the evidence to make the case for business action to invest in resource efficiency and in environmental technology. We also need to understand the distributional implications of rising resource costs, and the public acceptability of pricing the externalities associated with resource use.

Natural resources managed sustainability and equitably to promote growth, public health and healthy ecosystems

Key evidence challenges are around the following priority issues:

- Ensure recovery, adaptability and resilience in the face of change in marine, terrestrial and freshwater ecosystems.
- Manage water resources sustainably to maintain continued availability of supply.
- Support sustainable growth by quantifying the value of natural capital and integrating it into the economy.
- Optimise the trade-offs between the environmental and socio-economic impacts of demands on ecosystems and natural resources to promote sustainable growth.
- Determine where Government can best intervene to move towards a more circular economy and improve sustainable practices – based on values, practices and motivations of people, communities and businesses, and intelligence on market dynamics.

iii) Greater resilience through well managed risk, and better contingency planning and mitigation of risks associated with the natural environment

Defra and its network lead for government on the management of a range of natural and manmade risks which, when realised, can have detrimental impacts on animal and plant health, wider human and environmental health, wellbeing and the economy. These risks vary in nature from the relatively constant to less frequent but high impact events and include: risks to air, water and soil quality, food security, plant and animal pest and disease outbreaks and the threats from invasive species, chemical, biological, radiological and nuclear (CBRN) releases, and drought or flooding events. They also include the impacts of climate change, and new and emerging risks from new technologies. Such risks require careful management to ensure that the negative consequences are avoided or minimised, and that systems are resilient to future risks. We also have to ensure that opportunities arising from these risks are captured and capitalised upon. In order to achieve this we will need evidence describing both the environmental change over time and the degree to which we need to adapt our current systems and processes to deal with them. We will need to seize opportunities from emerging technologies and materials, as well as from the application of behavioural sciences to improve methods for identifying, understanding and assessing these risks and to promote innovations that will reduce them. We need evidence to support proportionate risk-based approaches, for example for pesticides, emerging chemicals and for genetically modified organisms. People and society have a significant role to play and we will need to draw on and develop the evidence base about how people's practices and behaviours can increase and /or mitigate risks e.g. through community resilience.

Greater resilience through well managed risk, better contingency planning and mitigation of risks associated with the natural environment

Key evidence challenges are around the following priority issues:

- Develop decision tools to prioritise risks and assess the cost/benefits of interventions in the face of uncertainty in complex interacting systems.
- Embed improved horizon scanning and risk and opportunity assessment in policy development and operations.
- Improve the effectiveness of interventions (drawing on behavioural science), and of risk and opportunity management approaches.
- Deliver better planning and response mechanisms – based on understanding public and business responses to environmental risks and controls.
- Develop easier, quicker, more robust disease diagnostics and detection methods.
- Enhance environmental, social and economic resilience in the marine, terrestrial and freshwater environment.
- Development of intelligent (or targeted) ecotoxicological approaches for chemicals and nanomaterials, which can better predict and minimise risks and maximise benefits whilst replacing, refining and reducing the use of animals in research.
- Assess the impacts of climate change and develop and evaluate adaption approaches.